ISSN: 2362-1036

3rd International Conference on AGRICULTURE AND FORESTRY 2016

"Sustainable Agriculture and Forestry as Essential Response to the Challenges of Global Food Security and Environmental Stability"

CONFERENCE PROCEEDINGS

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1st – 3rd, June, 2016

Manila, Philippines

Committee of the ICOAF - 2016

The International Institute of Knowledge Management (TIIKM)

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Official website of the conference

www.agroconference.com

Conference Proceedings of the 3rd International Conference on Agriculture and Forestry (ICOAF) 2016

Edited by Dr. Romeo C. Clemente and Others

ISSN: 2362-1036

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Published by The International Institute of Knowledge Management (TIIKM)

Tel: +94(0) 11 3132827

Fax: +94(0) 11 2835571

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Table of Contents Page No

Proceedings of the 3rd International Conference on Agriculture and Forestry, Vol. 2, 2016, pp. 1-6
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ISSN: 2362-1036 online
DOI: https://doi.org/10.17501/icoaf.2016.2101

THE GOAT TECHNOPRENEURIAL LEARNING PROJECT (TLP) OF THE NUEVA VIZCAYA STATE UNIVERSITY

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Abstract

This development project was conducted to increase enrollment and enhance the entrepreneurial capability and employability of AFNR students and graduates of SUCs in Region II and Region III through an alliance of learning of CLARRDEC and CVARRD. Specifically, it aimed to: 1) foster an intra and inter-regional/institutional alliance of learning in CLARRDEC and CVARRD; 2) enrich/develop and implement industry-responsive and harmonized curricular and short-term training; 3) enhance students' learning environment through upgrading of facilities and establishment of income generating projects; 4) improve the technical and entrepreneurial skills of AFNR students and graduates towards gainful employment and enterprise development; 5) establish linkages/partnership with the public-private sector; and 6) institutionalize the consortium alliance, enriched curriculum, income generating projects and public-private sector partnership to ensure sustainability of the initiated projects. Based on the results of this project, the following are recommended: shift from production of slaughter goats to breeder goats, upgrading of breeder stocks; shift from complete confinement to semi-confinement method; pasture development by planting legume trees along fences and planting of improve grasses and legumes; linkages with government agencies, goat and sheep producers' associations and entrepreneurs; conduct of the Goat Production and Entrepreneurship Training; and impact assessment study.

Keywords: maximum development project, industry-responsive, consortium, entrepreneurial

INTRODUCTION

Enrollment in agriculture, forestry and natural resources (AFNR) courses in State Universities and Colleges (SUCs) in the whole country has dwindled. This has been the trend not only in the Philippines but worldwide due to decrease in job opportunities for AFNR graduates and the decreased contribution of AFNR to the Gross National Product of the country for the last three decades.

It can be observed as well that the agriculture and agriculture related programs in the SUCs had become variable in academic quality, with insufficient attention on gaining practical skills towards entrepreneurship and often lacked relevance to industry needs. Given the situation, there is a need to strengthen institutional capability for quality education that will require improved professional capacities, responsive curriculum and upgrade present facilities, hoping that this would reverse the downtrend in enrollment and provide opportunities for more students to gain practical knowledge and skills towards entrepreneurship and gainful employment. The situation was addressed immediately and collectively. This included finding solutions and innovations to increase enrollment and employability and creating a generation of entrepreneurs, so as not to threaten the very existence of these SUCs. Building an intra and inter-regional/institutional alliance is a novel approach to collectively respond to the challenges in the spirit of partnership, complementation, cooperation and collaboration.

The consortium alliance of Central Luzon Agriculture and Resources Research and Development Consortium (CLARRDEC) and Cagayan Valley

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Agriculture and Resources Research and Development (CVARRD) exercised resource complementation, sharing of valuable information, experiences and best practices. The concerted effort capitalized on member- SUCs expertise and comparative ad-vantage in academics, science research, technology development, and testing, assessment, and development of products. The consortia proceeded in a unified effort of effectively utilizing resources, science-based technologies, multitude of progressive interventions, taking advantage of enhancing curriculum, building capacities, establishing income generating projects (IGPs), upgrading facilities, and building public-private sector partnership with the view of institutionalizing these efforts to ensure continuity and achieve the project goals and objectives.

The Nueva Vizcaya State University Small Ruminant IGE (Income Generating Enterprise) was a common venue for laboratory classes for the Animal Science and Animal Production subjects offered by the College of Agriculture. Thus, the establishment of the Technopreneurial Learning Project on Goat was crucial to the University's performance of its vision and mission as Center of Excellence.

Generally, this development project was conducted to increase enrollment and enhance the entrepreneurial capability and employability of AFNR students and graduates of SUCs in Region II and Region III through an alliance of learning of CLARRDEC and CVARRD. Specifically, it aimed to: 1) foster an intra and inter-regional/institutional alliance of learning in CLARRDEC and CVARRD; 2) enrich/ develop and implement industry-responsive and harmonized curricular and short-term training courses on AFNR;3) enhance students' learning environment through upgrading of facilities and establishment of income generating pro-jects; 4) improve the technical and entrepreneurial skills of AFNR students and graduates towards gainful employment and enterprise development; 5) establish linkages/ partnership with the public-private sector; and 6) institutionalize the consortium alliance, enriched curriculum, and public-private sector partnership to ensure continuity of the project efforts.

METHODOLOGY

Conceptual Framework

The conceptual framework of the fundamental elements and components of the project is shown in Figure 1.

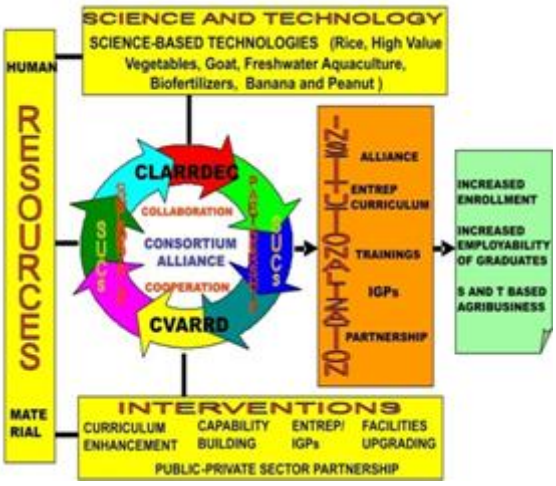

Figure 1 Conceptual framework of the fundamental elements and components of the project.

The utilization of resources, science and technology, and direction of interventions by the alliance of CLARRDEC and CVARRD enhanced the potential of institutionalization and meeting the project's goals of increasing the enrollment and employability of AFNR students and graduates of NVSU, as well as creating successful entrepreneurs of Science and Technology based agribusiness. Central to the implementation of the project was the intra and inter-regional/ institutional alliance of CLARRDEC and CVARRD. Member SUCs shared knowledge and information, learned from each other's best practices and approached challenges together in an environment of partnership, complementation, cooperation and collaboration thru visitations and consultative meetings. The existing resources of SUCs, both human and physical, as well as the funding support from DOST/PCARRD were tapped in order to bring about development of science-based technology for goats as well as technologies on hybrid and aromatic rice, high value vegetables (tomato and onion), freshwater aqua-culture, bio-fertilizers, peanut and banana which are other components under the consortium alliance.

This study was conducted mainly to establish a goat technopreneurial learning project (TLP) at NVSU. Other interventions included enhancing curriculum, building capacities, upgrading facilities, and building public-private sector partnership. Curriculum enhancement strengthened academic programs by integrating entrepreneurship with industry focus. Capacity building focused on faculty, staff, students and graduates development by providing them enriched curriculum design, R & D support, upgraded facilities and educational training to hone their technical and managerial skills. Upgrading of facilities focused on improving the learning environment for NVSU which was beneficial in enticing more students to enroll. The Goat TLP demonstrated the viability of science-based agricultural technology and served as training venue for students', graduates', and farmers' acquisition of technical and entrepreneurial skills necessary for starting their own businesses.

RESULTS AND DISCUSSION

Accomplishments

TLP Implementation

The Goat TLP started implementing activities with the purchase of one full-blood Boer Buck, 25 native and upgraded does (Anglo-Nubian and Boer) and six kids which were sourced from three goat farms in Nueva Vizcaya and one farm in Isabela from January 20 to 23, 2010 for ₱80,000.00. The project produced 27 kids, bought on loan one Anglo-Nubian Buck and sold 16 goats. However, due to inclement weather and diseases, 14 heads died including the Anglo-Nubian Buck. As of May 31, 2011, there were18 does, 4 buck and replacement bucks, and 8 kids valued at a total of ₱76,000.00 (Table 1).

Table 1: Inventory report from January 23, 2009 to May 31, 2011

Classification	Beg. Inventory		P	M	S	U	End. Inventory	
	Qty	₱	Qty	Qty	Qty	Qty	Qty	₱
Does	14	38,000	0	0	6	5	13	40,000
Replacement Does	7	20,000	0	0	2	-3	2	6,000
Buck	1	12,000	1	1	0	0	1	18,000
Replacement Buck	0	0	0	0	1	2	1	3,000
Doeling	5	5,000	0	3	1	2	3	3,000
Bucklings	2	2,000	0	1	3	4	2	2,000
Buckkids	0	0	14	3	0	-5	6	3,000
Doekids	0	0	13	6	0	-5	2	1,000
Culled Does	3	3,000	0	0	3	0	0	0
Total	32	80,000	28	14	16	0	30	76,000

Legend: P - produced or procured; M - mortality; S – sold

Curriculum Enrichment

Six curricular offerings of the College of Agriculture and College of Human Ecology were enhanced such as BSA, BAS-DVM,BSAB, DAT-BAT, BSHT and BSHM. Entrepreneurship is part and parcel of these curricula and hands-on class activities were undertaken to enable the students to experience owning and managing their classroom enterprises. The TLP on Goat has been incorporated in the syllabi as venue for laboratory activities in the different courses, and as a training ground for field practice, internship and on-the-job training for CA students.

Training Design and Module Preparation

Seven SUCs implementing TLPs on goat have prepared a common training module for Goat Production and Entrepreneurship. This has been used by the Goat TLP for the three trainings it had conducted and for future trainings to be conducted.

Facilities Enhancement and Equipment Purchased

NVSU fulfilled its commitment to share in funding this study (Goat TLP) by constructing the goat house costing ₱159,588.00 (₱95,032.58 cash purchases and

₱64,555.42 non-cash expense) from its capital outlay in 2009. The fence surrounding the five-hectare forage area has been repaired from which one hectare has been planted with improve grasses, such as Napier (*Pennisetum purpureum*) and Guinea grass (*Panicum maximum*), at a cost of ₱63,370.00 from both the AFNR and NVSU funds. The water and electrical facilities, which were tapped on NVSU system, were enhanced from AFNR funds amounting to ₱9,850.60.

An old motorcycle of the University was re-paired and fabricated with sidecar to facilitate hauling of cut grasses especially to distant area adjacent to the project. Dial-type hanging scale, wheelbarrow and rakes were purchased. All in all, NVSU has spent ₱175,568.00 while ₱84,889.60 of AFNR were used for facilities enhancement (Table 2).

Table 2: Facilities enhancement and equipment purchased from January 1, 2009 to May 31, 2011.

Item	Source and Amount (₱)		
	AFNR Budget	SUC Counterpart	Total (₱)
Goat House		159,588.00	159,588.00
Fence & Pasture	49,660.00	13,710.00	63,370.00
Water System	13,268.60	0	13,268.60
Electrical System	6,582,00	0	6,582,00
Tricycle	11,879.00	0	11,879.00
Weighing Scale	3,500.00	0	3,500.00
Wheelbarrow	0	1,950.00	1,950.00
Rake	0	320.00	320.00
Total	84,889.60	175,568.00	260,457.60

Trainings Conducted

The first training was conducted on March 5 & 6, 2010 at the NVSU Dumlao Farmers Training Center (DFTC) and the AFNR Goat TLP. The training was designed for students and was announced three weeks in advance even in University Radio. Seventy-three students signed-in but 103 were actually registered and attended the said first training. The first batch was 99 students, 1 AFNR alumnus, 1 farmer/goat raiser, and 2 budding entrepreneurs are the participants. The proceedings for the training were finished.

A shortened training was conducted on March 23, 2010 to accommodate the request of the members of the LGU of Rosario, La Union. There was a briefing on the goat industry (including its prospects), lectures on goat production management practices, and a visit to the NVSU-AFNR Goat TLP. It was attended by 127 local government officials and employees of the said LGU.

The second training was conducted in May 7 & 8, 2010 at the NVSU Dumlao Farmers Training Center (DFTC) and the AFNR Goat TLP. The training was designed for graduates of AFNR, farmers and entrepreneurs. It was announced over the University Radio Station 96.5 UFM for one week and thru the Municipal Agricultural Officers of Aritao, Bayombong, Bambang, and Solano. Members of the Abian-Abinganan Goat Raisers' Association and the Nueva Vizcaya Small Ruminant Raisers' Association were also informed about the said training. However, only 10 farmers and members of the said associations were able to participate due to previous commitment related to election that coincided at that time.

The third and last training was conducted specifically for the members of the two above-mentioned associations and for AFNR graduates on August 12 & 13, 2010. Forty clients were trained which include 23 AFNR alumni, 7 DA employees, 4 AFNR students, and 6 farmer-entrepreneurs involved in goat production.

After the last training, it was summed-up to have 308 trainees on the over-all. It is actually consisted of 125 AFNR students, 30 AFNR alumni, 135 LGU officers and employees, and 18 farmers, trainors and project staffs (Table 3).

Table 3: Trainings conducted and participants immersed from June 1, 2009 to May 31, 2011.

Title and Date ofTraining/Immersion	Number of Participants							
	Faculty & Staff		Students		Alumni		Other Clients	
	T	A	T	A	T	A	T	A
Goat Production and Entrepreneurship Training								
March 5-6, 2010		3		99		1		3
March 23, 2010		0		0		0		108
May 7-8, 2010		8		22		6		18
August 12-13, 2010		7		4		23		6
Total	3	18	40	125	30	30	38	135
OJT, Practicum, etc.	0	0	40	79	0	0	0	0

T – Target A- Actual

Immersion of Students, Alumni and Other Clients

The project served as laboratory for students in conducting relevant activities in goat production and management. Seventy nine (79) students had undertaken Field Practice, Occupational Internship Program (OIP), Practicum and Student Assistantship, and other goat management practices.

Linkages/Partnerships

The NVSU Goat TLP has established linkages with CLSU-SRC and CVHILROS as sources of technical assistance forage seeds and other planting materials, and other resources in support to the project. The Office of the Provincial Veterinarian has also provided some of the veterinary medicines (vaccines, dewormers, etc.) used in theTLP. Linkages of the TLP manager with the Abian-Abinganan Goat Raiser's Association, Inc. and the Nueva Vizcaya Small Ruminant Raisers' Association were strengthened with the conduct of the Goat Production and Entrepreneurship Training with some members of the two associations. Some LGUs of the province were tapped to recommend interested farmers and entrepreneurs on goat production (Table 4).

Table 4: Linkages of the project from June 1, 2009 to May 31, 2011

Agency/Institution	Nature of Linkage
Cagayan Valley Hillyland Research Outreach Station (CVHILROS)	• Training and technical assistance • Source of breeder, seeds & forages
CLSU – Small Ruminant Center	• Training and technical assistance
NV Provincial Veterinary Office	• Source of free veterinary medicines
Abian-Abinganan Goat Raisers Association	• Partner in production training • Source of industry information
NV Small Ruminant Raisers Association	• Partner in production training • Source of industry information
LGU of Rosario, La Union	• Client in goat production training
LGU of Aritao, Dupax del Sur, Dupax del Norte, Bambang, Bayombong, Sta. Fe & Quezon	• Partners in production training

SUMMARY AND RECOMMENDATIONS

Summary

The overall effect of the study on enrollment can be measured only indirectly after the effects of the intervening factors between the establishment of the TLP and enrollment in Agriculture, Forestry and Natural Resources are identified and quantified. However, the summary of findings and observations on the specific outputs of the NVSU Goat TLP are as follows:

1. The CVARRD and the CLARRDEC consortium alliance was established and functioned.
2. Six curricula were enriched with 120% accomplishment over target.
3. An entrepreneurial-based training manual was written by TLP Managers of seven SUCs implementing the establishment of goat TLPs, for a 100% accomplishment.
4. NVSU was able to establish its Goat TLP for a 100% accomplishment.
5. The Project enhanced its 5 hectare facility by building a goat house, which was the university's counterpart, improved its forage area, and purchased facilities that supported the TLP for a 100% accomplishment.
6. The TLP conducted training of 125 students, 30 AFNR graduates and 153 other clients for a 280% accomplishment over target number.
7. It has forged linkages and partnerships with government agencies, goat and sheep organizations, and entrepreneurs for a 100% accomplishment.
8. It institutionalized the TLP by turning it over to the University Business Affairs Program for sustainability.

RECOMMENDATIONS

The NVSU Goat TLP was established primarily to serve as avenue for trainings and a showcase of viable technology in goat production and entrepreneurship. Thus, inherent in this is the capacity to generate income to sustain the project. With the building and facilities, stock and management structure in place, the operational problem can be solved with the following:

1. Shifting from production of slaughter goats to breeder goats thus continued upgrading of breeder stocks.
2. Shifting from complete confinement to semi-confinement method of production.
3. Continued forage area/pasture development by planting legume trees along fences and planting of improve forage grasses and legumes.
4. Continued linkages with government agencies, goat and sheep producers' associations and entrepreneurs.
5. Continued conduct of the Goat Production and Entrepreneurship Training.
6. Conduct of impact assessment study.

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Proceedings of the 3rd International Conference on Agriculture and Forestry, Vol. 2, 2016, pp. 7-24
Copyright © TIIKM
ISSN: 2362-1036 online
DOI: https://doi.org/10.17501/icoaf.2016.2102

FEASIBILITY STUDY BUILDING MATERIAL OF SOIL PEAT CENTRAL KALIMANTAN

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Abstract

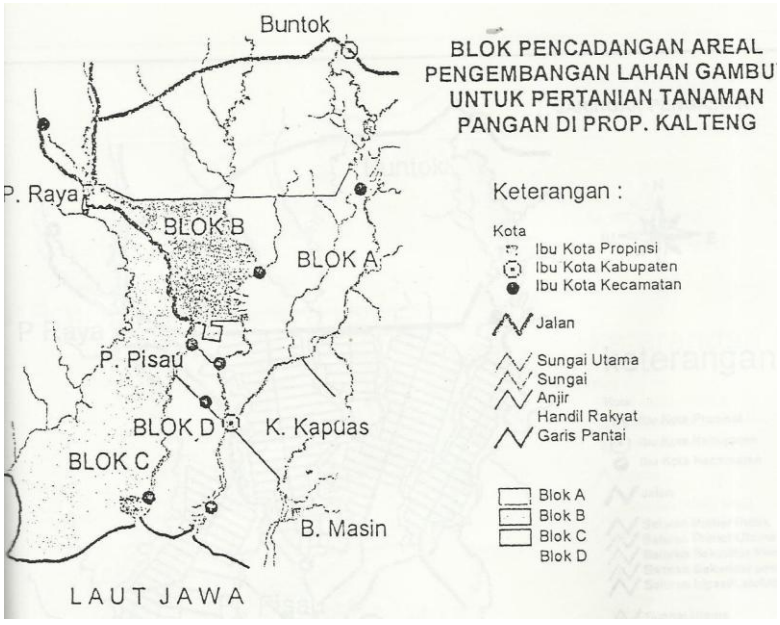
I have done research about using soil peat from Central Kalimantan as local building material in making red brick and tile ceramic, conclude : (a) Potency building material from mining material group C shaped soil peat generally stock enough and from 6 (six) sample that tested in laboratory as red brick and ceramic tile, fulfill technical requirements based on characeristics ; (b) Potency building material from mining material group C shaped quartz sand stock enough and can utilized as mortar plester ; (c) Location has choosen unit production red brick and ceramic tile that can developed technical ways is Lamunti, Palem Bahem, and Pulau Telo ; (d) Potency building material shaped soil peat stock enough and can utilized as red brick and tile ceramic, still need to do trial test production in field, that is means society around can spare transfer technology so hopefully can grow and develop new industries ; and (e) Utilization building material sand as building material, need to do testing in laboratory first before used.

This research is to continue that research result, by calculate how much the cost was needed to produce red brick and tile ceramic from soil peat Central Kalimantan, that cost will be cheaper or more expensive, compare with the cost of red brick and tile ceramic that have been sold in market.

This research also to calculate feasibility study if that red brick and tile ceramic from soil peat Central Kalimantan was produced by mass.

Keywords: feasibility study, red brick, tile ceramic.

INTRODUCTION



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Province Central Kalimantan have wide area 153.564 km^2 with geography position between 0'45° North Latitude and 3'30° South Latitude and between 111°-115° East Longitude contains 14 district and 1 sub district /city. Specifically, Project Development Peat Area 1 million hectare area block A and B is in District Kapuas (38.400 km^2), District Pulang Pisau (8.997 km^2) and District Barito Selatan (12.664 km^2).

Any location taken sample clay that possible can developed technical or economical way :

Transmigration settlements SP-2 – SKP-A, sub district Dadahup (area A), that is towards headwaters Kapuas river, sampling soil peat ± 10 m from river-bank with depth ± 1 m above land level, transportation can go through as long as 2 hours from Kapuas city by speed boat.

Sub district Lamunti (area B), that is towards headwaters Kapuas river. Sampling soil peat ± 50 m from river-bank with depth ± 1 m under soil peat level, can go through as long as 2 hours from Kapuas by speed boat.

Village Palem Bahem (area D), Village Pangkuh – sub district Pandihbatu, that is towards downstream Kapuas river also sampling soil peat ± 50 m from river-bank with depth ± 1 m under soil peat level. Time to go to that location as long as 3 hours from Kapuas regency by speed boat.

Village Buntoi, village Pulang Pisau – sub district Kahayan Hilir, that is towards downstream Kapuas river. Sampling soil peat ± 150 m from river-bank with depth ± 1 m, time to go to the location need 1,5 hours from Kapuas by speed boat.

Sub district Kahayan Hilir – Pulang Pisau (area F) – village Gohong – km 7 from Pulang Pisau, sampling ± 400 m from bridge Palangkaraya.

Village Kahayan also taken 2 sample soil peat with kinds black soil peat and reddish white soil peat.

Potency sand generally be found at stream flow Kapuas river. Sampling sand from location mining in stream flow river be located in village Keladan, sub district Mentangai. Mining method sand that be in the bottom of the river sucked by pump at depth ± 6 m. Capacity production mining ± 60 m^3 /day by boat.

To go to location mining need time ± 2 hours from Kapuas regency by speed boat. Result mining sand carried to Kapuas city.

The sand used as mortar, concrete, conblock, paving block, etc.

Location exploition Barito river be in a place 100 m from side of the highway – village Hilir Sper – village Kampel – South barito. In 1 day produce 1 ½ m^3 sand. Before sold the sand gradation done sieve using sieve 0,5 cm.

METHODOLOGY

This research is to calculate feasibility study red brick and tile ceramic from soil peat Central Kalimantan was produced by mass.

RESEARCH RESULTS

Only soil peat from Pulau Telo that have SiO_2 content 51.79 %, include category clay. Soil peat from other location still under limit content SiO_2 that required for clay. But the value almost same, means soil peat from other location also have chemical characteristic closer to clay.

Soil peat from six location have chemical content Al_2O_3, Fe_2O_3, CaO, MgO same with chemical content of clay.

Soil peat from Palem Bahem and Pulau Telo have SO_3 content 0, same with chemical content clay. Soil peat from Dadahup, Lamunti, Handel Usang, and Buntoi have SO_3 content above SO_3 content of clay.All sample soil have dry shrinkage value between 8 % - 11 %, so include category soil very sensitive to drying, so need special treatment on process drying after produce by no crack and no break of production results.

Similarly from test results on sensitivity value to drying /DSE 3 sample have DSE value between 1 – 2 and 3 sample soil peat have DSE value above 2, than sample soil taken in general can categorized sensitive to drying.

Test results to index plasticity value shows that 2 sample have IP value between 20 % - 30 % and 4 sample soil above 30 %, than the sample soil include plastis and very plastis loam.

Based on analysis large grain was described in diagram Winkler, generally the sample soil can be described as material ceramic tile and red brick.

While based on flexure strength dry condition whole sample soil have flexure strength above 10 kg/cm^2 so generally have base strength good enough.

Next done fire test with various temperature, that is 800˚C, 850˚C, and 900˚C to know temperature maximum or burning temperature was needed so obtained best results by flexure strength was obtained from sample test after burned.

From the testing founded optimal burning temperature, that is 900˚C with result optimal flexure strength and fulfill technical requirements of sample test to all location.

From sample soil peat was taken from the field, next doing test to make tile ceramic and red brick to know technical properties as base its development.

From testing result of soil peat, obtained data :

Shape tile ceramic : curve flat type M-20 ;

Table 1. Nominal size tile ceramic

Size	Total	Utilized	Hook
Length, cm	32,2	24,2	3,2
Width, cm	23,5	20,0	1,5
Wide, cm	1,45	-	0,8
Weight, kg	2,5	-	-

Water absorption : not absorp.

Tile curve flat is tile with cross section middle part flat and the sides curved.

Tile ceramic for whole quality level must resistance to water absorption. At testing water absorption, water can not dripping from bottom part of tile in less than 2 hours.

Tile ceramic of soil peat resistance to water absorption or not absorp water, because at the time testing water absorption, water not dripping from bottom part of tile in less than 2 hours.

Requirements size of tile ceramic according to SNI 03-2095-1991 “Quality and test method tile ceramic” :

Table 2. Size of tile ceramic

No.	Description	Tile Ceramic			Explanation
		Small	Medium	Large	
1	Length utilized (reng distance, mm)	200	250	333	Penyimpangan
2	Width utilized, mm	200	200	200	
3	Distance cover longitudinal, min, mm	40	50	67	
4	Distance cover transverse, min, mm	40	40	40	
5	Hooks : Height, mm Length, mm	 10 30	 10 30	 10	

No.	Description	Tile Ceramic			Explanation
		Small	Medium	Large	
	Width, mm				

Tile ceramic of soil peat have medium sized.
Shape red brick : rectangular (massive) with nominal size :
Length, cm 19,4 ; wide, cm : 4,8
Width, cm 9,7 ; weight, kg : 1,5

Table 3. Characteristics of red brick[)]

No.	Location	Water Content Average (%)	Water Absorption (%)	Furnace Absorption (gr /dm^2 /minute)	Density	Pressure Strength Average (kg /cm^2)	Salt Content
1	Lamunti	0,34	19,16	58	1,68	27,62	No
2	Palem Bahem	0,48	17,96	50	1,70	23,27	No
3	P. Telo	0,34	18,51	42	1,68	-	No

Outside view red brick of soil peat must have sides that sharp and angle, the field of flat side not indicate any crack and changing the form of excessive.

Red brick size according to SNI 15-2094-1991 : [7)]

Length : maximal 240 mm and minimal 230 mm.

Width : maximal 15 mm and minimal 110 mm.

Height : maximal 52 mm and minimal 50 mm.

Pressure strength red brick must fulfill requirements according to SNI 15-2094-1991 "Quality and test method red brick massive" :

Quality Level	Average Pressure Strength (kg /cm^2)
I	> 100
II	80 - 100
III	60 - 80

Red brick of soil peat have average pressure strength very low, not fulfill requirements SNI 15-2094-1991, under average pressure strength quality III. To increase average pressure strength red brick of soil peat, must go through combustion process beforehand.

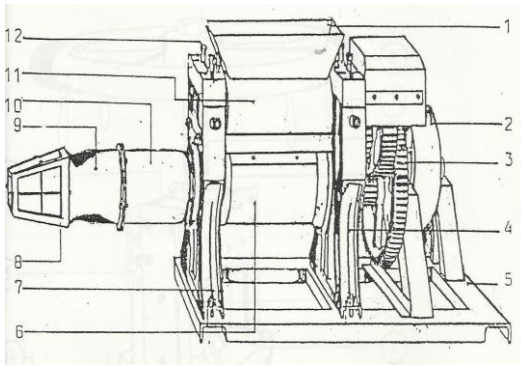
Salt content can not show signs that according test result represented hazard, that is if the red brick soaked in water with standing position half soak, for at least 3 days, has seems white spots on the surface.

If less than 50 % called not hazard, but if more than 50 % hazard.

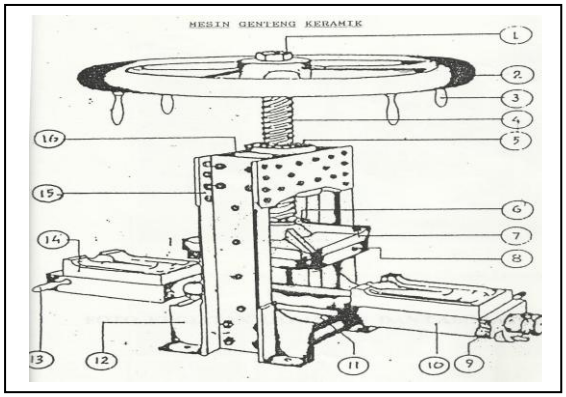
Red brick of soil peat does not contain salt content, so not hazard.

ANALYSIS AND DISCUSSION

Machine was used in making red brick and tile ceramic :



Extruder, machine to make red brick



Machine to make tile ceramic

ESTIMATION INVESTATION AND COST PRODUCTION RED BRICK

List Price Unit Tools Production Red Brick

Capacity : **288.000** **pieces/year**

960 **pieces/day**

No.	Kind of Tools	Quantity	Unity	Price Rp.	
				Unit	Total
1	Extruder machine	2	Unit	20.000.000,00	40.000.000,00
2	Mixer machine	1	Unit	20.000.000,00	20.000.000,00
3	Tool assist	1	Unit	5.000.000,00	5.000.000,00
				T o t a l	**65.000.000,00**

Total Machines and Tools **= Rp.** **65.000.000,00**

Depreciation per year **= Rp.** **6.500.000,00**

Depreciation per piece product **= Rp.** **22,57**

Investation Unit Production Red Brick

Capacity **288.000** **pieces/year**

No.	COST OF INVESTATION	PRICE (Rp.)
1	TOOLS PRODUCTION RED BRICK	65.000.000,00
2	COST INSTALLATION ELECTRICITY AND WATER	5.000.000,00
3	LAND FACTORY & CONCESSION (250 m2)	125.000.000,00
4	BUILDING PRODUCTION (125 m2)	125.000.000,00
5	EQUITY WORK 3 MONTHS	54.000,00
	TOTAL INVESTATION	**320.054.000,00**

Source Payment

Credit bank **75 %** **240.040.500,00**

Self equity	**25 %**	**80.013.500,00**
T O T A L		**320.054.000,00**

Estimation Cost Production Red Brick

Capacity : 288.000 pieces/year

Salary worker

No.	Explanation	Salary/month (Rp)	Worker	Total Salary (Rp)
1	**Direct Salary**			
	Worker	1.700.000,00	3	5.100.000,00
	Assistance	1.500.000,00	3	4.500.000,00

Direct Salary

Salary/month	Rp.	**9.600.000,00**
Salary/year	Rp.	**115.200.000,00**
Allowance 1 Month Salary	Rp.	**9.600.000,00**
Total Salary & Allowance	Rp.	**124.800.000,00**
Salary & Allowance/piece	Rp.	**433,33**

Estimation Cost Production Red Brick

Capacity Production : **9.600** pieces/10 days
Mixture composition 1 : 3
Day work : **300** days/year
Capacity per year : **288.000** pieces/year

Direct Cost :

Explanation	Unity	Volume	Unit Price (Rp)	Total Price (Rp)
Solar and Olie	Ltr	288	6.700,00	1.929.600,00
Sand	Gr	151.200.000	0,75	113.400.000,00
Clay peat	Gr	550.800.000	0,50	275.400.000,00
Electricity	Kwh	2.400	4.200,00	10.080.000,00
Material and energy				400.809.600,00
Salary				-
			T o t a l	**400.809.600,00**

Indirect Cost :

Explanation	Unity	Volume	Unit Price (Rp)	Total Price (Rp)
Depreciation	%	5	65.000.000,00	3.250.000,00
Overhead	%	5	-	-

Maintenance	Ls	0,05	65.000.000,00	3.250.000,00
Salary				-
				T o t a l 6.500.000,00

Payment + Equity Bank per year 190.677.004,26

TOTAL (1+2+3) 597.986.604,26

MAIN PRICE PER PIECE 2.076,34

Profit 20 % **415,27**

Taxes 10 % **207,63**

SELL PRICE PER PIECE 2.699,25

Break Event Point (BEP)

Unit Production Red Brick Capacity : 9.600 pieces/10 days

288.000 pieces/year

No.	Explanation	Rp./piece
1)	**Fixed Cost :** - Salary	-
	- Payment + Equity Bank	662,07
	- Depreciation	22,57
	- Overhead	-
	- Maintenance	11,28
	Total 1 =	**695,93**
2)	**Variable Cost :** - Salary	433,33
	- Material and overhead	35,00
	Total 2 =	**468,33**
3)	**Main Price**	**2.076,34**
4)	**Sell Price**	**2.699,25**

$$\textbf{BEP} = \frac{\text{Fixed Cost}}{\text{Sell price - Var. Cost}} \times 100\ \% = \textbf{31,19 \%}$$

Cash flow unit production red brick

No.	Explanation	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1	Balance cash beginning	0	0	179.395.981	376.731.561	593.800.698	832.576.749	1.095.230.405	1.384.149.427	1.701.960.351	2.051.552.367
2	Income	320.054.000	777.382.586	855.120.844	940.632.928	1.034.696.221	1.138.165.843	1.251.982.428	1.377.180.671	1.514.898.738	1.666.388.611
3	Outcome	320.054.000	597.986.604	657.785.265	723.563.791	795.920.170	875.512.187	963.063.406	1.059.369.747	1.165.306.721	1.281.837.393
4	Difference cash (2-3)	0	179.395.981	197.335.579	217.069.137	238.776.051	262.653.656	288.919.022	317.810.924	349.592.016	384.551.218
5	Balance cash ending	0	179.395.981	376.731.561	593.800.698	832.576.749	1.095.230.405	1.384.149.427	1.701.960.351	2.051.552.367	2.436.103.586

Main price red brick Rp. **2.076,34** /piece

Sell price red brick Rp. **2.699,25** /piece

Capacity production **288.000** pieces/year

Cost production red brick estimation increase as much as : **10** %/year

Total investation Rp. **320.054.000**,-

Calculation Internal Rate of Return (IRR) Production Red Brick

Capacity Prod.: **288.000** pieces/year

Sell Price : **2.699,25** rupiah/piece

Main Price : **2.076,34** rupiah/piece

Investation : **320.054.000,00** rupiah

Year	0	1	2	3	4	5
Income	0	777382586	777382585,5	777382586	777382586	777382585,5
Outcome	320054000	597986604	597986604,3	597986604	597986604	597986604,3
Net Cash Flow :	-320054000	179395981	179395981,3	179395981	179395981	179395981,3
NPV 50 % :	1	0,6666667	0,444444444	0,2962963	0,19753086	0,131687243
NPV 40 % :	1	0,7142857	0,510204082	0,36443149	0,2603082	0,185934432
NPV 30 % :	1	0,7692308	0,591715976	0,45516614	0,3501278	0,269329074
NPV 20 % :	1	0,8333333	0,694444444	0,5787037	0,48225309	0,401877572

Total NPV 50 % : **-8510361,732** rupiah

Total NPV 40 % : **45.046.228,45** rupiah

Total NPV 30 % : **116.877.425,66** rupiah

Total NPV 20 % : **216.449.799,46** rupiah

IRR = **46,27** %

Pay Back Period = **1,78** year

Profit = **20,00** %

No.	Explanation	2016	2017	2018	2019	2020	2021	2022	2023
1	Income	777.382.586	855.120.844	940.632.928	1.034.696.221	1.138.165.843	1.251.982.428	1.377.180.671	1.514.898.738
2	Cost Production	597.986.604	657.785.265	723.563.791	795.920.170	875.512.187	963.063.406	1.059.369.747	1.165.306.721
3	Profit before equity & tax	179.395.981	197.335.579	217.069.137	238.776.051	262.653.656	288.919.022	317.810.924	349.592.016
4	Equity loan + payment	119.342.552	119.342.552	119.342.552	119.342.552	119.342.552	0	0	0
5	Profit before tax	60.053.429	77.993.027	97.726.585	119.433.499	143.311.104	288.919.022	317.810.924	349.592.016
6	Tax	68.768.459	75.645.305	83.209.836	91.530.820	100.683.902	110.752.292	121.827.521	134.010.273
7	Profit netto	(8.715.030)	2.347.722	14.516.749	27.902.679	42.627.203	178.166.730	195.983.403	215.581.743

Sell price Rp. **2.699,25** /piece

Main price Rp. **2.076,34** /piece

Capacity production **288.000** piece/year

Investation Rp. **320.054.000**

Loan Rp. **240.040.500**

Equity loan (Flat) **29,72** %/year = Rp. **247,69** /piece

Payment Rp. **167** /bh

Taxes **10,0** % = Rp. **238,78** /piece

Cost production estimation

ESTIMATION INVESTATION AND COST PRODUCTION TILE CERAMIC

List Price Unit Tools Production Tile Ceramic

Capacity : 288.000 pieces/year

No.	Kind of Tools	Quantity	Unity	Price Rp.	
				Unit	Total
1	Machine to make tile ceramic	2	Unit	20.000.000,00	40.000.000,00
2	Mixer machine	1	Unit	20.000.000,00	20.000.000,00
3	Tool assist	1	Unit	5.000.000,00	5.000.000,00
			T o t a l		**65.000.000,00**

Total Machines and Tools = Rp. 65.000.000,00

Depreciation per year = Rp. 6.500.000,00

Depreciation per piece product = Rp. 22,57

Investation Unit Production Tile Ceramic

Capacity : 288.000 pieces/year

No.	COST OF INVESTATION	PRICE (Rp.)
1	TOOLS PRODUCTION TILE CERAMIC	65.000.000,00
2	COST INSTALLATION ELECTRICITY AND WATER	5.000.000,00
3	LAND FACTORY & CONCESSION (250 m^2)	125.000.000,00
4	BUILDING PRODUCTION (125 m^2)	125.000.000,00
5	EQUITY WORK 3 MONTHS	54.000,00
	TOTAL INVESTATION	**320.054.000,00**

Source Payment

Credit bank = 75 % = 240.040.500,00

Self equity = 25 % = 80.013.500,00

T O T A L = 320.054.000,00

Estimation Cost Production Tile Ceramic

Capacity : 288.000 pieces/year

Salary worker

No.	Explanation	Salary/month (Rp)	Worker	Total Salary (Rp)
1	**Direct Salary**			
	Worker	1.700.000,00	3	5.100.000,00
	Assistance	1.500.000,00	3	4.500.000,00

Direct Salary

Salary/month = Rp. **9.600.000,00**

Salary/year = Rp. **115.200.000,00**

Allowance 1 Month Salary = Rp. **9.600.000,00**

Total Salary & Allowance = Rp. **124.800.000,00**

Salary & Allowance/piece = Rp. **433,33**

Estimation Cost Production Tile Ceramic

Capacity Production : **9.600** pieces/10 days

Mixture composition 1 : 3

Day work : **300** days/year

Capacity per year : **288.000** pieces/year

Direct Cost :

Explanation	Unity	Volume	Unit Price (Rp)	Total Price (Rp)
Solar and Olie	ltr	288	6.700,00	1.929.600,00
Sand	gr	136.573.517		102.430.137,60

			0,75	
Clay peat	gr	497.517.811	0,50	248.758.905,60
Electricity	Kwh	2.400	4.200,00	10.080.000,00
Material and energy				363.198.643,20
Salary				-
			T o t a l	**363.198.643,20**

Indirect Cost :

Explanation	Unity	Volume	Unit Price (Rp)	Total Price (Rp)
Depreciation	%	5	65.000.000,00	3.250.000,00
Overhead	%	5	-	-
Maintenance	Ls	0,05	65.000.000,00	3.250.000,00
Salary				-
			T o t a l	**6.500.000,00**

Payment + Equity Bank per year = 190.677.004,26

TOTAL (1+2+3) = 560.375.647,46

MAIN PRICE PER PIECE = 1.945,75

Profit = 20 % = **389,15**

Taxes = 10 % = **194,57**

SELL PRICE PER PIECE = 2.529,47

Break Event Point (BEP)

Unit Production Tile Ceramic Capacity : 9.600 pieces/10 days

288.000 pieces/year

No.	Explanation	Rp./piece
1)	**Fixed Cost :** - Salary	-
	- Payment + Equity Bank	662,07
	- Depreciation	22,57
	- Overhead	-
	- Maintenance	11,28
	Total 1 =	**695,93**
2)	**Variable Cost :** - Salary	433,33
	- Material and overhead	35,00
	Total 2 =	**468,33**
3)	**Main Price**	**1.945,75**
4)	**Sell Price**	**2.529,47**

$$\textbf{BEP} = \frac{\text{Fixed Cost}}{\text{H. jual - Var. Cost}} \times 100\ \% = \textbf{33,76 \%}$$

Cash flow unit production tile ceramic

No.	Explanation	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1	Balance cash beginning	0	0	168.112.694	353.036.658	556.453.018	780.211.014	1.026.344.810	1.297.091.985	1.594.913.878	1.922.517.959
2	Income	320.054.000	728.488.342	801.337.176	881.470.893	969.617.983	1.066.579.781	1.173.237.759	1.290.561.535	1.419.617.689	1.561.579.457
3	Outcome	320.054.000	560.375.647	616.413.212	678.054.533	745.859.987	820.445.985	902.490.584	992.739.642	1.092.013.607	1.201.214.967
4	Difference cash (2-3)	0	168.112.694	184.923.964	203.416.360	223.757.996	246.133.796	270.747.175	297.821.893	327.604.082	360.364.490
5	Balance cash ending	0	168.112.694	353.036.658	556.453.018	780.211.014	1.026.344.810	1.297.091.985	1.594.913.878	1.922.517.959	2.282.882.450

Main price red brick = Rp. **1.945,75** /piece

Sell price red brick = Rp. **2.529,47** /piece

Capacity production = **288.000** pieces/year

Cost production tile ceramic estimation
increase as much as =:**10** %/year

Total investation = Rp. **320.054.000**,-

Calculation Internal Rate of Return (IRR) Production Tile Ceramic

Capacity Prod.: **288.000** pieces/year

Sell Price : **2.529,47** rupiah/piece

Main Price : **1.945,75** rupiah/piece

Investation : **320.054.000,00** rupiah

Year	0	1	2	3	4	5
Income	0	728488342	728488341,7	728488342	728488342	728488341,7
Outcome	320054000	560375647	560375647,5	560375647	560375647	560375647,5
Net Cash Flow :	-320054000	168112694	168112694,2	168112694	168112694	168112694,2
NPV 50 %	1	0,6666667	0,444444444	0,2962963	0,19753086	0,131687243
NPV 40 %	1	0,7142857	0,510204082	0,36443149	0,2603082	0,185934432
NPV 30 %	1	0,7692308	0,591715976	0,45516614	0,3501278	0,269329074
NPV 20 %	1	0,8333333	0,694444444	0,5787037	0,48225309	0,401877572

Total NPV 50 %:= **-28105205,89** Rupiah

Total NPV 40 %:= **22.082.889,77** rupiah

Total NPV 30 %:= **89.396.193,04** rupiah

Total NPV 20 %:= **182.705.864,26** rupiah

IRR = **43,28** %

Pay Back Period = **1,90** year

Profit = **20,00** %

Balance Sheet Loss and Profit Production Tile Ceramic

No.	Explanation	2016	2017	2018	2019	2020	2021	2022	2023	2024
1	Income	728.488.342	801.337.176	881.470.893	969.617.983	1.066.579.781	1.173.237.759	1.290.561.535	1.419.617.689	1.561.579.457
2	Cost Production	560.375.647	616.413.212	678.054.533	745.859.987	820.445.985	902.490.584	992.739.642	1.092.013.607	1.201.214.967
3	Profit before equity & tax	168.112.694	184.923.964	203.416.360	223.757.996	246.133.796	270.747.175	297.821.893	327.604.082	360.364.490
4	Equity loan + payment	119.342.552	119.342.552	119.342.552	119.342.552	119.342.552	0	0	0	0
5	Profit before tax	48.770.142	65.581.412	84.073.808	104.415.444	126.791.244	270.747.175	297.821.893	327.604.082	360.364.490
6	Tax	64.443.199	70.887.519	77.976.271	85.773.898	94.351.288	103.786.417	114.165.059	125.581.565	138.139.721
7	Profit netto	(15.673.057)	(5.306.108)	6.097.537	18.641.545	32.439.955	166.960.758	183.656.834	202.022.517	222.224.769

Sell price = Rp. **2.529,47** /piece

Main price = Rp. **1.945,75** /piece

Capacity production = **288.000** piece/year

Investation = Rp. **320.054.000**

Loan = Rp. **240.040.500**

Equity loan (Flat) = **29,72** %/year = Rp. **247,69** /piece

Payment = Rp. **167** /bh

Taxes = **10,0** % = Rp. **223,76** /piece

Cost production estimation increase as much as = **10** % every year

Price red brick in market = Rp. 600,- per piece, while while price red brick production result = Rp. 2.700,- per piece. Price red brick production result more expensive, cause of calculation feasibility study using analyze making industry red brick, while add buying machine, buying land production, making building production, land concession for road to location production, cost of depreciation, profit, taxes, bank equity, installation electricity and water, working capital for 3 months, worker salary, and supported material.

Red brick production result have better quality, compared with red brick that sold in market, cause red brick production result using mixture composition 1 sand : 3 soil peat, while red brick that sold in market using mixture composition 1 sand : 5 clay until 1 sand : 6 clay. That matter is same with quality tile ceramic, have better quality if compared with tile ceramic that sold in market.

Price tile ceramic in market = Rp. 9.700,- more expensive from price tile ceramic that produced by production = Rp. 2,550,-. This is caused tile ceramic that sold in market have layered by glazing, and processed burning in oven. But tile ceramic production result also have burned in furnace, until 900 ˚C.

CONCLUSION

In make one house type 49 m^2, need ± 7,875 red brick and ± 3,675 tile ceramic. Or 7,875 x Rp. 2.700,- + 3,675 x Rp. 2,550,- = Rp. 30,633,750,-

Price one house type 49 m^2 = Rp. 30,633,750,-, only from price wall from red brick and price roof from tile ceramic.

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Proceedings of the 3rd International Conference on Agriculture and Forestry, Vol. 2, 2016, pp. 25-38
Copyright © TIIKM
ISSN: 2362-1036 online
DOI: https://doi.org/10.17501/icoaf.2016.2103

COMPARISON BETWEEN FIRE RESISTANCE LIGHTWEIGHT BRICK AND FIRE RESISTANCE RED BRICK

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Abstract

At this moment, lightweight brick are widely used, considering lightweight brick is a modern development of producing conblock that usual and always done by society.

Lightweight brick is a kind of brick for building was made from silica sand which is resistant to heat and can reduce risk fire. Lightweight brick is building component that produced by process technology modern using modern machines through process aeration and autoclave to produce high quality products, lightweight, strength, waterproof, fireproof, and soundproof.

Lightweight bricks designed by ergonomic and accurate which makes it more efficient in the use of cement compared with conventional construction and can give more value to the building.

The process of aeration are homogeneous and controlled by computerized, produce lightweight brick that have highest pressure strength but lightest in its class. These products have started to use at building and housing.

Lightweight brick can directly given mortar without plastered beforehand, by using specific kind of cement. To use it, this cement only mixed with water. Lightweight bricks generally has size 60 cm x 20 cm with thickness 8 - 10 cm.

Red brick is a kind of brick for building was made from clay that shaped then burned with high temperature so become dry completely, hardened and reddish colored. Housing or building that have walls made of red brick will be more comfortable, stronger, durable, and resistant to heat.

Red brick have length 17 - 23 cm, width 7 - 11 cm, thick 3 - 5 cm, and average weight 3 kg per peace.

The purpose of this research is to find out how differences between the usage of lightweight brick with the usage of red brick as building component in make housing or building.

Also to know how far lightweight brick's strength compared with red brick's strength, in its ability to fire resistance level.

So the society or government which built using lightweight brick or red brick, can get benefit by using building components in make housing or building that have fire resistance level, so that housing or building can avoid from fire hazard, which lately often occur in large city, due to climate change.

The benefits of this research is to get comparison value testing result fire resistance level from lightweight brick or red brick as building component, which is more resistant to fire resistance level.

And to get building components that have high fire resistance level, so housing or building that have built using that building component can avoid of fire hazard.

The scope of this research consists of : (a) To find out the advantages and disadvantages of lightweight brick and red brick ; (b) To know how physical properties and chemical properties of lightweight brick and red brick, so can be used as fire resistant building component ; (c) To know the utilization of lightweight brick and red brick, as building component in make housing or building ; (d) To know burning temperature in furnace at fire resistance test to lightweight brick and red brick ; and (e) To compare fire resistance level that was produced with standard requirements.

Keywords: fire resistance, lightweight brick, red brick.

INTRODUCTION

Lightweight Brick

Lightweight brick or often called hebel or celcon made by using machines in factory. This brick quite light, smooth and have good flatness level. Lightweight brick was invented in order to make lighter load structure of building construction, accelerate construction, and minimize waste material that occur during process construction wall.

Mixture composition of lightweight brick, consist of sand kwarsa, cement, lime, gypsum, water, and aluminum pasta as accelerate material (air filler chemically). After mixture was mixed perfectly, will expand as lpng as 7 – 8 hours. For construction at wall width 1 m^2, ± need 8 pieces lightweight brick.

Specification lightweight brick :

- Dry density : 520 kg/m^3.
- Normal density 650 kg/m^3
- Pressure test > 4,0 N/mm^2.
- Thermal conductifity 0,14 W/mK,
- Thick space between lightweight brick 3 mm.
- Fire resistance 4 hours.
- Amount per 1 m^2 : 22 - 26 pieces with construction waste, or 8 – 9 pieces without construction waste.

Advantages lightweight brick :

- Have size and quality that homogeny so can decrease neat wall.
- No need space between lightweight brick that thick so save usage mortar.
- Lighter 50 % than red brick so minimize load of structure.
- Easy to handling.
- The construction is faster than red brick, because have bigger size and lighter.
- Not required thick plastering, generally determined only 2.5 cm. Save plastering and space until 75 % because its size larger than red brick.
- Water proof, walls not easy to moist and quick to dry.
- Sound proof, so soundness level is low.
- High pressure strength.
- Have good durability against earthquake.

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- Heat insulation, make temperature indoor so stable.
- Fire resistance.
- Environmentally because 70 % the material is air.
- Generally have size 60 cm x 20 cm with thickness 8 – 10 cm.

Disadvantages lightweight brick :

- Need specific skill to construction, because if not its impact to be seen.
- The size is middle, throw remaining quite a lot.
- Have specific adhesive. Generally is cement instant, mortar.
- If exposed to water, hence to become thoroughly dried out needed more time of red brick.
- If forced plastered before dry then shall arise yellow spotting on plastering.
- Price relatively more expensive than red brick.
- Almost difficult to get it. Only large material store that sells lightweight brick in large volume (m^3).

Red Brick

1 m^2wall, if using red brick sized 23 cm x 17 cm x 5 cm, need ± 70 pieces red brick. Raw materials was needed into space between red brick is cement and sieve sand. At the time of construction not requiring specific adhesive, at wall watertight required a mixture 1 cement : 2 sand or 1 cement : 3 sand. Meanwhile, at wall not watertight can use a mixture 1 cement : 4 sand to 1 cement : 6 sand.

Specifications red brick :

- Dry specific gravity (ρ) : 1500 kg/m^3.
- Normal specific gravity (ρ) : 2000 kg/m^3.
- Pressure strength : 2.5 – 25 N/mm^2 (SII-0021, 1978).
- Thermal conductivity : 0.380 W/mK.
- Thick space between red brick : 20 - 30 mm.
- Fire resistance : 2 hours.
- The number of necessity red brick per 1 m^2 : 70 - 72 pieces with construction waste, or 30 - 35 pieces without construction waste.

Advantages red brick :

- Not requiring specific skill to put up.
- Small size, easy to handling.
- Easy to build, small size.
- Cheap price.
- Easy to get it.
- Unnecessary specific adhesive.
- Heat-resistant.
- Waterproof, so rare seepage water on the wall due to rain.
- Crack relative infrequent.
- Strong and durable.

Disadvantages red brick :

- Takes time and difficult to make masonry being tidy.
- Absorbing heat in summer time and absorbing cold in winter, so room

temperature could not conditioned or unstable.

- Difficult to get masonry that quite neat, required plastering that thick enough to produce a wall that quite plain.
- Time to construction was longer than the other material for wall.
- Heavy, so overburden structure that shore up.

METHODOLOGY

Apparatus

- Vertical furnace and small furnace, made from steel plate and the inside part covered by mulite, steel resistance to fire, material isolation, mortar, and so on.
- An instrument to laying sample shaped wheeled truck equipped 4 pieces clamps sample in furnace.
- An instrument burner consist of 4 pieces burner. Fuel used gases and kerosene.
- Coolant furnace made of steel no rust, installed on the upper part of furnace.
- Pump with motor 0,2 kW.
- Fan with air flow 12 m^3 /minute, static pressure 700 mm column of water, with motor 3,7 kW.
- Fan reckoner type turbo fan air flow 65 m^3 /minute, static pressure 40 mm column of water, with motor 2,2 kW.
- Chimney made of steel plates that equipped paint fire proof, diameter 300 mm, high 1.000 mm.
- Chimney door shaped butterflies wing installed in the middle of chimney, the benefit to air circulation system.
- Oil tank made of steel plate with diameter 760 mm, high 1.200 mm, equipped with volumenometer.
- Temperature recorder with 6 pieces pen, distance measurement of temperature can be arranged from 0 ˚C - 300 ˚C, 0 ˚C – 600 ˚C, 0 ˚C – 1.200 ˚C.
- The speed of turnaround paper graph : 12,5 ; 25 ; 75 ; 150 ; 375 ; and 750 mm /hour.
- Thermocouple refractory in diameter 10 mm, length 2,000 mm, installed in the range each end of heat of 30 mm thermocouple from the surface of sample, while distance installation thermocouple on the walls of furnace installed parallel not less than 100 mm.
- Thermocouple to measure temperature surface at unexposed surface sample, diameter 0,84 mm length 4.000 mm.
- Control panel made of steel plates, functioned to set burning.

Procedure

- Before testing, first sample dried in a room with good ventilated.
- Sample after constructed on truck wheeled, burned in furnace equipped with 5 thermocouple installed dispersed so obtained average temperature. Burning test ways of sample arranged in accordance with component function in building : walls are burned on one surface with an upright direction /vertical.
- Standard temperature curve :
  - 760 ˚C at the first 15 minutes.
  - 840 ˚C at the next 30 minutes.
  - 880 ˚C at the next 40 minutes.
  - 895 ˚C at the next 50 minutes.
  - 905 ˚C at the next 50 minutes.
  - 915 ˚C at the next 55 minutes.
  - 925 ˚C at the next 1 hours.
  - 1010 ˚C at the next 2 hours.
  - 1050 ˚C at the next 3 hours.
- Measurement burning temperature at sample, both given load and not given load, done every 5 minutes.

TESTING RESULTS

Sample lightweight brick were made and then put up the thermocouple for measure temperature surface construction lightweight brick.

Construction lightweight brick that tested is used for wall. Dimension one lightweight brick : length 600 mm x width 200 mm x thick 100 mm, construction wall lightweight brick : width 1050 mm x length 1060 mm x thick 100 mm.

Temperature air ambient at the beginning of testing is 23.2 ˚C.

Furnace temperature was arranged so follows standard curve time – temperature according to SNI 1741 – 2008.

Furnace temperature were measured by five thermocouple TC #1 - TC #5 that separated in furnace and placed 300 mm from sample surface.

Unexposed surface temperature of sample were measured by five thermocouple TC#6, #7, #8, #9 and #10 that put up exact way at wall surface of sample that unexposed by fire.

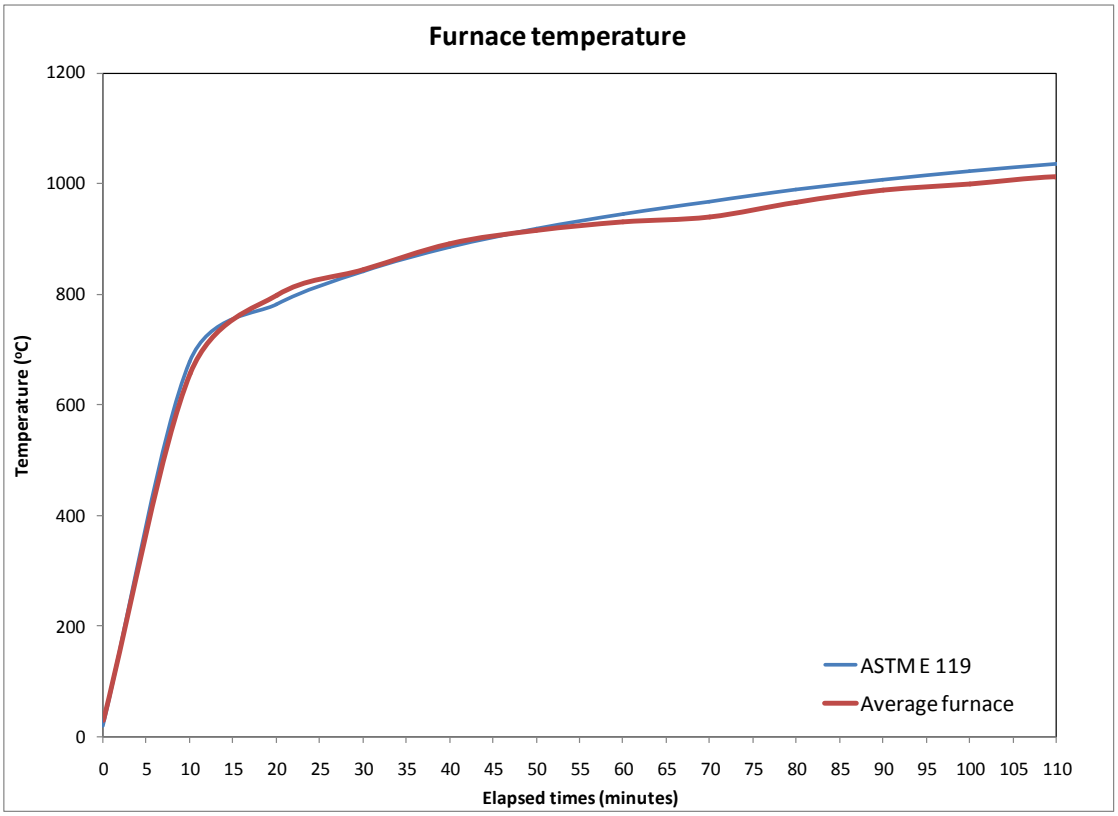
Fire test was conduct as long as 170 minute.

Average furnace temperature was showed at Table 1 and Graph 1.

At the end of test, average furnace temperature achieved 1047 ˚C.

Table 1. Average Furnace Temperature

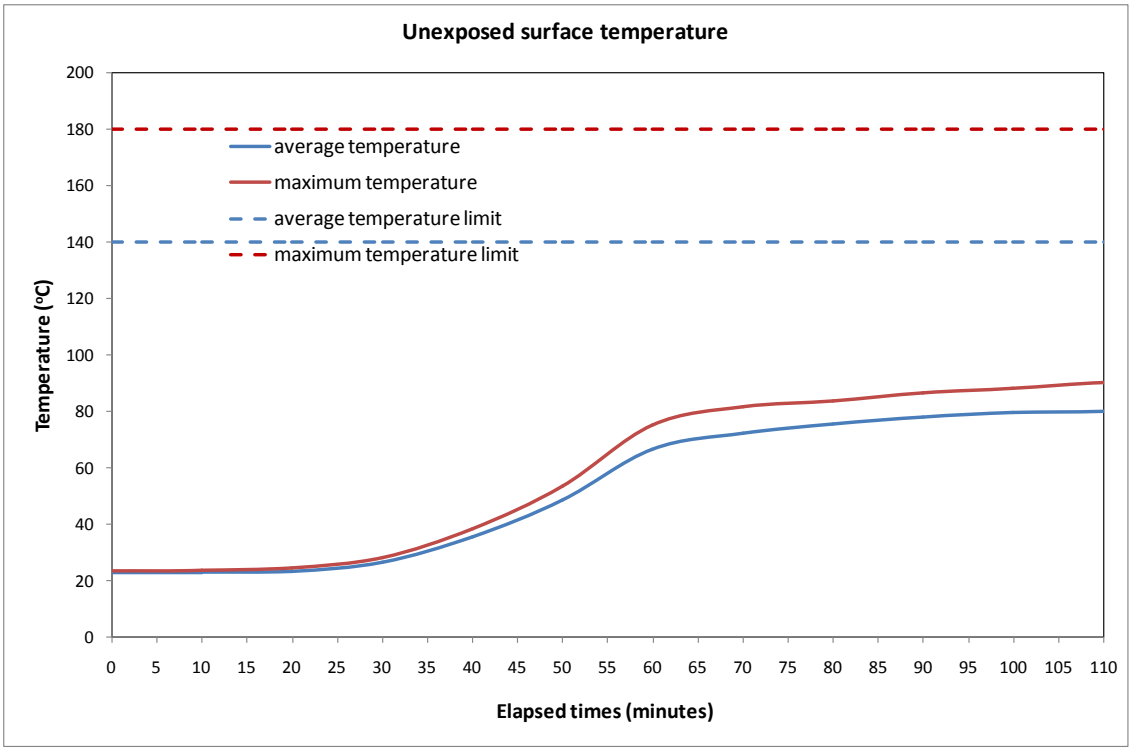
Minute	Average Furnace Temperature °C	Standard Furnace Temperature SNI 1741 – 2008
0	31	20
10	657	678
20	799	781
30	844	842
40	892	885
50	915	918
60	930	945
70	939	968
80	967	988
90	987	1006
100	999	1022
110	1012	1036
120	1012	1049
130	1017	1061
140	1025	1072
150	1031	1082
160	1038	1092
170	1047	1101



Graph 1 Unexposed surface temperature was showed at Table 2 and Graph 2.

Table 2. Temperature at Surface Sample

Minute	TC #6 °C	TC #7 °C	TC #8 °C	TC #9 °C	TC #10 °C	Average °C	Average ΔT °C	Maximum Level (SNI 1741 – 2008)
0	23.5	22.5	23.2	22.8	22.7	22.9	0.0	180
10	23.6	22.6	23.2	22.9	22.7	23.0	0.1	180
20	24.6	23.1	23.4	23.0	22.7	23.4	0.4	180
30	28.3	28.1	25.0	24.3	27.2	26.6	3.6	180
40	38.6	38.0	31.5	31.7	38.6	35.7	12.7	180
50	53.5	50.2	43.8	42.0	53.0	48.5	25.6	180
60	75.3	60.4	65.5	62.0	70.7	66.8	43.8	180
70	81.7	62.7	72.2	70.4	74.5	72.3	49.4	180
80	83.8	65.1	75.6	77.0	77.1	75.7	52.8	180
90	86.7	65.9	78.8	80.4	79.3	78.2	55.3	180
100	88.1	67.2	79.7	84.1	79.0	79.6	56.7	180
110	90.4	68.2	81.9	80.6	79.9	80.2	57.3	180
120	90.7	68.9	82.8	88.1	81.0	82.3	59.4	180
130	92.2	70.0	84.3	89.7	81.2	83.5	60.5	180
140	97.8	69.9	86.1	89.7	82.1	85.1	62.2	180
150	93.8	70.4	86.9	91.4	82.1	84.9	62.0	180
160	94.5	71.0	87.9	92.6	82.2	85.6	62.7	180
170	94.8	71.3	88.8	93.4	82.2	86.1	63.2	180



Graph 2

Construction work of sample was conduct in laboratory and then put up the thermocouple for measure sample surface temperature.

Sample that was tested is red bricks sized 200 mm x 100 mm x 50 mm. Red brick was glued between one and another using mortar mixture until become wall with total dimension : length 2640 mm x width 2640 mm x thick 100 mm. Laboratory did not conduct verification mortar quality that was used.

Ambient air temperature at the beginning of testing is 24.9 ˚C.

Furnace temperature was arranged so follows standard curve time – temperature according to SNI (Standard National Indonesia) 1741 – 2008.

Furnace temperature were measured by nine thermocouple TC #1 - TC #9 that separated in furnace.

Unexposed surface temperature of sample were measured by nine thermocouple TC#10 - TC#18 that put up exact way at wall surface of sample that unexposed by fire.

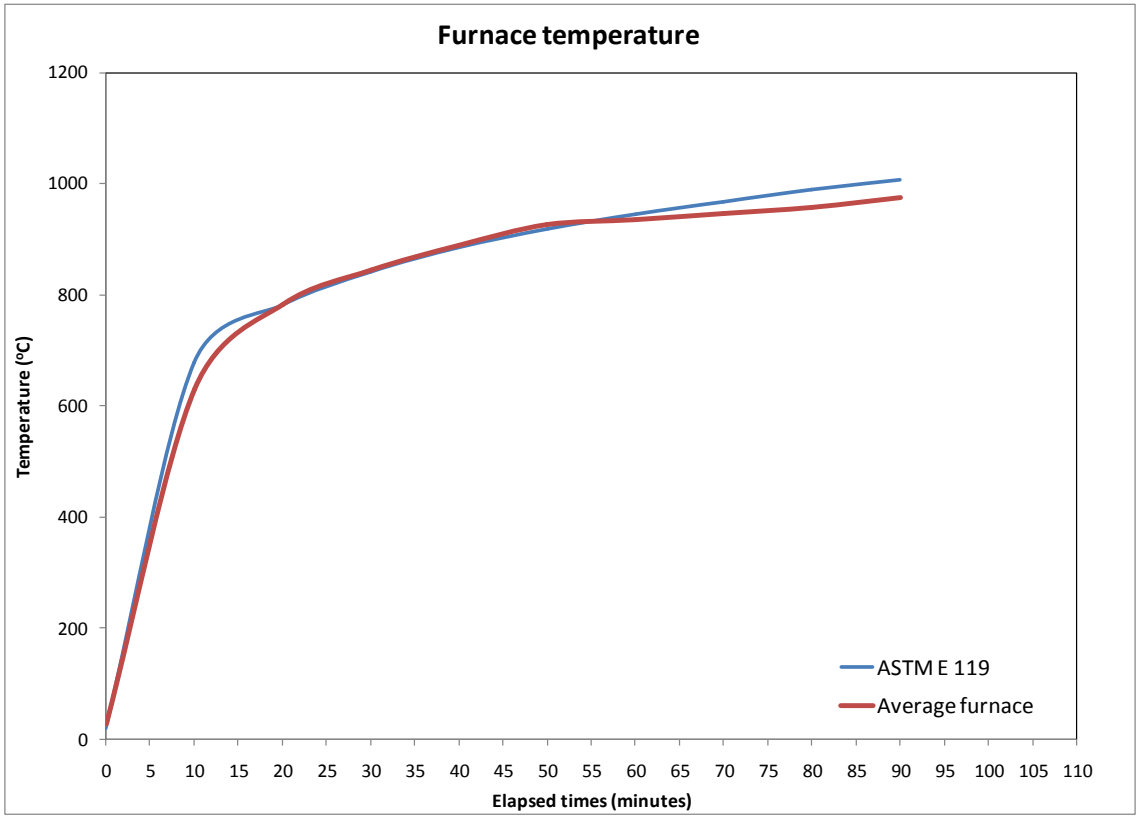
Fire test was conduct as long as 90 minute.

Average furnace temperature was showed at Table 3 and Graph 3.

At the end of test, average furnace temperature achieved 975 ˚C.

Table 3. Average Furnace Temperature

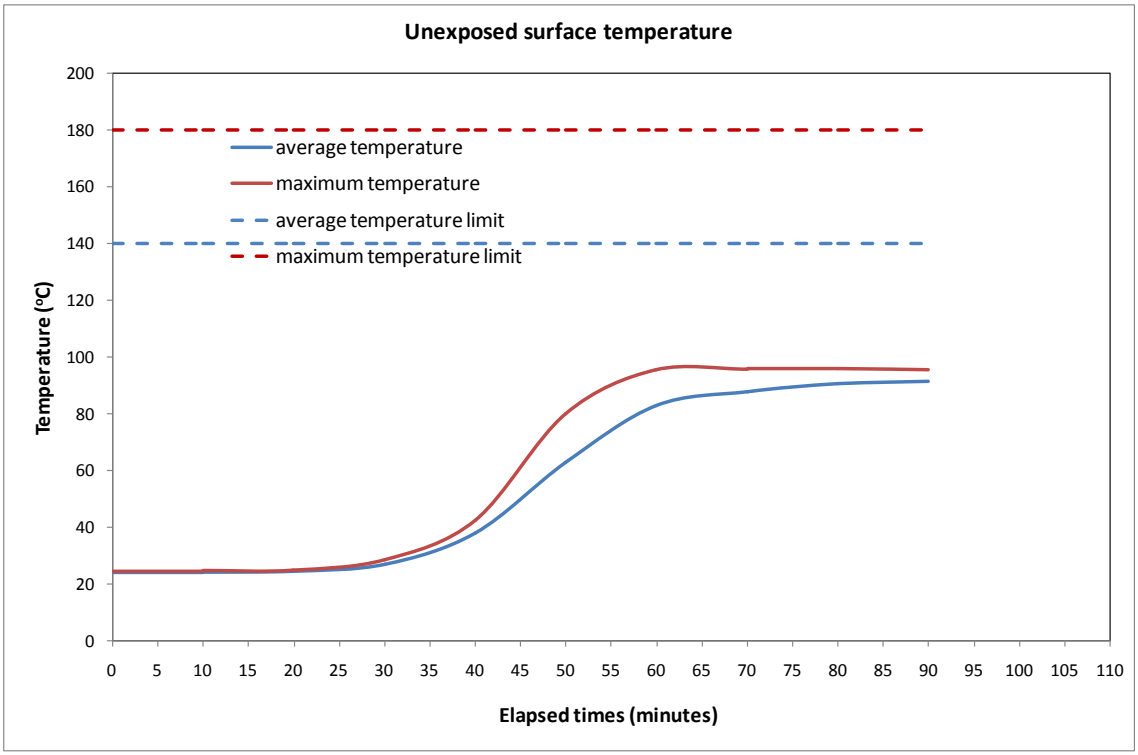
Minute	Average Furnace Temperature °C	Standard Furnace Temperature SNI 1741 – 2008
0	29	20
10	631	678
20	783	781
30	844	842
40	889	885
50	926	918
60	935	945
70	946	968
80	957	988
90	975	1006



Graph 3 Unexposed surface temperature was showed at Table 4 and Graph 4.

Table 4. Temperature at Surface Sample

Minute	TC #6 °C	TC #7 °C	TC #8 °C	TC #9 °C	TC #10 °C	Average °C	Average ΔT °C	Maximum Level (SNI 1741 – 2008)
0	24.6	23.8	24.4	24.3	24.0	24.2	0.0	180
10	23.8	24.7	24.2	23.6	24.7	24.2	0.0	180
20	24.4	24.7	24.7	24.2	24.8	24.6	0.3	180
30	26.8	28.2	25.0	28.5	26.7	27.0	2.8	180
40	34.7	42.5	31.0	41.3	40.6	38.0	13.8	180
50	48.0	80.1	48.0	62.9	74.9	62.8	38.6	180
60	66.1	95.6	76.8	86.1	90.6	83.0	58.8	180
70	81.0	95.8	86.9	83.8	92.3	88.0	63.7	180
80	90.0	95.8	90.3	84.2	92.4	90.5	66.3	180
90	93.1	95.4	91.7	85.2	92.6	91.6	67.4	180



Graph 4

ANALYSIS AND DISCUSSION

Building component is a part of housing and building, both bearer load and not bearer load (wall, column, wall partition, beam, floor, and roof).

Fire resistance of building component is characteristics of the building component to fire resistance, without loosing the function as structure that expressed in time ½ hour, 1 hour, 2 hour, and 3 hour.

Building material is all sorts of material worn on or for construction housing and building, either as material layer covering inside building (finishing material for interior) or material form of building components. Building material may consist of one kind of material or combination some kinds of material that shaped. Materials interior that cannot be moved as : closet cropping, carpet, curtains, furnishing household supersized and so on, that is contents of the building, include in this sense.

Fire resistance of building component, both non structural and structural, fulfill requirements Standard National Indonesia (SNI) 1741-2008 "Test Method Fire Resistance Component Structure Building for Prevention Fire Hazard on Housing and Building".

Based on their characteristics when fire tested (burning characteristics), building material classified in 5 (five) level quality, namely level quality 1 (M1), level quality 2 (M2), level quality 3 (M3), level quality 4 (M4) and level quality 5 (M5). M1 is non combustible material and M5 is combustible material.

Material level quality 1 (M1) to be able to comply with the requirements material M1 must be able to meet the requirements of fire test on surface, if : when testing, the temperature in furnace increase not more 50 ˚C.

Material level quality 5 (M5) is all materials are not able to meet the requirements of fire test on surface, or materials not able to meet the requirements of material M4.

Based on fire resistance, building components can be divided into five classes as follows :

- fire resistance 3 hour, that is main building component that resistant to fire at least 3 hour.
- fire resistance 2 hour, that is main building component that resistant to fire at least 2 hour.
- fire resistance 1 hour, that is main building component that resistant to fire at least 1 hour.
- fire resistance 1/2 hour, that is main building component that resistant to fire at least 1/2 hour.
- Specific fire resistance, that is main building component which is not covered in 3, 2, 1 and ½ hours, and not arranged in this provision, but organized specifically.

Building component bearer load, should fulfill the requirements :

- Material to main building component like outer wall, column, and beams should meet the requirements of material M1.
- Material to main building component like inside wall should meet the requirements of material M1 or M2.
- Material covering roof and floor should meet the requirements of material M1 or M2.

Testing results fire resistance level of building component, expressed with time unit in minutes, as follows :

- Stability, limit in which building component suffer destruction (collapse), means that component can not functioned bearer load.
- Integrity, limit in which building component that functioned as fire retardant, like wall and floor occur cracks translucent, so fire or smoke can getiing out.
- Insulation, limit in which surface wall or floor that not burned occur average increase temperature no more than 180 ˚C, or one of thermocouple surface unexposed fire no more than 220 ˚C.

Outer side wall of building should have fire resistance not less than 0.5 hours, but not applied to outer side wall that not bearer load.

Wall partition should have fire resistance not less than 1 hour, but not applied to wall partition between buildings that not divided into compartments.

Joint wall partition with outer side wall : if wall partition connect with outer side wall, then outer side wall and wall partition should bound together and joint between the two walls has to be fire resistance.

Table 5. Classification Characteristic Material

Testing	Observation	Non Combustible Material M1	Combustible Material			
			Difficult to Burn M2	Fire Retards M3	Little Retards M4	Flammable M5
Fire	Temperature increase in furnace	Temperature increase ≤ 50 ˚C and inside furnace does not occur a continuous flame for 10 seconds or more.	Temperature increase in furnace above 50 ˚C			

Table 6. Classification Quality Material

Kinds of Material	Description	Usage	Level Quality
Mortar	Composition : ½ - ¼ portland cement (PC) : 1 lime : 5 trass	Masonry red bricks, conblock, hollow brick	M1
Mortar plaster cast	Containing 66 % heavy compound of calcium sulphate ($CaSO_4$, ½ H_2O)	For plastering, as protector of columns and beams	M1
Red brick	Length 200 mm ; width 100 mm ; thick 5 mm	Wall bearer, wall not bearer, outside wall, fence	M1
Lightweight concrete block (aerated concrete block)	Made from silica sand, lime, cement, water, and aluminum powder, small porous. Process production : *autoclave*. Length 590 mm Width 440 mm 190 mm Thick 150 mm 125 mm 100 mm 75 mm	Wall not bearer load and wall partition.	M1

Table 7. Classification Fire Resistance Building Component

Kinds of Material	Description	Usage	Resistance Level
Red brick panel	Mortar composition : 1 PC : 3 sand Size : Length 1070 mm Width 1050 mm Thick 100 mm	For outside wall and inside wall (not bearer load)	>3 hours
Lightweight concrete block (aerated concrete block)	Made from silica sand, lime, cement, and aluminum powder. Small porous on surface, process production : *autoclave*. Mortar composition for space : 1 PC : 3 sand Size of panel : Length 1070 mm Width 1050 mm Thick 100 mm	For outside wall and wall partition not bearer load	3 hours

CONCLUSION

Sample lightweight brick have dimension : length 600 mm x width 200 mm x thick 100 mm, construction wall lightweight brick have dimension : width 1050 mm x length 1060 mm x thick 100 mm meet the requirements of fire resistance level - /170 /170 according to SNI 1741-2008. That is stability /integrity /insulation.

Stability : it is not required for non structural components. Integrity : does not occur crack translucent so smoke /fire did not get out as long as 170 minutes. Insulation : as long as 170 minutes, increase temperature maximum at one thermocouple on surface unexposed fire, no more than 180 ˚C ; or increase temperature average no more than 180 ˚C.

Sample test wall red brick thick 100 mm without plastering meet the requirements of fire resistance level - /90 /90 according to SNI 1741-2008.

Lightweight brick have weight lightly but require expensive material, while red brick have weight more heavy but cheaper in cost construction. So can concluded that if want cheaper building construction (house) suggested to wear red brick, because it can diminish the expense to construction masonry wall. While for project construction highrise building advised to wear lightweight brick as masonry wall, because it is light, can reduce the burden of building construction, so can diminish the expense incurred to building construction.

Each material have advantages and disadvantages. Red brick heavy enough so indirectly affect load factor of building structure. While lightweight brick have advantages : the construction more neat and precision, not require much mortar to space between, but the price more expensive compare with red brick.

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Proceedings of the 3rd International Conference on Agriculture and Forestry, Vol. 2, 2016, pp. 39-46
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ISSN: 2362-1036 online
DOI: https://doi.org/10.17501/icoaf.2016.2104

PRODUCTION AND OIL CONTENT OF PHYSIC NUT (*Jatropha curcas L.)* FOR THE FIRST AND SECOND HARVEST YEARS IN EAST NUSA TENGGARA-INDONESIA

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Abstract

Jatropha curcas Linn. is one of many bioenergy plants which is potential to produce biodiesel in the tropical country. However, has not found highly potential varieties on dry land yet. The purpose of this research is to gain information of *J. curcas* L. seeds production and oil content on first and second harvest in East Nusa Tenggara breeding location. The research was conducted in East Nusa Tenggara province – Indonesia, with the materials used in this research are the four numbers of *J. curcas* hybrids, they are SP8×SP16, SP8×SP38, SP33×HS49, SM35×SP38, and two control accession from Indonesia Agricultural Ministry IP3A and IP3P. The SP8×SP16 hybrid produces the highest number of fruits /plant (97.23 fruits/plant) and seeds dry weight average (179.34 g/plant) in second harvest, with dry weight of 100 seeds 71.25 gram, oil content 31.252 %, and first harvest time 90-91 days. And than followed by SP33×HS49 hybrid, with average seed dry weight 123.07 g/plant, number of fruits 71.22, oil content 30.72%, but the first harvest time longer than another hybrids (101-102 day). In this research, all off hybrids produce higher seed dry weigh compare to control plant (IP3A and IP3P).

Keywords: East Nusa Tenggara, first and second harvest, hybrids, *Jatropha curcas* Linn.

INTRODUCTION

The increasing demand of fuel requires significant effort to develop new and renewable energy resources nationwide (Irianto, 2010). To support the utilization of bioenergy as a renewable resource, Indonesian government has declared a President Decree No. 5 of 2006 on National Energy Policy which, among other things, sets the target use of biofuels from 0.2% to more than 5% of national energy consumption by 2025 (Sardjono, 2007).

J.curcas plant is one of the pants producing energy which can be found in almost all provinces in Indonesia (Hasnam et al, 2007).

This plant has broad adaptability, grows in all types of soil, and able to withstand long periods of drought. *Jatropha* can survive in critical land where the availability of water and nutrients is limited or in marginal land (Ikbal et al, 2010). *J.curcas* is a versatile plant and all its body parts have high potential for usage. One of the advantages is that the seeds contain oil by 35-40% which can be used as biodiesel. *J.curcas* is also included as a plant fuel to support diversification program of alternative energy resources. *J.curcas* oil, in addition to its function as a source of renewable oils, is also included as non edible oil so it does not compete with human consumption needs such as palm oil and other vegetable oils. The usage of *J.curcas* oil as biodiesel material is seen as an ideal alternative to reduce the demand of fuel as well as to substitute diesel oil (Center for

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Research and Development of Estate Crops, 2008).

J.curcas is categorized into *Euphorbiaceae* family that has high potential as a producer of biofuels, lubricating oil, raw material in the manufacture of high quality soaps, raw materials in insecticides industry, fungicides and moluskasida and as anti-tumor drugs. *J.curcas* is very prospective to be manufactured as a source of biodiesel since it has the ability to grow in less fertile soil. It has strong root system which is able to withstand ground water and can serve as barriers to erosion (Divakara et.al., 2010). Jatropha can be grown in a variety of textures and types of soil, such as in rocky, sandy, argillaceous or clay ground. Jatropha's ability to grow on dry land has not been widely studied, but the results of several studies have explained the performance of Jatropha plants under conditions of minimal water availability (Achten et.al., 2010; Pompelli et.al., 2010).

In an effort to accelerate the supply and utilization of biofuels (BBN), the President Decree followed by President Instruction No. 1 of 2006 were regulated which, among other things, instruct the Minister of Agriculture to encourage the provision of *J.curcas* planting. Therefore, in order to achieve a high-productivity planting materials, the producers have done various selection processes. However, quality yielding variety of planting materials has not been discovered or released until now (Hariyadi, 2005). There is not any available planting material which has production potential of more than 10 tons/ha/year (Irianto, 2010); therefore, the presence of new varieties and superior planting material are of urgency.

Plant breeding is a human activity in maintaining and producing plants' offspring while improving its quality (Salim, 2010). Attempts to obtain superior planting materials through conventional breeding activities are generally conducted through crossbreeding. The success of breeding programs to obtain planting material is determined by the richness of the available genetic resources (Hasnam et al., 2007). The presence of new individuals in the population as a result of crossbreeding can encourage variety and diversity from recombination processes in the crossbred and has a close relationship with its varied parent. Genetic diversity information is highly significant as the data base for breeding programs, conservation, evaluation, and selection of plants.The availability of high genetic diversity will allow breeders to select genetic material. Initial characterization activities have to be done before making variety repair, in order to know the identity of each individual.

Several studies have explained the behaviors of some *J.curcas* accessions in different environmental conditions (Achten et.al., 2010). Although Jatropha is known to have capability to grow in dry climates and marginalized area, these plants still need water and sufficient nutrients to be able to produce optimally. In commercial scale of Jatropha plant development, the availability of quality seeds is to be one of the obstacles. This is because until now there has not been obtained any Jatropha variety that has special abilities in a specific environment (Hartati, 2012). To overcome this problem, efforts should be made in Jatropha planting material through the improvement of plant breeding activities (Maftuchah et.al., 2013).

Indonesia has quite extensive potential of non-productive dry land, especially in eastern part of Indonesia. Most of these regions have more arid climates that have not been used maximally for agricultural cultivation. These locations are very suitable for Jatropha's plantation. The research team has been conducting cross breeding to obtain

properties of plants tolerant to drought. This activity was followed by the selection of potential hybrid products (Maftuchah et.al, 2015). Currently, four numbers featured hybrids have been selected (SP8XSP16, SP8XSP38, SP33XHS49, SM35XSP38) and proceeded with multi-location test. This study aimed to obtain information of production level and seed oil level of some *J.curcas* hybrids in the first and the second year of harvests in East Nusa Tenggara province.

MATERIALS AND METHOD

The research was conducted in Maumere, East Nusa Tenggara, using four different varieties of *J.curcas* hybrids, i.e. SP8XSP16, SP8XSP38, SP33XHS49, SM35XSP38 and two comparative crops set by the Ministry of Agriculture; they were IP3A and IP3P. Both accession comparators were high potential yielding accessions as the results of mass selection in Asembagus and Pakuwon.

The study was conducted by applying a simple Randomized Block Design (RBD), with four groups. Each group utilized 20 plant samples. The planting material used was *J.curcas*stem cuttings with 30 cm long cuttings and 2-3 cm in diameter. Seeding stage was done in a polybag with a diameter of 15 cm and a length of 20 cm, which had been filled with soil planting medium, sand, and manure with a ratio of media 1: 1: 1. Maintenance activities included daily seedling watering, manual weeding, fertilizing, and pest and disease control done when necessary. Treatment for plants was conducted within 2 months, until the Jatropha plant was ready to be transferred to the field.

Planting hole was made in the field with the size of 40x40 cm and a hole depth of 40 cm with a spacing of 2x2 meters. At the bottom of the hole, manure was given as much as 50 kg/hole. After the age of 2 months, *J.curcas* seedlings were transplanted to the field. Transplanting was done during the rainy season. Observations on the plant height were conducted every month until the plant reaches two years old. Observations on the parameters of generative plants, such as the first harvest age, the number of bunches per plant, the number of fruits per plant, seeds' dry weight per plant, dry weight of 100 seeds and seed oil content were executed every time the crop enters the generative phase. This study was conducted over the past two harvest seasons. Seed oil level was then analyzed through a micro Kjeldahl method.

RESULTS AND DISCUSSION

The result presented that there was no significant difference to the life of the first crop on each *J.curcas* hybrid tested in East Nusa Tenggara. The test result also showed that the average age of first harvest of *J.curcas L* hybrid was in the range of 90 to 101 days after transplanting (Table 1).

The average age of first harvest, the number of bunches, fruit, dry seed weight, and dry weight of 100 seeds of hybrid numbers from the first crop were shown in Table 1, while the second harvest details were shown in Table 2. In the first harvest, there was no significant difference in the number of fruit, whereas in the second crop, there was significant difference in the number of fruits per plant.

Duncan test results to the amount of fruit bunches indicated a difference in the first and second crop harvests, while in the parameters of the number of pieces only indicated a difference in only the second harvest. The highest number of bunches in the second crop was achieved by hybrid SP8XSP16 (producing fruit bunches of 21,286), and not significantly different in the case of SP33XHS49

treatment (number of bunches: 15,911). Similarly, the highest number of fruits was obtained from hybrid SP8XSP16 (97.23 pieces) and was significantly different from all other treatments including the control group. The highest dry seed weight in the second harvest was also obtained from the SP8XSP16 treatment (179.34 g/plant) and it was higher than all other treatments (Table 1 and 2).

Jatropha is a perennial plant that is relatively tolerant to drought. However, the level of Jatropha production is influenced by genetic potential, environmental conditions and crop management level (Ratree, 2004). Observation of the level of production and quality of Jatropha can be done via the measurement of the parameter number of fruits per plant, dry seed weight per plant, dry weight of 100 seeds and seed oil content.

Jatropha can be generatively cultivated by seed and vegetatively grown by planting stem cuttings. Plants from cuttings tend to bloom their flower faster than that derived from seeds, it is because the plants derived from the seeds must go through a juvenile phase (Sudhakara, et.al., 2012). Results of other studies have also shown that Jatropha derived from vegetative propagation will enter the flowering phase faster than propagated from seed.

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Table 1. The average age of first harvest, the number of fruit bunches, fruit number, dry seed weight, dry weight of 100 seeds of J.curcashybrids on the first harvest in Maumere, East Nusa Tenggara.

Accessions	Age of First Harvest (HST)	∑ fruit bunches per plant	∑ fruit per plant	Dry Seed Weight(gram/plant)	Dry weight for 100 seeds (gram)
SP8XSP16	90.041 a	16.10 ab	26.989 a	44.87 a	66.167 ab
SP8XSP38	96.696 a	14.57 ab	23.526 a	36.60 ab	66.083 ab
SP33XHS49	101.330 a	13.65 ab	23.733 a	38.90 ab	68.417 a
SM35XSP38	94.821 a	18.44 a	27.695 a	47.63 a	70.125 a
IP3A	99.754 a	6.98 b	11.467 a	9.83 b	62.833 bc
1P3P	96.842 a	9.61 ab	14.980 a	17.60 ab	59.833 c

Notes: HST=days after transplanting to the field; BK = Dry Weight;the numbers followed by the same letter in the same column are not significantly different at 5% Duncan test.

Table 2. The average number of fruit bunches, fruit number, dry seed weight, dry weight of 100 seeds of J.curcas hybrids on the second harvest in Maumere, East Nusa Tenggara.

Accessions	∑ fruit bunches per plant	∑ fruit per plant	Dry Seed Weight (gram/plant)	Dry weight for 100 seeds (gram)
SP8XSP16	21.286 a	97.23 a	179.34 a	71.25 a
SP8XSP38	14.411 bc	62.53 bc	80.11 bc	56.67 a
SP33XHS49	15.911 ab	71.22 b	123.07 b	72.50 a
SM35XSP38	12.155 bc	51.73 bc	89.05 bc	55.63 a
IP3A	9.060 c	43.68 c	65.66 c	49.58 a
1P3P	9.291 c	41.21 c	73.64 bc	50.83 a

Notes : BK= Dry Weight; The numbers followed by the same letter in the same column are not significantly different at 5% Duncan test.

The number of productive branches on *J.curcas* will determine the productivity of the plant (Ratree, 2004). *J.curcas* seed production in the first year may reach 318 g/plant (Heller, 1996). In India,

J.curcas starts its production in the second year and is able to produce seeds from 0.4 to 12 tonnes/ha (Lele 2005). If planted as a hedge plant, Jatropha seed production ranged between 0.8-1.0 kg of seeds/plant, equivalent to 2.5-3.5 tonnes/ha/year (Henning, 2004). Based on the potential oil production of 1,590 kg oil/ha/year derived from the seeds of Jatropha, the production achieved in this study would be lower. However, in this research, Jatropha cultivation was done on land that is the dry land of East Nusa Tenggara which generally cannot be used for cultivation.

In the first harvest, the dry weight of 100 seeds reached by Jatropha hybrids ranged from 66,083 up to 70,125 grams. The four tested hybrids produced the dry weight of 100 seeds higher than the IP3P IP3A control plants. Whereas in the second harvest, the dry weight of 100 seeds did not indicate any difference among all tested treatments (Table 1 and Table2).

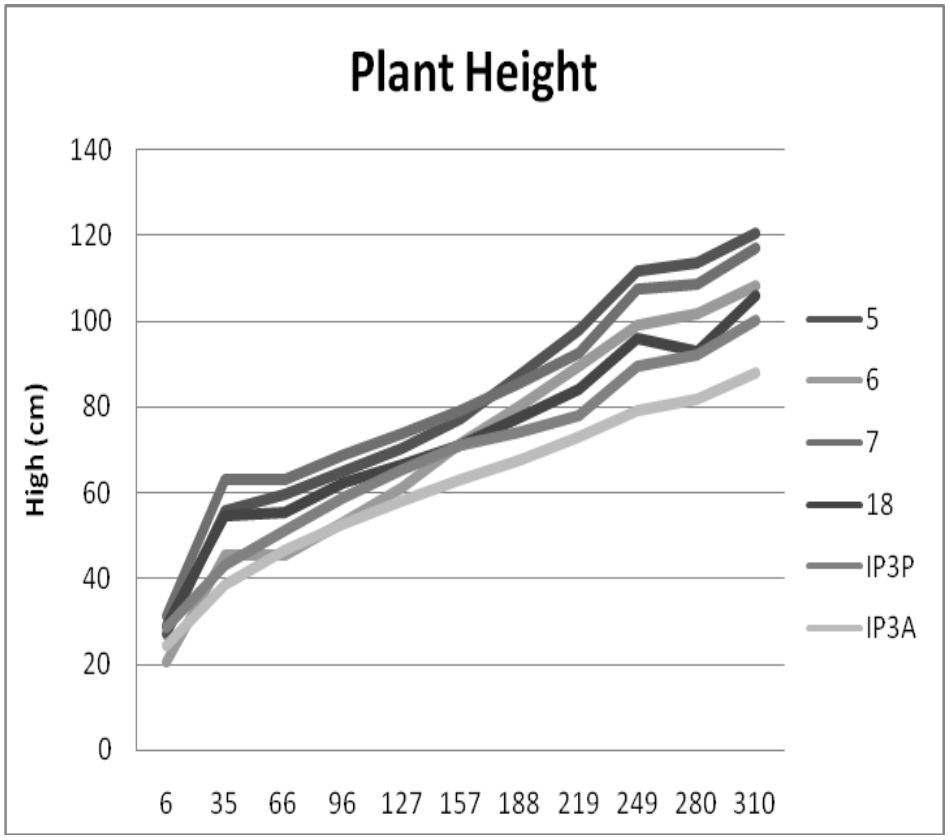

Figure 1.The Height of J.curcas L. hybrid varieties in Maumere-East Nusa Tenggara at the age of 6 up to 310 days after transplanting.

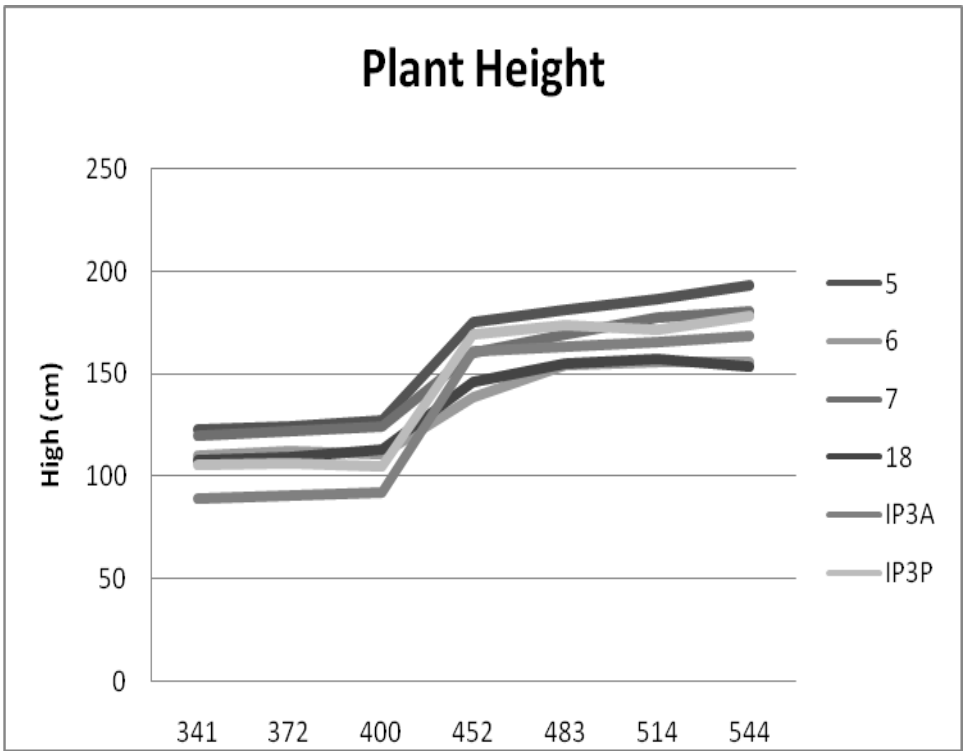

Figure 2.The Height of J.curcas L. hybrid varieties in Maumere-East Nusa Tenggara at the age of 341 up to 544 days after transplanting.

Data of plant height from varieties of *J.curcas L.* hybrid, which were tested in East Nusa Tenggara field at the age of 6 to 310 days and 341 up to 544 days after transplanting, were shown in Figures 1 and 2. In this study, the planting of Jatropha was implemented by using trunk cuttings which was about 30 cm long. Plant height growth charts showed that the average plant height achieved by *J.curcas* SP8XSP16 hybrid was higher than the other three hybrids and plant control. The figure also interpreted that upon entering the generative phase, Jatropha plants displayed a reduction in the growth rate of its height, compared to the beginning of the growing season (Figure 2)

Table 3. Average seed oil level of J.curcas L hybrids on the first and second harvests in Maumere, East Nusa Tenggara.

Accessions	Oil Level of First Harvest (% dry seed)		Oil Level of Second Harvest (% dry seed)	
SP8XSP16	36.336	a	31.252	a
SP8XSP38	36.511	a	30.190	a
SP33XHS49	36.455	a	30.717	a
SM35XSP38	37.210	a	29.232	a
IP3A	33.232	b	28.180	a
1P3P	33.537	b	29.304	a

Notes : BK= Dry Weight; The numbers followed by the same letter in the same column are not significantly different at 5% Duncan test

The average oil level of *J.curcas* hybrids' seed varieties on the first and second harvests in Maumere, East Nusa Tenggara, are presented in Table 3. The observation of seed oil level of *J.curcas* projected a difference in the first year observation. Duncan test results showed that the

four tested hybrids provided higher production of oil than the control plants. Oil level in the tested seeds of hybrid plants ranged from 36,336 to 37,210 percent of their dry weight; while in the second year of harvesting, seed oil level analysis did not show any significant differences (Table 3).

The higher number of fruit bunches and total fruits in each bunch tend to be followed by higher dry weight. This is consistent with results of previous studies, proving that the characters which have positive correlation with dried seed yielding potential and have more prominent heredity value are: leaf width, number of primary branches, number of secondary branches, total of bunches per plant and the number of fruit per plant. Therefore, these characters can be used as selection criteria in planting *J.curcas* (Zainudin et. al., 2014).

In one research on Jatropha's yielding potential in West Lombok, West Nusa Tenggara, it was reported that the production potential of the seeds in the first year could reached 189.86 g/cuttings from the origin plant, and 170.75 g/plant from seeds (Sudhakara et.al. 2012). Compared to the previous data, the potential results obtained in this study could be lower. However, in the course of this research, irrigation for plant was not given at all in order to test the sustainability of plant growth and to check potential yielding crop under severe drought.

CONCLUSION

This study results showed that SP8XSP16 hybrid plant produced the highest number of fruit/plant (97.23 fruit/plant) and the highest average dry weight of seed (179.34 g/plant) in the second harvest, with a dry weight of 100 seeds of 71.25 grams, with seed oil level of 31.252 percent and the age of first harvest on 90-91 days after transplanting. It was then followed by SP33XHS49 hybrid, with an average weight of 123.07 grams of dry seed/plant, with total fruit of 71.22, oil level of 30.72%, but the age of first harvest was longer than the other hybrids (101-102 days). In this study, the overall tested hybrids produced dry seed weight higher than the control plants (IP3A and IP3P).

ACKNOWLEDGEMENT

This study was funded by the Directorate General of Higher Education through Excellence Research Scheme of Higher Education for 2013 fiscal year. A sincere thank is delivered to the head and staffs of Research Institute for Agricultural Technology (BPTP) of East Nusa Tenggara province on aiding the maintenance and observations of planting and harvesting during the study.

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Proceedings of the 3rd International Conference on Agriculture and Forestry, Vol. 2, 2016, pp. 47-50
Copyright © TIIKM
ISSN: 2362-1036 online
DOI: https://doi.org/10.17501/icoaf.2016.2105

ALLELOPATHIC EFFECTS OF *Cyperus rotundus* L. AND *Cynodan dactylon* L. ON GERMINATION AND GROWTH RESPONSES OF LETTUCE (*Lactuca sativa*)

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Abstract

This study was conducted to investigate the allopathic effects of *Cyperus rotundus* and *Cynodan dactylon* (L.) extracts on seed germination and seedling growth characters of lettuce (*Lactuca sativa*). Four concentrations (5, 10, 15 and 20 %) of whole plant aqueous extracts of both weeds were tested for assessing their allelopathic effect on seed germination and seedling growth of Rapido 344 lettuce variety. This study was conducted at Biology Laboratory of Uva Wellassa University, Sri Lanka in 2014 and experimental units were petri dishes in depths and diameters of 2 and 5 cm, respectively. The shoot and root length, dry weight, germination percentage were measured. The experimental results revealed that all the concentrations of both the weed extracts had inhibition effect on germination percentage, shoot & root length and dry weight of lettuce. The inhibitory effect of the extracts was concentration dependent. However, at 5% of *C. dactylon* extract did not significantly affect on seed germination and growth of seedlings. The highest degree of growth inhibition was observed in 20 % of both weed extracts.

Keywords: *Cyperus rotundus*, *Cynodan dactylon*, lettuce, allelopathy

INTRODUCTION

The lettuce (*Lactuca sativa*) comes under the family compositae. It is one of the most important vegetable crops in the world. In Sri Lankan context lettuce is not cultivated as a monocrop. It is always mixed with other crops which ultimately result in low productivity. The quality, too is poor due to poor management practices. Specially weeds are the most severe and widespread biological constraint to lettuce as experienced in lettuce grown cultivars in Sri Lanka (Department of Agriculture, 2010).

Weeds are undesirable plants which compete with main crops in the growth media for nutrients, moisture, space, light and hamper the healthy growth ultimately reducing the growth and yield both qualitatively and quantitatively. Allelopathy is a harmful effect generated as a result of the secretion of biochemical substances by a given plant on a receiver plant (Rice, 1984). Allelopathy is of two types, one is true allelopathy and other is functional allelopathy.

The true allelopathy is the release of substances that are toxic in the form in which they are produced in the plant. Functional allelopathy is the release of substances that are toxic or a result of transformation by micro-organism (Wittekar, 1999). According to Muller (1969) the term allelopathy refers to the overall influence of one plant on another, due to the chemical compounds being added to the environment. The phenomenon of allelopathy has reviewed a wide attention in the past three decades in Sri Lanka.

Cyperus rotundus L. (Family Cyperaceae), also known as purple nutsedge or nutgrass, is a common perennial weed with slender, scaly creeping rhizomes, bulbous at the base and arising singly from the tubers which are about 1-3 cm long. *Cynodon dactylon* (Family: Poaceae, Arugampullu in Tamil, Dhub in Hindi, Bermuda grass in English). A creeping herb rooting at the joints with smooth upward stem. Previous phytochemical studies on C. *rotundus*

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revealed the presence of alkaloids, flavonoids, tannins, starch, glycosides and furochromones, and many novel sesquiterpenoids (Xu et al., (2008); Sayed et al., (2007) and Jeong et al., (2000)).

C. *dactylon* contains beta sitosterol, beta-carotene, vitamin C, palmitic acid, and triterpenoids. Alkaloids like ergono- vine, ergonovivine (Ravindra, 2003).

Allelopathy can be the most effective form of interference during the juvenile stages of the susceptible plants and allelopathic interactions play a major role in the determining the distributions of plants in nature and yield of different crops (Fisher, 1980). Hence, in the present investigation an attempt has been made to study the allelopathic effect of *Cyperus rotundus* L. and *Cynodan dactylon* L. on seed germination and seedling growth lettuce.

METHODOLOGY

The experiment was conducted in the Biology Laboratory at Uva Wellassa University, Sri Lanka. The experiment was performed with four different concentrations of extract of *Cyperus rotundus* L. and *Cynodan dactylon* (5, 10, 15, 20 %) and a control (0%). Each treatment including control was replicated four times. The preparation of aqueous weed extracts and germination studies were followed as per the methods of Padhy et al. (2000) and Bhatt and Chauhan (2000). The collected fully matured whole parts of *Cyperus rotundus* L. and *Cynodan dactylon* L. were air dried, ground to fine powder and extracted in water. 20 g of ground weed material was soaked in 1 L of distilled water and kept 48 hours at room temperature with occasional shaking. The infusion was decanted and filtered through three layers of Whatman number1 filter paper. From this weed extracts of 20%, further dilutions of 15, 10 and 5% were prepared with distilled water. The test units were petri dishes (diameter 4 cm and depth 2 cm). Next, 10 ml of each extract was added to each sterilized petridish and ten seeds of Rapido 344 lettuce seeds were placed. After that petri dishes were placed in the growth room in completely darkness both day and night at 25 °C. In order to neutralize evaporation and changes to the various extracts, the caps of the petri dishes were closed firmly. There were two steps in the experiment. The effect of *Cyperus rotundus* and *Cynodan dactylon* on germination, shoot length, root length and dry weight of lettuce seedlings was examined separately as two steps. Each step consisted with five treatments including control. There were four replicates in each treatment. Germination percentage, shoot length, root length, dry weight were measured. Morphological parameters were recorded on 15^{th} day after sowing. Seeds were considered germinated when the emergent root reached 2 mm length. Germination percentage was calculated using the following formulas (Eq. 1) (Mostafavi, 2011). The mean data was statistically analyzed by ANOVA followed by Duncan's multiple Significant Difference test (DMRT) at $P<0.5\%$.

$$GP = SNG/SNO \times 100\% \quad \text{(Eq.1)}$$

Where: GC is germination percentage, SNG is the number of germinated seeds, and SNO is the number of experimental seeds with viability.

RESULTS AND DISCUSSION

Aqueous weed extracts of *C. rotundus* and *C. dactylon* caused a significant inhibition on the germination of lettuce seeds over control. The intensity of inhibition differed depending upon the concentration and weed species. As the concentration of the weed extracts increased the degree of inhibition on germination percentage was increased and the extracts of both the weed species significantly affected the germination percentage of lettuce more at their higher concentration (20%). As the concentration increased, germination percentage, shoot length, root length and dry weight of lettuce seedlings decreased (Table 1).

These results are similar to the finding of Verma et al. (2002), that found the extracts of *C. rotundus* adversely inhibited the seed germination, seedling growth and biomass production of Brassica and tomato. Mandal et al., (2005), found that the higher concentrations of Populus deltoids plant extract were adversely inhibited germination, seedling growth and reduction in the content of sugar, proteins in three varieties of green gram. The reduction in the seedling growth and biomass may be due to imbalance in water uptake or osmotic balance of the tissues for germination and growth (Blum et al., 1999).

Table 1: Germination percentage, shoot length, root length and dry weight of lettuce seedlings exposed to aqueous extracts of Cyperus rotundus and Cynodan dactylon.

Extract Concentrations (%)	Germination (%)		Shoot Length (cm)		Root Length (cm)		Dry Weight (g)	
	Cyperus rotundus	*Cynodan dactylon*	*Cyperus rotundus*	*Cynodan dactylon*	*Cyperus rotundus*	*Cynodan dactylon*	*Cyperus rotundus*	*Cynodan dactylon*
Control	98a	98a	0.9a	1.2a	1.5a	1.2a	0.08a	0.07a
5	80b	85.5ab	0.5ab	1.0a	0.7b	1ab	0.05b	0.06a
10	52.5c	75b	0.3ab	0.7b	0.5b	1ab	0.01c	0.04b
15	33.3d	48.4c	0.1b	0.7b	0.3bc	0.8bc	0.005d	0.03b
20	15.5e	25d	0c	0.4ab	0.1c	0.5c	0.001e	0.01c

*Statistically, there is no significant difference among the means with the same letter in each column in Duncan's test (p = 5%)

The inhibitory effects may be due to the presence of higher amounts of growth inhibitory substances in the tuber extracts that were released during extraction. The differential degree of inhibitory (5, 10, 15 and 20 %) effect on the growth of lettuce may be due to the presence of various allelochemicals at different level in both the weed extracts. The presence of inhibitory chemicals in higher concentrations of the extract might be the reason for differential behavior of the extracts and causing maximum reduction in growth of the seedlings. Phytotoxicity of allelochemicals present in the weed extracts might be caused synergistic activity on the germination and growth of rice seedlings rather than single chemical.

CONCLUSIONS

The highest germination percentage and maximum shoot & root length and dry weight were achieved from the control treatment (no extract). The statistically observed significances are evident for the inhibitory effects of *Cyperus rotundus* and *Cynodan dactylon* on the growth of Rapido 344 lettuce variety.

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Proceedings of the 3rd International Conference on Agriculture and Forestry, Vol. 2, 2016, pp. 51-60
Copyright © TIIKM
ISSN: 2362-1036 online
DOI: https://doi.org/10.17501/icoaf.2016.2106

UTILIZATION OF AGRICULTURAL WASTES FOR OIL SPILLS REMEDIATION

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Abstract

Utilization of agricultural wastes as high-value products is gaining importance not only because it reduces the volume of waste but also solves serious environmental problems. Crustacean shells and chicken eggshells are the notable wastes generated by agro-based industries. Bioconversion of these wastes for oil spill remediation is considered a very promising and challenging approach. Chitosan from shrimp shells and Calcium Carbonate ($CaCO_3$) from chicken eggshells are among the excellent candidates for the adsorption of oil spills due to their unique properties such as biocompatibility, biodegradability and intrinsic porous structure. In this study, different proportions of Chitosan and $CaCO_3$ (50:50; 40:60 and 30:70) were varied to determine the optimum ratio that will give the highest oil removal rate. Scanning electron microscopy (SEM) showed the detailed morphology and uniform dispersion of the needle-shaped $CaCO_3$ on the Chitosan matrix. XRD analysis demonstrated sharp peaks at $2\theta = 9.40°, 29.7°, 37.3°$ which are the characteristics of crystalline Chitosan and calcite polymorph of $CaCO_3$. Oil removal efficiency test revealed that 50:50 Chitosan- $CaCO_3$ composite is the optimum ratio that yield a highest oil removal efficiency of 99%. The oil adsorption capacity of 50:50 Chitosan-$CaCO_3$ composite is 4.03g/g which is 4 times of its weight.

Keywords: Chitosan, Calcium Carbonate, oil removal efficiency, adsorption capacity

INTRODUCTION

According to the Bureau of Agricultural Statistics (2011) , the Philippines produced 4.24 Million Metric Tons of chicken and duck eggs and 55,797.12 Metric Tons of Shrimp in 2010. This represents a significant amount of waste as the shells of eggs and shrimp are normally unusable and thrown away. Kitchen scraps accounts for 45% of the country's household solid waste generation, contributing to 0.50kg/Capita/day of waste, or about 4,020 Metric Tons collected daily (World Bank, 2006; Bernardo, 2008). However, many useful compounds can be derived from these discarded materials, such as Chitosan from shrimp shells and Calcium Carbonate from chicken eggshells. Hence, methods that can extract these compounds from shells will be able to provide the benefits of reduced waste and added resources for industry.

Chitosan has drawn special interest as an effective biosorbent due to its low cost, biocompatibility, biodegradability, non-toxicity, and other unique properties such as film forming ability, chelation, adsorption and anti-microbial properties (Dutta et al, 2004). It is produced from the deacetylation of Chitin, a natural carbohydrate polymer found in the skeleton of crustaceans such as crab, shrimp and lobster. It is a cationic polysaccharide with a linear chain structure consisting of β-(1,4)-linked 2-acetamino-2-deoxy-β-D-glucopyranose and 2-amino-2-deoxy-β-D-glucopyranose. The degree of deacetylation of Chitin exceeding 50% converts the biopolymer into Chitosan. The increase of primary amine groups in Chitosan is mainly responsible for the adsorption of cations (by chelation), anions (by electrostatic attraction) or polar molecules (by interactions as ion-dipole, dipole-dipole, Van der Waals forces, etc.) (Mendez, 2010).

Calcium Carbonate is another excellent candidate as an adsorbent material due to its intrinsic porous structure. It is naturally occurring and is the most abundant inorganic material. One of the potential

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sources of Calcium Carbonate is waste chicken eggshells. Eggshells consist mainly of two materials: the calcified eggshell made of calcite and Calcium Carbonate crystals and the eggshell membrane consisting of organic matter. Dry chicken eggshells contain approximately 80-90% Calcium Carbonate by weight (Stadelman, 2000). Several studies have also successfully applied eggshells for the treatment of environmental contaminants (Park, 2007; Witoon, 2011; Ahmed et al 2012; Tsai et al 2006).

Due to the complexity of handling oil spills and its detrimental effect to humans and the environment, it is more challenging and promising to apply these useful compounds as oil adsorbent. Oil spills impose a significant cost upon the communities affected, in the form of cleanup and social costs like loss of tourism and fishing (Cohen, 2010), not to mention the destruction of the marine ecosystem, which would have far-reaching effects over many years. While the cost estimation for the cleanup of oil spills is complex and unique to the spill in question, it has been estimated that the cleanup cost of spills for the Asia-Pacific Region, particularly in the West Philippine Sea amounts to (in 1997 US Dollars) $16,006.22 per ton of contaminant spilled (Etkin, 1999), which is equivalent to $27,296.25/ton in today's money. Therefore, there is a large imperative to find low-cost, effective solutions that could both minimize solid waste and mitigate the effects of oil spills.

METHODOLOGY

1. Synthesis of Chitosan containing Calcium Carbonate from waste shrimp shells

Chitosan extraction from shrimp shells usually involves the following steps: demineralization, deproteinization and deacetylation. However, in this work, the demineralization process was not performed to retain the Calcium Carbonate inherently present in shrimp shells. Deproteinization and deacetylation were carried out by alkali treatment. The resulting Calcium Carbonate-containing Chitosan was then washed, sun-dried, ground and prepared for characterization.

2. Extraction of Calcium Carbonate in chicken eggshells and modification to superhydrophobic and oleophilic Calcium Carbonate

The eggshell membranes were removed and then the shells were rinsed and sun-dried. The dried eggshells were triturated and sieved with a 150-mesh size. Powdered Calcium Carbonate was modified into superhydrophobic and oleophilic Calcium Carbonate in a process previously discussed by Arbatan et .al. (2011).

3. Preparation of Chitosan-$CaCO_3$ composite film

Three different ratios of Chitosan and Calcium Carbonate (50:50; 40:60 and 30:70) were prepared. The Chitosan containing Calcium Carbonate from shrimp shells were dissolved in weak acid, mixed thoroughly until the solution become viscous. Then, powdered Calcium Carbonate was mixed into the solution until homogenous. The resulting mixture was poured in molding pan and dried (Figure 1).

Figure 1. Process flow of Chitosan containing Calcium Carbonate extraction

4. Analysis

The extracted Chitosan containing $CaCO_3$ from shrimp shells and $CaCO_3$ from chicken eggshells were characterized using FTIR analysis. Calcium

Carbonate content of shrimp shells and eggshells were analyzed by titrimetric method. Scanning electron microscopy (SEM; JEOL 5300, Japan) and X-ray diffraction with Cu Kα radiation (XRD; XRD-6000, Shimadzu, Japan) analyses of composite film were also performed.

5. Treatability Study

A preliminary treatability study of oil spills remediation using Chitosan-Calcium Carbonate composite film was carried out by preparing a simulated oil-contaminated water sample which was allowed to pass through the composite film by external pressure (Figure 2). The oil content of treated wastewater was analyzed using the standard method for oil and grease determination. The amount of oil removed after treatment was calculated and used for the determination of oil removal efficiency and oil adsorption capacity of the composite film.

Figure 2. Treatability study set-up

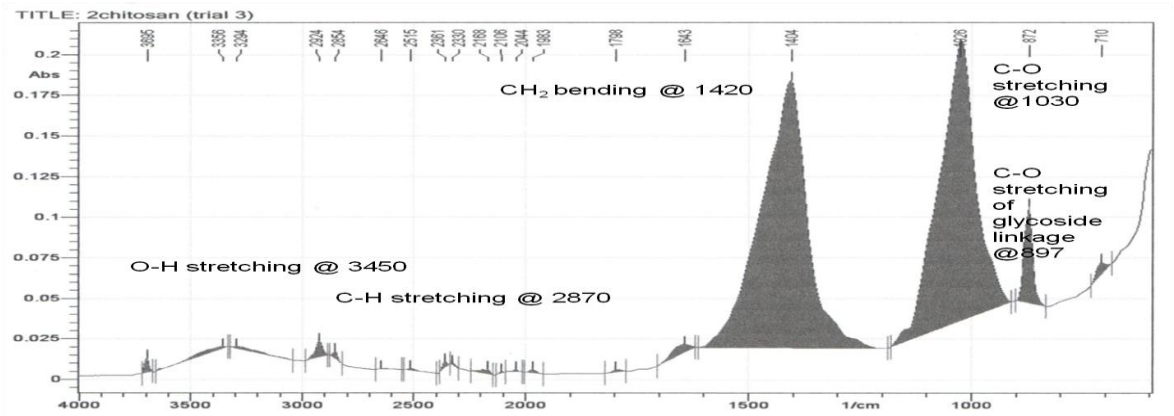
RESULTS AND DISCUSSION

1. Extraction of Chitosan containing Calcium Carbonate from waste shrimp shells

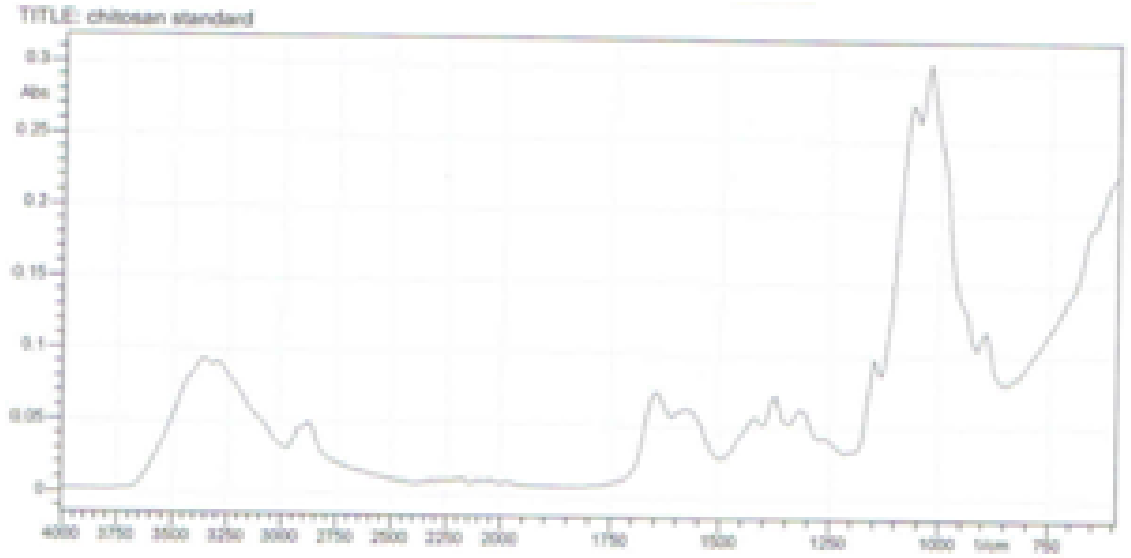
Figures 3a-c show the FTIR spectra of Chitosan containing Calcium Carbonate from shrimp shells, standard Chitosan and standard Calcium Carbonate respectively. Chitosan containing $CaCO_3$ spectra gave characteristics bands at 3450 cm^{-1} which is attributed to N-H stretching vibration of the NH_2 group and the OH stretching vibration. The band for amide I at 1643 cm^{-1} is seen in the IR spectrum of Chitosan. The characteristic carbonyl stretching of Chitosan at 1793cm^{-1} is also observed. The peaks due to C-H stretching vibrations are observed at 2923.9 and 2854.4 cm^{-1}. The major bands that correspond to Calcium Carbonate are 1396, 872, 710. All these bands appeared to be present in the reference standard spectra of Chitosan and Calcium Carbonate which confirmed the identity of the extracted Chitosan containing Calcium Carbonate.

2. Extraction of Calcium Carbonate from waste chicken eggshells

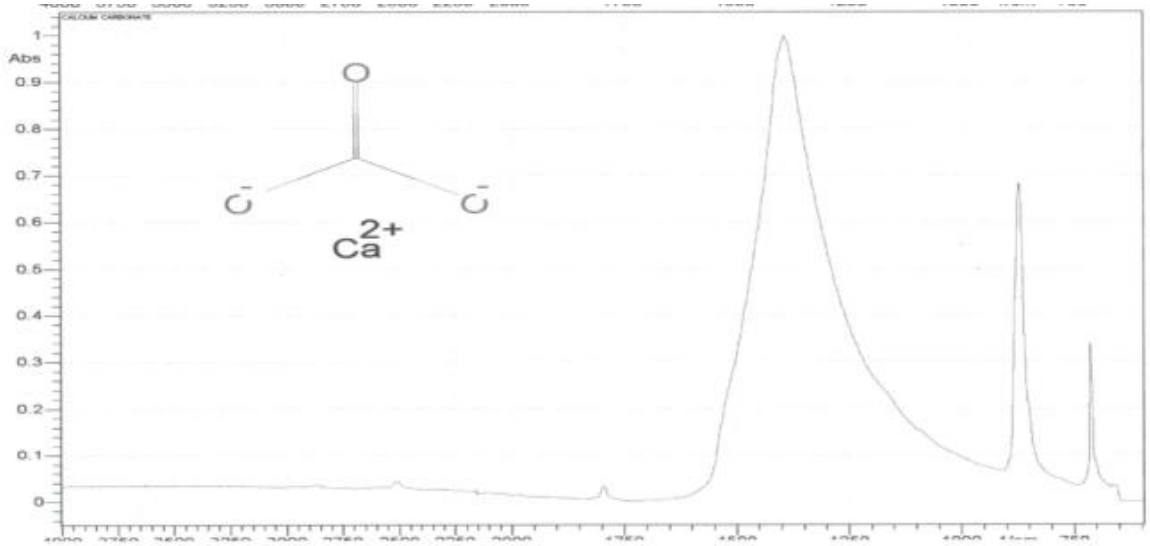
The FTIR spectra of Calcium Carbonate shown in Figure 4 illustrates the most significant intensity peak of the eggshell particle at 1404 cm^{-1}, which is strongly associated with the presence of Carbonate minerals within the eggshell matrix (Lange, 1987). There are also two observable peaks at about 709 cm^{-1} and 871.8 cm^{-1}, respectively, which are associated with the in-plane deformation and out-plane deformation modes, in the presence of Calcium Carbonate (Busca et al, 2000). The spectrum of Calcium Carbonate obtained from chicken eggshells is similar to the standard Calcium Carbonate which only proves that high quality Calcium Carbonate was extracted from chicken eggshells.



a. Extracted Chitosan containing Calcium Carbonate



b. Standard Chitosan



c. Standard Calcium Carbonate.

Figure 3. FTIR Spectra a) Extracted Chitosan containing Calcium Carbonate b) Standard Chitosan c) Standard Calcium Carbonate.

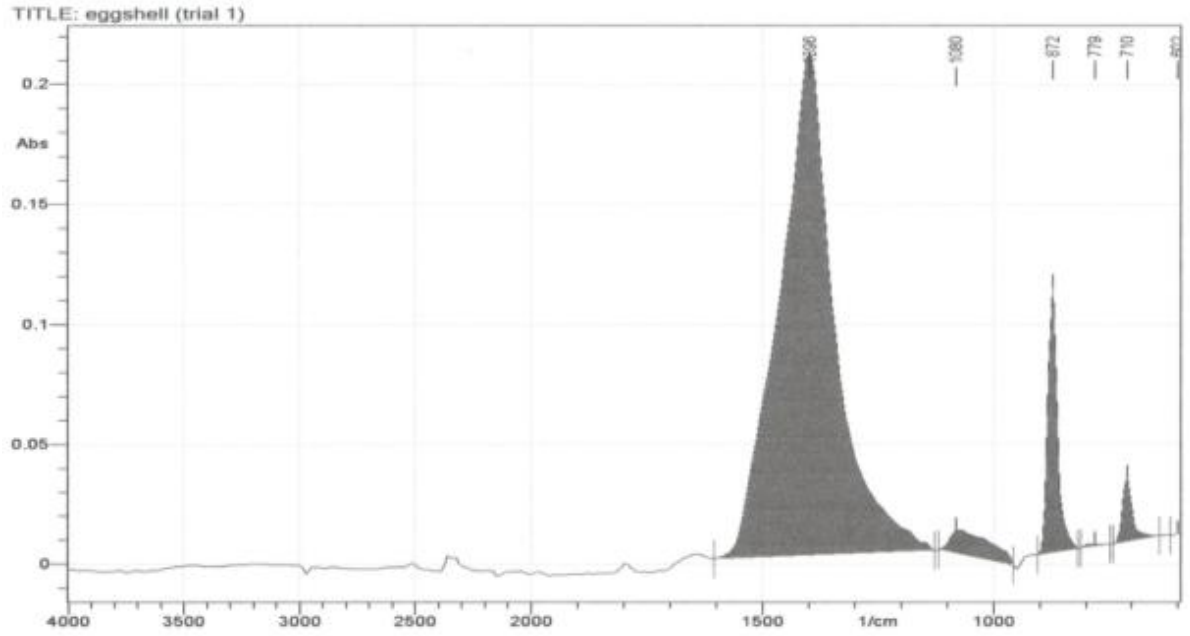


Figure 4. FTIR spectra of Calcium Carbonate from chicken eggshells.

3. Preliminary treatment of oil contaminated wastewater using Chitosan containing $CaCO_3$ from shrimp shells and $CaCO_3$ from chicken eggshells

Prior to composite film preparation, preliminary treatability of individual material was conducted to examine the potential of each material in the treatment of oil spills. Figure 5 shows the potential of the two materials in absorbing diesel oil in simulated wastewater. Chitosan containing $CaCO_3$ extracted from shrimp shells immediately adsorbed diesel oil and formed flocs. Similarly, $CaCO_3$ instantly absorbed the diesel oil but the agglomerated $CaCO_3$ settled down. In the treatment of oil spills, it is more ideal and practical to obtain larger clumps that float for ease of collection and operation. Thus, $CaCO_3$ was modified into superhydrophobic and oleophilic $CaCO_3$.

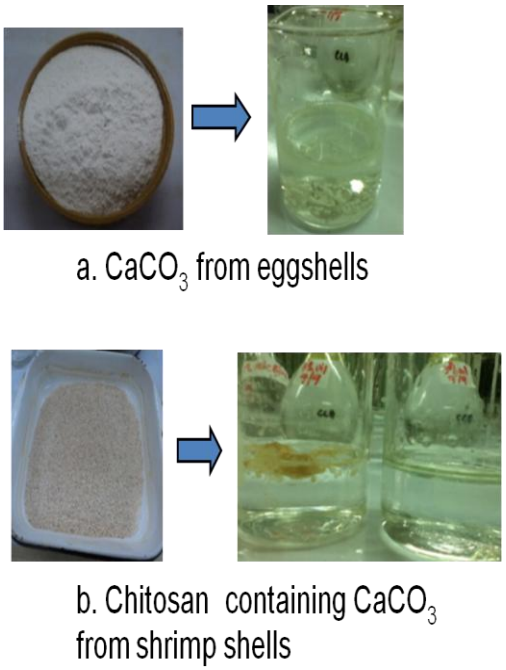


Figure 5. Preliminary treatment in the removal of oil from wastewater.

4. Determination of $CaCO_3$ content in shrimp shells and eggshell

Analysis showed that $CaCO_3$ content of extracted shrimp shells is 16.7%. Bellaaj et.al. (2012) reported that mineral matter in shrimp shells ranges from 15-70%. The lower concentration of $CaCO_3$ in

shrimp shell indicates a higher amount of Chitosan in shrimp shells. It has been noted that one of the factors determining the good quality of Chitin is the low mineral content (Tolaimate et al, 2003).

Figure 6 shows the effect of acetic acid in $CaCO_3$ content in eggshells. Acetic acid solution was used to easily remove the membrane from the shell. It was observed that raw eggshells contain 96.36 % $CaCO_3$ but after 2% acetic acid treatment, the concentration of $CaCO_3$ reduces to 92.5 % and with 4% acetic acid lowers to 92.1%. Results revealed that treatment of acetic acid slightly affects the concentration of $CaCO_3$ in chicken eggshells.

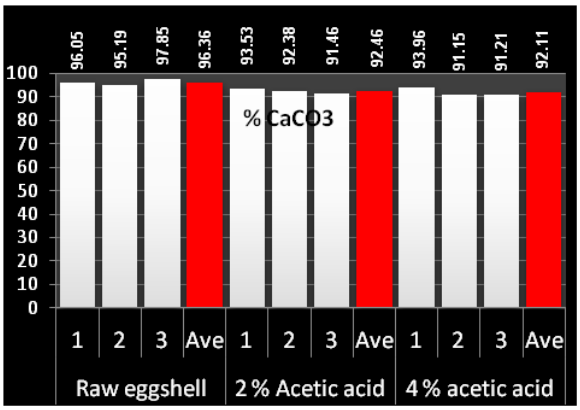


Figure 6. Effect of acetic acid in the Calcium Carbonate content of chicken eggshells.

5. Preparation of superhydrophobic and oleophilic $CaCO_3$ from chicken eggshells

Calcium Carbonate obtained from waste chicken eggshells was modified into superhydrophobic and oleophilic Calcium Carbonate to improve the physical and chemical properties of the Chitosan-Calcium Carbonate composite film. Calcium Carbonate was treated with stearic acid to improve the oil selectivity. The modified Calcium Carbonate was tested for superhydrophobicity in comparison with the unmodified Calcium Carbonate. Figure 7 illustrates that superhydrophobic Calcium Carbonate formed a suspension, separated from water which indicates an improvement on its physical properties. The impact of Calcium Carbonate on hydrophobicity was primarily attributed to the larger specific surface area of modified Calcium Carbonate. Surface treatment of Calcium Carbonate using stearic acid caused erosion effect on its surface resulting to a rougher and larger surface area.

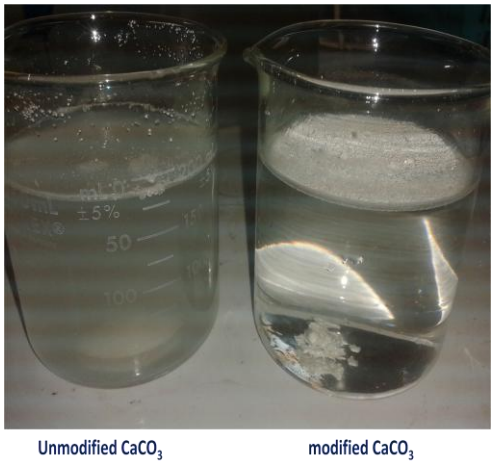


Figure 7. Comparison of modified and unmodified Calcium Carbonate.

6. Analysis of mechanical properties of Chitosan-$CaCO_3$ composite film

Figure 8 shows the tensile strength of different composite films (50:50 unmodified, 50:50 modified, 40:60 modified and synthesized Chitosan containing Calcium Carbonate). The 30-70 composite was not included in the analysis because of the weak properties that was observed during preparation. The 50:50 modified composite film exhibits the highest tensile strength of 2.32 MPa while 40:60 modified composite film displays the lowest value of 0.6 MPa. The significant increase of tensile strength of 50:50 unmodified to 50:50 modified composite film indicates that superhydrophobic and oleophilic Calcium Carbonate was dispersed homogenously and worked effectively as reinforcement filler in Chitosan composite film. The composite film became more flexible compared with the film made from unmodified Calcium Carbonate. Also, tensile strength of 2.32 MPa proved that the film can sustain higher stress load.

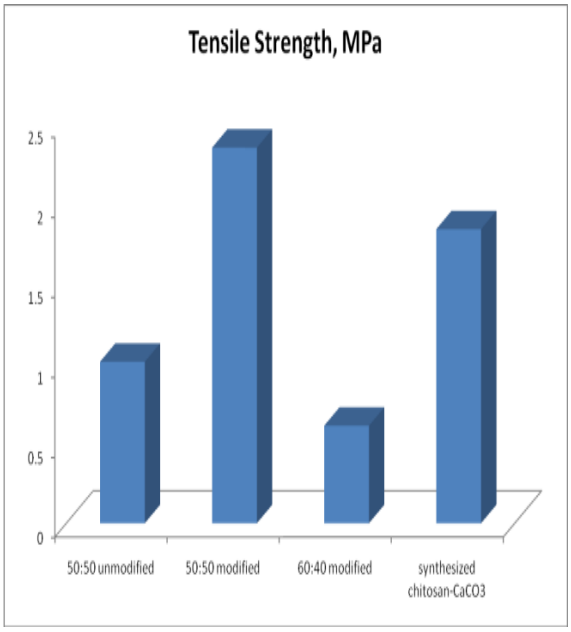
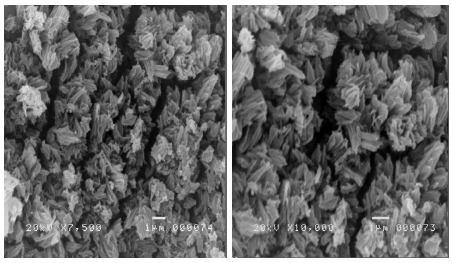


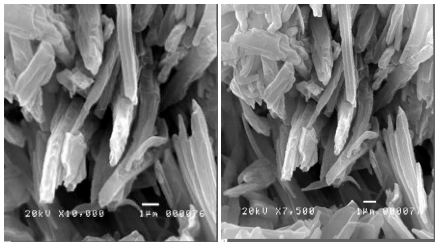
Figure 8. Tensile strength of Chitosan-$CaCO_3$ composite film.

7. Surface characterization of composite film

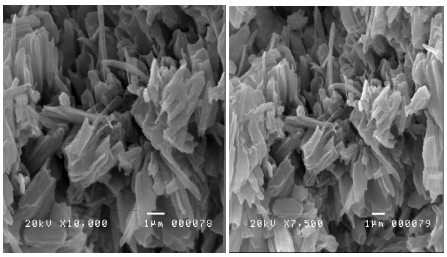
Composite films produced were subjected to surface characterization scanning electron microscopy (SEM) as shown in Figure 9. Different ratios of Chitosan and Calcium Carbonate mixture show rough and coarse microstructures which can be attributed to the presence of modified Calcium Carbonate distributed and embedded in the Chitosan matrix. The Calcium Carbonate crystal surface became rough due to the erosion effect of the stearic acid treatment. The higher proportion of needle-shaped Calcium Carbonate crystal in the composite film demonstrated an increase on particles microstructure of Calcium Carbonate. Composite film with 50:50 Calcium Carbonate-Chitosan mixture showed uniform microstructure aggregates of Calcium Carbonate.



a. 50:50 Chitosan-modified Calcium Carbonate composite film



b. 40:60 Chitosan-modified Calcium Carbonate composite film



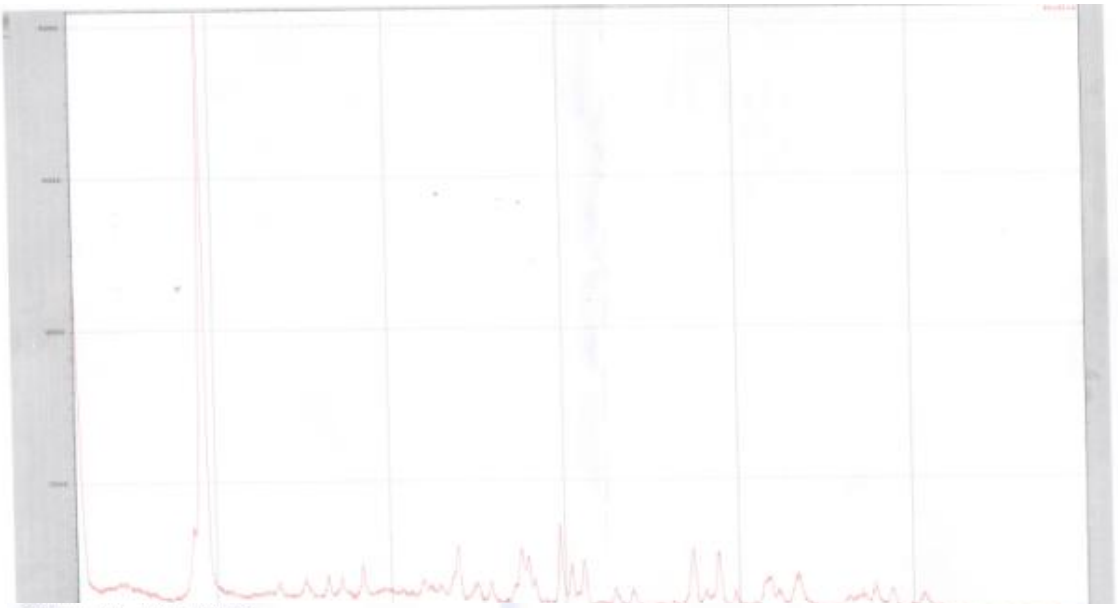
c. 30:70 Chitosan-modified Calcium Carbonate composite film

Figure 9. Scanning electron microscopy photographs of composite films at 7,500x and 10,000x magnifications.

8. XRD analysis of Chitosan-Calcium Carbonate composite film

X-ray diffractogram of 50:50 composite film shows sharp peaks at 2θ = 9.40°, 29.7°, 37.3° (Figure 10a). The first sharp peak which is a broad diffraction peak at 2θ = 9.40° may be attributed to the crystal form of Chitosan and 2θ = 29.7° and 37.3° featured the calcite polymorph of $CaCO_3$. This was validated by the XRD pattern of pure Calcium Carbonate (Figure 10b) which highlighted the high and sharp peak at 29.8° and small peaks at 36.1° and 39.6°. Yen and Mau (2007) found that fungal Chitosan showed crystalline reflection at 9.7º. Prashanth et al. (2002) also found that the WAXD (wide-angle X-ray diffraction) patterns of shrimp Chitosan showed major characteristic peak at 2θ = 9.9–10.7º. Similarly, Zhang and Gonsalves (1998) demonstrated that high peak at 2θ = 37.6° and small peaks at 28.8° represent the (110) and (104) planes of calcite. Also, it was observed from the X-ray diffractogram that lower content of $CaCO_3$, as indicated by less intense peaks, was dispersed in the Chitosan matrix.

a.



b.

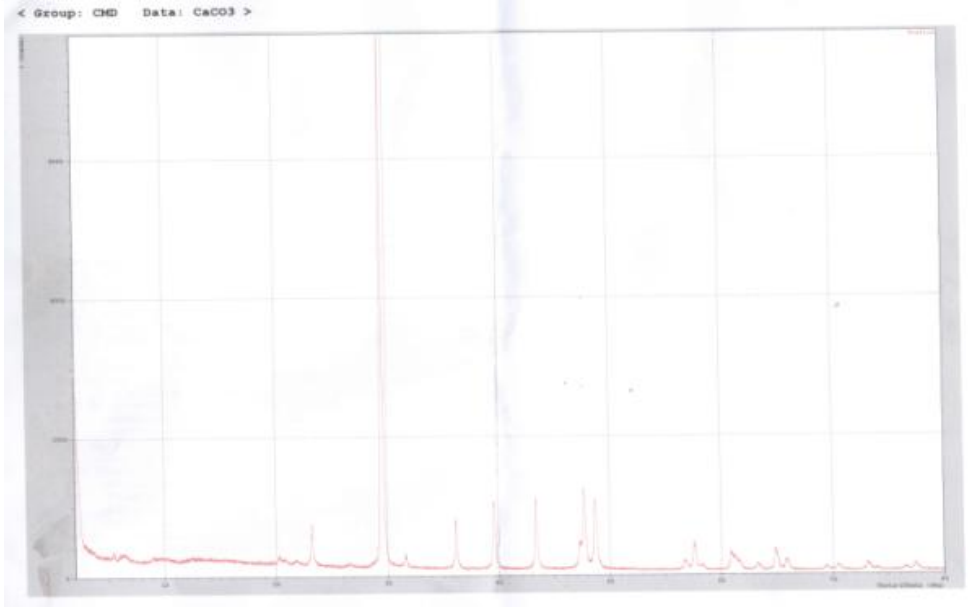


Figure 10. X-ray diffraction patterns of a) Chitosan containing Calcium Carbonate b) Calcium Carbonate

9. Oil removal efficiency test of Chitosan-Calcium Carbonate composite film

The oil removal efficiency of Chitosan-Calcium Carbonate composite film is shown in Figure 11. The initial concentration of the simulated vegetable oil contaminated water that was treated is 18,333 mg/L. A high concentration sample was used to simulate the actual oil spill scenario. Oil removal efficiency test of different Chitosan-$CaCO_3$ composite films demonstrated that 50:50 composite film can remove about 4,670 mg/L waste vegetable oil while 40:60 can treat 4,102 mg/L and 30:70 can adsorb 4,077 mg/L waste oil respectively. Also, Table 1 shows that chitosan-$CaCO_3$ composite film gave the highest diesel oil remove rate of 99.9%. Although, the removal rates of the different composite films have no significant differences, 50:50 composite film was still chosen as optimum ratio due to its physical attributes.

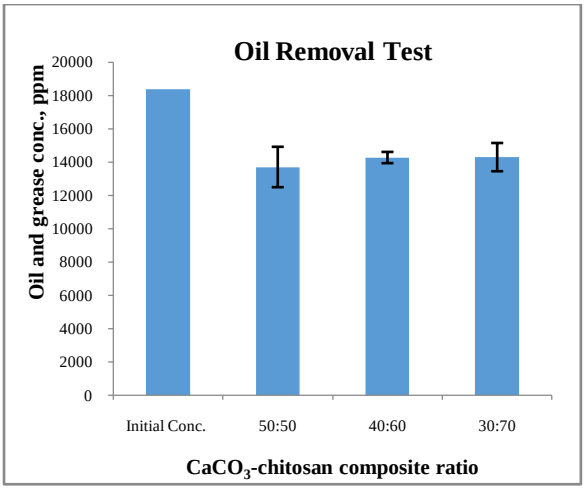


Figure 11. Vegetable oil removal/reduction rate of different Chitosan-$CaCO_3$ composite films.

Table 1. Diesel oil removal efficiency of composite films (n=3; rsd < 10%)

Composite Film Mixture	Initial Conc. (ppm)	Final Conc. (ppm)	% Removal Rate
50:50	**5000**	**5**	**99.9%**
40:60	**5000**	**15**	**99.7%**
30:70	**5000**	**15**	**99.7%**

The oil adsorption mechanism of the composite film may be attributed to the amine functional group of Chitosan which attracts anionic ions to bind and bridge (Osman and Arof, 2003). This factor causes the residue oil to bind and bridge with Chitosan film. Therefore, Chitosan a positively charged biopolymer could adsorb residue oil and destabilize the negatively charged colloids of residue oil and emulsion by charge neutralization mechanism (Jill et al., 1999). Also, the presence of superhydrophobic and oleophilic Calcium Carbonate repels water and attracts oil causing oil to bind on its surface area. The improved surface roughness of $CaCO_3$ increased its oil adsorption capacity. The oil adsorption capacity of 50:50 Chitosan-$CaCO_3$ composite film is 4.03g/g which is 4 times of its weight.

CONCLUSION

Chitosan-$CaCO_3$ composite obtained from agricultural waste (shrimp shells and chicken eggshells) was successfully developed and applied for the removal of oil (diesel and vegetable) in water. The 50:50 Chitosan-$CaCO_3$ composite exhibited a significantly high oil removal rate both for vegetable and diesel oil. The physical properties of the 50:50 composite film was also considered the best among the other composite ratios. The adsorption of residual oil on Chitosan surface can be explained by charge neutralization mechanism. The adsorption of oil on the cationic biopolymer Chitosan increases the electro-steric repulsion between oil droplets resulting to an enhanced colloidal stability. Also, addition of superhydrophobic $CaCO_3$ on Chitosan matrix promotes repulsion of water and attraction of oil on composite surface area. The improved surface roughness of $CaCO_3$ caused an increase of oil adsorption capacity of the composite materials. The maximum capacity of Chitosan-$CaCO_3$ composite film to adsorb oil (vegetable and diesel) from oil–water mixture was found to be 4.9g/g of adsorbent.

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Proceedings of the 3rd International Conference on Agriculture and Forestry, Vol. 2, 2016, pp. 61-71
Copyright © TIIKM
ISSN: 2362-1036 online
DOI: https://doi.org/10.17501/icoaf.2016.2107

TRADITIONAL METHODS OF LIVESTOCK DISEASES MANAGEMENT AMONG HERDERS IN ADAMAWA STATE, NIGERIA

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Abstract

This study analyzed the traditional methods of livestock diseases management among cattle herders in Adamawa State, Nigeria. Primary data were collected by the used of questionnaire administered to randomly selected 363 respondents. Data collected were analyzed using percentages and regression analysis. Result of the analysis showed that 87.9% of the respondents were above 40 years of age and 80% of the respondents had more than 24 years of cattle herding experience. The most common diseases in the study area were foot and mouth disease and diarrhea. Use of herbs (98.3%) and hygiene (98.9%) were the most commonly used control methods. The result of the regression analysis gave $R^2$of 96% and it revealed that there was a positive relationship between the coefficient of age, number of cattle owned and number of cattle affected by diseases at 5% level of significance. Deforestation was the major constraint to utilization of control methods. The study concluded that traditional control methods were well established and utilized by the respondents. The research recommended that investigationshould be undertaken by research institutes to ascertain the constituents of the herbs use by the herders and the precise dosage to be use in the treatment of cattle diseases. There is also need for extension workers and services to be strengthened so as to incorporate the traditional methods used by the herders.

Keywords: Traditional, livestock, disease, control

INTRODUCTION

Livestock production is a source of employment and livelihood to many people in the developing countries of sub-Saharan Africa. The industry provides continuous sources of essential food products (meat, milk, other dairy products), generates animal power and organic manure for arable farming in rural areas. In Nigeria, among all the livestock species domesticated, cattle are the most prominent and important in terms of animal protein supply, value and biomass among others. They are a form of capital that have shaped the lifestyle and cultures of many people. Cattle are essential in enabling the use of natural resources for sustainable livelihoods. It contributes to food security for both rural and urban areas and also contributes to household finances in many ways, as it can be a primary source of savings, income, credit, insurance, loan, gifts and investments. Among the nomadic Fulani pastoralists, cattle serve as index of social prestige (Ikhatua, 2000).

More than half of the total livestock population of Nigeria is permanently resident in the northern part of the country due to abundant land for grazing. Transhumance is the dominant system of cattle production. The animals are predominantly in the hands of the nomadic cattle herders who hold over 90% of the Nigeria's 19.9 million cattle (Usman, 2016). For centuries, cattle herders used a considerable wealth of traditional knowledge in cattle diseases management. These knowledge practices are developed by the herders through observation and real life experiences over a period of time, communicated orally from one generation to the other with the ultimate aim of molding their thought for the sole purpose of ensuring survival and progress. These knowledge practiceshas been the only methods available to cattle herders before

the introduction of veterinary medicine in Nigeria. But with the coming of modern veterinary medicine into the country, the traditional methods of cattle diseases control were relegated to the background and described as stagnant for the new technologies to be adopted. This may be for the assumption that, any innovation or technological breakthrough made by farmers on their own was thought to be accidental and to have developed unsystematically. It is commonplace to regard information or practice that was derived from the traditional knowledge of the people as inferior to those of modern veterinary practices. This was true especially in matters that dealt with health delivery systems (human and animals).

It was not long after the introduction of the modern animal health care system in Nigeria that the system was plagued by many problems. These include inadequate manpower, logistics and inputs, scarcity and erratic supply of veterinary services, increasing cost of veterinary drugs, poor communication facilities and other modern techniques. Due to these problems, the dependence on modern veterinary medicine alone cannot solve most of the animal health problems. Many have gone back to the use of traditional methods of livestock diseases management.

Adamawa state is one of the principal livestock producing states in Nigeria. The state has estimated 3.2 million heads cattle with abundant traditional knowledge for the control of cattle diseases (Ministry of Agriculture, 2016). The herders are familiar with these practices, they understand, handle and maintain them better than introduced modern practices and technologies. The traditional knowledge are drawn from local resources that are cheap and less dependent on outside supplies that can be costly, scarce or unavailable (Bamiboye and Kuponiyi, 2010). These resources were not documented. For instance, the study conducted in the state was mainly on documentation of parasites and diseases affecting livestock without recourse to their traditional control methods despite lots of traditional knowledge and capacity in areas of diseases control which needs to be harnessed and documented.

OBJECTIVE OF THE STUDY

The main objective of the study was to analyze the traditional methods of livestock diseases management among herders in Adamawa State, Nigeria. The specific objectives of the study were to; describe the socio-economic characteristics of the respondents; identify the traditional control methods of livestock diseases used by the respondents; ascertain the relationship between socio-economic characteristics of the respondents and use of traditional control methods and identify the constraint to utilization of traditional control methods of diseases management.

METHODOLOGY

The Study Area

The study was conducted in Adamawa State, Nigeria. The state lies between latitudes 7^0 N and 11^0 N of the equator and longitudes 11^0 E and 14^0 E of the Greenwich meridian (Adebayo and Tukur, 1999). It has a tropical climate marked by distinct dry and wet seasons and mean annual temperature is about 34.6^0c. The annual rainfall of the area ranges between 760mm in the northern part of the state to 1000mm in the southern part and has a landmass of 7,282.2 km^2. The study area has a population of 3,168,101 persons in 2006 (4,117,676 people, as at 2016 based on 2.9% growth rate) UNFPA-Nigeria (2010).

Sampling Technique

Seven out of the 21 Local Government Areas of Adamawa state were purposively selected based on the concentration of registered cattle herders. The list of registered members was obtained from the officials of their association. Based on the list obtained, respondents were randomly selected proportionate to the number of registered members from each of the Local Government Area selected using Taro Yammana's formula as adopted by (Usman *et al*., 2015). The formula is expressed as;

$n = N/1+N\,(e)^2$

Where;

n = number of respondents

N= Population of the study

e = error

In all, 400 respondents were randomly selected. However, out of the 400 questionnaires administered, 363 (91.0%) questionnaires were retrieved and used for the study

Data Analysis

Regression analysis was employed to ascertain the relationship between socio-economic characteristics of the respondents and the utilization of the control methods. Frequencies and percentages were used to analyze the socio-economic characteristics of the respondents, traditional control methods and constraints to the use of traditional control methods.

RESULTS AND DISCUSSION

1.1: Socio-economic Characteristics of the Respondents

Result on Table 1 shows that none of the respondents is below 30 years of age. About 12.1% of the respondents were between the ages of 30-39 years, while 25.3% were above 59 years. The result shows that majority (59.5%) of the respondents were above 49 years of age. Older people may have tendency of being strict on the use of the methods. This assumption stems from the fact that older people may be less adventurous and less favourably disposed towards trying new things, as opposed to younger ones (De Bono, 1993). Hence, older herders may have low expectation of benefits derived and less favourable attitudes towards use of modern veterinary practices. The management system of cattle by respondents reveals that87.6% practiced extensive system of management while 10.7% practiced semi-intensive and only 1.7% practiced intensive system of livestock management. This indicated that 87.6% of the respondents were nomadic by nature moving over long distances in search of pasture and water and sometimes moving away from suspected disease infested locations.

Result of the extension visits to the respondents was also presented in Table 1. The result reveals that about 48% of the respondents did not had any extension visit, while 18.7% had 2 visits in a year and only 3.9% had up to 12 visits in a year. Those 3.9% that indicated a visit in every month are herdsmen that are close to local government headquarters and they had to personally call the extension workers to their herds. The result implies that there were inadequate extension services to the cattle herders, because the frequency of contact between herdsmen and extension agents shows that extension service as related to cattle herding was very low.

Table 1: Socio-economic Characteristics of the Respondents (n = 363)

Socio-economic variable	Frequency	Percentage (%)
Age (years)		
30-39	44	12.1
40 – 49	103	28.4
50 – 59	124	34.2
>59	92	25.3
Herding experience (years)		
< 25	72	19.8
25-34	107	29.4
35-44	112	30.8
45-54	51	14.0
>54	22	6.0
Management Practices		

Intensive	6	1.7
Semi-intensive	39	10.7
Extensive	318	87.6
Extension Contact		
Once a month	14	3.9
Once in 2 months	5	1.4
Once in 6 months	68	18.7
Once a year	103	28.4
Not at all	173	47.7

Source: Field Survey, 2015

1.2: Number of Cattle Owned by the Respondents, Affected by Diseases and Diseases Affecting Cattle

Number of cattle owned by the respondents is presented in Table 2. About 48% of the respondents owned between 41-80 heads of cattle, while 28.4% owned less than 40 heads of cattle only 1.1% owned more 160 heads of cattle. From the result it can be seen that about 72% of the respondents owned more than 40 heads of cattle. According to Ikhatua (2000),cattle serve as index of social prestige **a**mong the nomadic Fulani pastoralists apart from the economic gain. This could be the reason why they accumulated the cattle.

Result on Table 2 also reveals that 44.9% of the respondents had between 31 – 60 heads of their cattle affected diseases and only 0.5% had more 120 heads of their affected by diseases. The result shows that all the respondents complained of occurrence diseases among their cattle. This may be as a result of extensive management system practiced by the respondents moving over long distances in search of pasture and water. In the process their cattle may be infected or aggravate the already existing infections in their herds (Inuwa, 2012). The common diseases encountered as indicated by the respondents were Foot and Mouth disease, Bloat and Contagious bovine pleura-pneumonia among others.

Table 2 Number of Cattle Owned, Affected by Diseases and Diseases Affecting the Cattle

Variable	Frequency	Percentage (%)
Number Cattle Owned		
≤ 40	103	28.4
41-80	173	47.7
81-120	73	20.1
121-160	10	2.8
>160	04	1.1
No. Cattle Affected By Diseases		
≤ 40	103	28.4
41-80	163	44.9
81-120	41	11.3
121-160	10	2.8
>160	02	0.5

Source: Field Survey, 2015

Traditional Control Methods of Cattle Diseases

Many herders manage and treat their animals without any inputs that cost money, especially if the illness is common and can be diagnosed easily. In most cases they relied on experience gained over time to arrive at a type of ailment. This is common with diarrhea, skin diseases and foot and mouth disease. The symptoms according to the respondents include frequent defecation for diarrhea, mucous dropping from mouth, fever, blisters on the teats and between the toes for foot and mouth disease. The result obtained compared favourably with the finding of a similar study conducted by Naso (2010) in Gambia. These methods of control are;

Hygiene

About 99% of respondents practiced this control method. According to respondents, it involves keeping the environment clean by weeding or cutting of shrubs and grasses and clearing their surroundings. Walter and

Dietrich (1992) reported similar finding in study conducted in Somalia. The diseases control by this method are CBPP, Tuberculosis among others. Epu (2010)assert that herders maintained cleanliness in and around enclosure in order to prevent spread of disease.

Table 3: Traditional Control Methods Used by the Respondents (n=363)

Control Methods	Frequency	Percentage (%)
Hygiene	359	98.9
Movement away from infected area	349	96.1
Bush burning	160	44.1
Use of Holy books	278	76.6
Using hot object to create scare	301	82.9
Incantations (Spiritual)	118	32.5
Isolating affected animals	351	96.7
Use of smoke	363	100
Dietary supplement to sick animals	363	100
Use of Herbs	363	100

Source: Field Survey, 2015

Movement away from the infected area

Ninety six percent of the respondents practiced this method. It involves leaving an area for another when they notice the presence of diseases especially in the case of sudden death of cattle or where they believed that there is evil spirit in the area. In the studies conducted in Somalia, Walter and Dietrich (1992) reported that most herders move away from an area if they suspect the presence of evil spirit or infection. Moving away may have advantages to the herders, but it may also result to rising conflicts between resource users.

Use of holy books

About 77% of the respondents practiced this method (Table 4.5). Verses from the holy Qur'an are read over the animals in the morning and evening for protection or read in a container with water to give to sick animal to drink. Sometimes these verses were even written on a paper and rapped up into an amulet to be worn by the animal(s) for protection or therapy against ailment (Plate 4.2). Padmakumar (1998) pointed out that, there are two main indigenous methods of treating disease by pastoralists in India, these methods according to him are magic- religious healing, mostly done by holy Qur'an and use of herbs. Adekunle *et al.* (2002) found out that 48.1% of

their respondents practiced this method in a study they conducted in Kogi and Niger states, Nigeria.

Use of Herbs

About 98% of the respondents use various herbs to control cattle diseases. It involved cutting of leaves, stem or bark, roots, seeds of herbs and boiling them for the animals to drink. It is sometime dried, grounded and added to fed or dried grounded soaked in drinking water or mixed with oil to rub on skin. For example, oil extract from the seed of Vitellariaparadoxa is used in controlling treatment of brucellosis, mastitis, ring worm, mange, foot and mouth disease and open wounds. While *Vitellaria paradoxa l*eaves is used in the treatment of CBPP. Similarly, stem bark of *Detarium microcarpum* is used in the treatment of pneumonia and open wounds, also stem bark, roots and leaves are use in the treatment of diarrhea, Mange and brucellosis (Table 4).

Table 4: Diseases Affecting Cattle and Traditional Herbs Used In Treating Cattle Disease in the Study Area

Disease	**Plant**	**Part of plant used**	**Mode of administration**
Diarrhea	*Adansoniadigitata*	Leaves	Oral
	Acacia nilotica	Seed	Oral
	Khayasenegalensis	Stem bark	Oral
	Stereospermumkunthianum	Stem bark	Oral
	Detariummicrocarpum	Stem bark, roots, leaves	Oral
	Annonasenegalensis	Stem bark	Oral
	Tamarindusindica	Leaves	Oral
	Azadirachaindica	Leaves	Oral
	Prosopisafricana	Roots	Oral
	Leptadeniahastata	Whole legume	Oral
	Vignaunguiculata	Leaves	Oral
Anthrax	*Maeruaangolensis*	Leaves, stem bark	Oral
	Nicotiatabacum	Roots and leaves	Oral
	Boswelliadalzilii	Leaves	Oral
	Piliostigmareticulatum	Bark	Tie to the head of the animal
Black quarter	*Boswelliadalzilii*	Leaves	Feed to animal
	Boswelliadalzilii	Leaves	Oral
	Piliostigmareticulatum	Bark	Tie to the head of the animal
Streptothricosis	*Aframomum Moleguetta*	Oil from the seed	Tropical
	Parkiabiglobosa	Stem bark	Tropical
CBPP	*Balanitesaegyptiaca*	Leaves	Oral
	Vitellariaparadoxa	Leaves	Feeds to animals
Lumpy skin disease	*Oncobaspinosa*	Leaves	Feeds to animal
	Guierasenegalensis	Leaves	Oral

Brucellosis	*Strigahermontheca*	Whole part	Feed to animals
	Balanitesaegyptiaca	Seed	Tropical
	Detariummicrocarpum	Roots and leaves	Tropical
	Khayasenegalensis	Stem bark	Tropical
	Oncobaspinosa	Stem bark	Feeds to animals
	Khayasenegalensis	Stem bark	Feeds to animals
	Piliostigmareticulatum	Stem	Tie to the neck of affected animal
	Vitellariaparadoxa	Seed	Tropical
	Piliostigmareticulatum	Bark	Tie to the head of the animal
Tuberclosis	*Citrus aurantifolia*	Fruits	Oral
	Allium sativa	Bulb	Oral
	Allium sativa	Bulb	Oral
	Jetrophacurcas	Leaves	Feed to animal
	Allium sativa	Bulb	Oral
	Carisaedulis	Leaves	Oral
Ring worm	*Vitellariaparadoxa*	Stem	Tropical
	Ricinuscommunis	Stem	Tropical
	Khayasenegalensis	Stem bark	Tropical
	Khayasenegalensis	Stem bark	Add to feeds
	Calotropisprecera	Whole plant	Tropical
Mastitis	*Ziziphusspina-christi*	Leaves	Tropical
	Vitellariaparadoxa	Seeds	Tropical on the udder
	Aspsragusrececosus	Leaves	Tropical as paste on the udder
	Ecliptaprostaste	Leaves	Tropical as paste on the udder
	Khayasenegalensis	Seed	Tropical on the udder
	Ricinuscommunis	Leaves	
	Boswelliadalzilii	Leaves	Tropical as paste on the udder
Mange	*Piliostigmareticulatum*	Leaves	Tropical
	Adansoniadigitata	Leaves	Tropical
	Detariummicrocarpum	Roots	Oral
	Aframomummoleguetta	Seeds	Tropical
	Calotropisprecera	Roots	Tropical
	Vitellariaparadoxa	Seeds	Tropical
Poor milk laid down	*Calotropisprecera*	Stem	Tropical
	Ricinuscommunis	Stem, leaves	Oral
	Carcia papaya	Roots, leaves	oral
	Crimiumzylanicum	Whole climber	Oral
	Parkiabiglobosa	Seed	Feeds to animals
	Psidiumguajava	Leaves and stem	Oral

	Musa sapientum	Fruits	Oral
Open wounds	*Vitellaria*	Seed	Tropical
	Boswelliadalzilii	Stem bark	Tropical
	Calotropisprecera	Whole plant	Tropical
	Detariummicrocarpum	Stem bark	Tropical
	Ricinuscommunis	Seed	Tropical
	Ricinuscommunis	Stem bark	Tropical
	Adansoniadigitata	Stem	Tropical
	Crimiumzylanicum	Whole climber	Tropical
	Oncobaspinosa	Stem bark	Tropical
	Arachyshypogeal	Shell	Tropical
Bloat	*Nicotianatabacu*	Whole plant	Intramuscular injection
	Adansoniadigitata	Leaves	Oral
	Strigahermontheca	Whole plant	Oral
	Tamarindusindica	Seeds	Oral
	Arachishypogeal	Seeds	Oral
	Boswelliadalzilii	Stem bark	Feed to animal
	Stereospermumkunthianum	Stem bark	Oral
	Detariummicrocapum	Stem bark	Oral
Food and mouth disease	*Sorghum bicolar*	Roots	Tropical
	Acacia nitolica	Seed	Tropical
	Hibiscus sabdarifa	Leaves	Tropical
	Zea mays, pennisetumglaucum	Grain	Oral and tropical
	Allium sativa and allium cepa	Bulb	Tropical
	Lawsoniainermis	Leaves	Tropical and paste
	Leptadenia hastate (formally L. lancifolia)	Leaves	Oral and tropical
	Khayasenegalensis and ziziphusspinachristi	Leaves	Oral and tropical
	Ziziphusmauritania	Leaves	Oral and tropical
	Balamitesaegyptiaca	Fruits	Oral
	Adansoniadigitata	Stem bark	Tropical
	Mimosa pigra	Stem bark	Tropical
	Mauritania	Stem bark	Oral and tropical
	Piliostigmareticulatum	Leaves	Tropical
	Jetrophacurcas	Whole plant	Tropical
	Khayasenegalensis	Stem bark	Tropical
	Sesamum	Plant	Tropical
	Citrus aurantifola	Leaves	Tropical
	Prosopisafricana	Leaves	Oral and tropical
	Parkiabiglobosa	Stem and leaves	Tropical
	Vitellariaparadoxa	Seeds	Tropical

To foster love between dam and calf	*Asparagus flagellaris*	Aerial parts	Tropical on the calf
Fracture of bone	*Debregeasisdealbata*	Sticks from the plant	Reposition and immobilized the fracture part
Fixation of fractured mandibular	*Acacia nilotica*	Fresh sticks	Reposition and immobilized
Boils	*Tamarindusindica*	Stem bark	Tropical

Source: Field Survey, 2015

RESULT OF THE REGRESSION ANALYSIS

The socio-economic characteristics affecting the utilization of traditional control methods were determined by OLS regression analysis, which is shown in Table 5. Double log was selected as the lead equation based on the coefficient of determination (R^2), and the statistical significance of the estimated regression coefficients. The R^2 was 0.96, which means that 96% of the variation in the dependent variable was explained by the various independent variables in the model.

Table 4 Result of the Regression Analysis

Variable	Coefficient	Standard error	T-value
Age ($X_{1)}$	1.194	0.121	9.863***
Management practices (X_2)	0.270	0.115	2.346**
Experience (X_3)	0.663	0.325	2.040**
No. of Cattle owned (X_4)	0.239	0.051	4.709***
No. of Cattle Affected(X_5)	18.219	3.569	5.105***
Extension Visits (X_6)	0.081	0.145	0.560 ^{NS}
Constant	0.836		
R^2	0.96		
Adjusted R^2	0.94		
F-ratio	4.19		

Source: Computed from Field Survey, 2015

*** = Significant =at 1%; ** = Significant =at 5%; NS= Not significant

Analysis of the result in Table 4 shows that coefficient of age (X1), number of cattle owned by the respondents (X4) and number of cattle affected by diseases (X5) were positive and statistically significant at 1% level. This implies that, as the herder's age increases, the more the tendency of the respondent being adhere to the use of traditional control methods. Age may influence the use of traditional control methods of cattle diseases. Older people may have tendency of being strict on the use of the methods. This assumption stems from the fact that older people may be less adventurous and less favourably disposed towards trying new things, as opposed to younger ones (De Bono, 1993). Hence, older herders may have low expectation of benefits derived and less favourable attitudes towards use of modern veterinary practices.In corroborating this position, David (2012),asserted that old people are more likely to adhere to use of

indigenous control methods of cattle diseases as it may be difficult to convince them to accept modern veterinary practices compared to young herders.

The number of cattle owned by the respondents (X4) and use of traditional control methods shows that, the higher the number of cattle owned by herder, the more the likelihood of the herders using traditional methods of diseases control. This could be because there is tendency of having diseases occurrence among their cattle most especially with extensive management system practiced by the respondents.

Coefficients of Management system (X2) and Experience (X3) were positively and significantly related to the use of traditional control methods of cattle diseases control at 5% level. The interpretation of this result is that, herders practicing extensive management system have more tendency of using traditional control methods of cattle diseases. This could be because the cattle are more exposed to diseases and the herders too have easy access to herbs since they are always in the bush with their cattle. The positive and significance relationship of years of experience implies that, as the herders experience increases, so also their knowledge on cattle diseases control methods and the ability to make use of the knowledge. Experience implies more familiarity, specialization and perfection with the practice of traditional methods, which could encourage their adherence to these methods.

Constraint to Utilization of Traditional Knowledge

Problems that inhibit utilization of traditional knowledge by the respondents were presented in Table 5. Deforestation rank first among all the problems confronting the respondents. This could be as a result increased in human activities as a result of population increase which results to clearing of forest for housing, farms and other human activities. Lack of government recognition rank second in the constraints to utilization of traditional knowledge of diseases and parasites control. Unlike modern veterinary medicine where there are research centers veterinary clinics and other logistics support, traditional knowledge people have no support, assistance or recognition from government. The constraint that ranks third was western education which many youths are exposed to. Akullo *et al.* (2007) reported that, the exposure of young generation to western education and other modern training have shifted youths attitudes away from using traditional knowledge; some youths feel it is time consuming, dirty, exhausting and sometimes dangerous to hunt for herbs in the forests and bushes than the modern technique which they see it as easier to manage. Concealment of the knowledge was another problem. Mostly traditional people share the knowledge only to their trusted children who are mostly in western education school.

Table 5:Constraints to Utilization of Traditional Control Methods

Constraint	*Frequency	Percentage
Deforestation	359	98.9
Lack of Government recognition	349	96.1
Western education	278	76.6
Concealment of knowledge	363	100
Depletion of herbs	351	96.7

Source: Field Survey, 2015

CONCLUSION

Based on empirical evidence of the study, the following conclusions were drawn: majority of the respondents were aged more 50 years of age, majority are well experienced in cattle herding and used of traditional control methods of livestock diseases. It is therefore rational and easy for the herdsmen to practice traditional methods of cattle pests and diseases control on their herds. This knowledge system can be used as a foundation for the success of all sustainable animal health care programmes and also serve as a source of pride to the herdsmen to stimulates their willingness to participate in development projects.

In view of the finding of this study, the following recommendations were made:

i. Traditional knowledge system should be incorporated in the modern teaching of veterinary medicine since the knowledge is well accepted by herders.

ii. Investigations need to be undertaken by research institutes to the constituents of the herbs ascertain the precise dosage to be use in the treatment and control of cattle diseases.

iii. There is a greater need for extension workers and services to be strengthened so as to incooperate the indigenous methods used by the herders. In this case, both access to extension service and the frequency of contacts between extension agents and herders should be strengthened.

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Proceedings of the 3rd International Conference on Agriculture and Forestry, Vol. 2, 2016, pp. 72-98
Copyright © TIIKM
ISSN: 2362-1036 online
DOI: https://doi.org/10.17501/icoaf.2016.2108

ENERGY UTILIZATION OF YAM BEAN (*Pachyrhizus erosus* L. Urban) GENOTYPES IN ILOCOS NORTE, PHILIPPINES

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Abstract

A field experiment was conducted in three sites of Ilocos Norte: to evaluate the growth and yield performance of yam bean genotypes grown at different sites; determine the nutrient-use efficiency of yam bean genotypes grown at varying fertilizer treatments; determine the energy cost of producing different yam bean genotypes with fertilizer treatments in different growing sites; and, compute for the cost and return analysis of the different yam bean genotypes grown at varying fertilizer treatments and sites in Ilocos Norte.The experiment was laid out in split-plot design with fertilizer treatments (control, organic, 50% organic + 50% inorganic, inorganic) as the main-plot factors and genotypes (G1, G2, G3, G4 and G5) as the sub-plot. Results were tested and compared across three sites. Generally, fertilizer significantly affected yield and yield contributing characters in all sites but not all with genotypes. To improve yield and other plant characters as well as enhance soil fertility conditions, the use of organic fertilizer can be done since this is the cheapest, locally available, energy efficient and gives high returns.

Keywords: yambean, genotypes, energy utilization

INTRODUCTION

Yam bean is one of the Neotropical legume genera with edible tuberous roots. It is extensively cultivated, both as a garden crop, and on a large scale for export.

In the Philippines, this crop is popularly grown particularly in Luzon areas specifically in northeastern areas like Ilocos Norte, produces high root yields of 25-40 t ha^{-1} to as high as 60 t ha^{-1}, and seed or grain yield of 4-5 t ha^{-1} (BAS, 2005). Currently, the area planted is not so wide, 24.30 ha (BAS POC Ilocos Norte, 2009) although it is periodically increasing due to attention being given because of its potential as source of additional income especially in its processed forms.

The Bureau of Agricultural Statistics Provincial Office (BASPO) of Ilocos Norte noted that there are different genotypes being grown with variable sizes and shapes at different sites in Ilocos Norte. Specifically, there are five genotypes observed being grown and sold in the local market, and in other provinces and regions that have not been identified and characterized for maximum yields and adaptability under varying growing conditions.

Yam bean root contains 32% soluble sugars and 15% starch as storage carbohydrates on dry basis (Paul and Chen, 1988). The functional properties of yam bean starch, allows it to be used as potential source of starch (Melo et al., 2003

The seeds are characterized by high oil (20-28%) and protein (23-34%) contents. Seed oil contains high concentrations of palmitic (25-30% of the total fatty acids), oleic (21-29%), and linoleic acids (35-40%) (Gruneberg et al., 1999).

The mature seeds contain up to 26% protein and 30% vegetable oil – a composition comparable to ground nut and cotton seed oils. However, the mature seeds contain up to 0.5% rotenone (an isoflavonoid), an insecticidal compound that makes them inedible but this secondary metabolite can

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prevent harmful insects in vegetable fields. (Villar and Valio, 1994).

Organic farming is not only energy efficient, as it was also found to be equally or slightly more productive. Aside from improving the fertility status of the soil, organic fertilizer sources could be locally available and does not require much energy for the handling and processing. The FAO stressed that organic farming fights hunger, tackles climate change and is good to farmers, consumers and the environment because of its non-reliance to fossil fuel. It uses locally available resources with minimal agro-ecological stresses and is cost-effective (Burcher, 2007).

Yam bean genotypes generally survive in all types of soil characteristics, but respond well to the addition of fertilizer materials. In addition, the crop shows favorable response to added nutrient inputs (Sorensen, 1990).

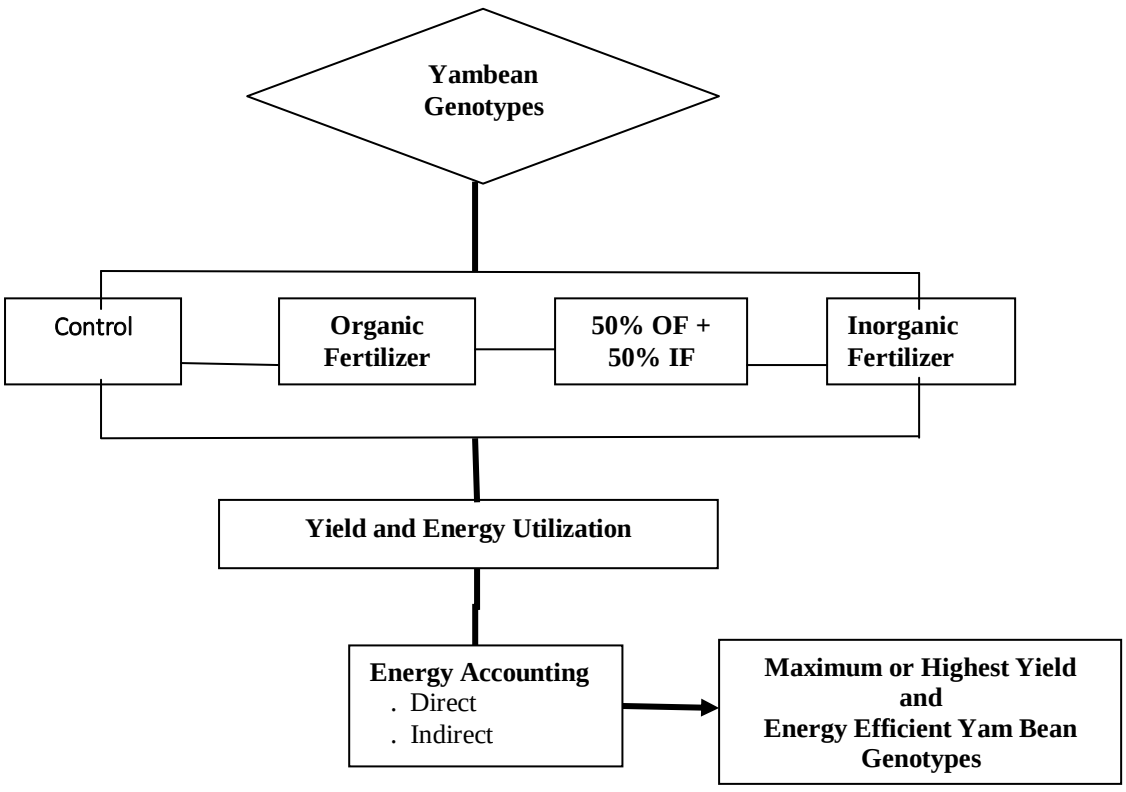
In Ilocos Norte, yam bean farmers usually apply inorganic fertilizer to their yam bean plants and it was observed based on record that the yield increased to 47.67 mt ha^{-1} (Table 1) as compared to yield during the last 5 years which was 15-20 mt ha^{-1} (DA PAO, 2009).

Energy consumption per unit area in agriculture is directly related with the development of technological level and production. The inputs such as fuel, electricity, machinery, seed, fertilizer and chemical take significant share of the energy supplies to the production system in modern agriculture. However, some problems in agricultural production have been faced due to mainly high level dependency on fossil energy. Improving the end-use energy efficiency is one of the most effective ways to reduce energy consumption in the industrial, commercial, transportation, utility, residential and agricultural sectors and their associated pollutant emissions (Dyer and Desjardins, 2003).

With the increasing demand due to the benefits from the crop, there is a need to clearly identify and evaluate these existing genotypes as to where they could fit in for optimum production.

This study was conducted to evaluate the growth and yield performance of yam bean genotypes grown at different sites; the energy cost of producing; and, compute for the cost and return analysis of the different yam bean genotypes grown at varying fertilizer treatments andsites in Ilocos Norte.

CONCEPTUAL FRAMEWORK OF THE STUDY



MATERIALS AND METHODS

Prior to the conduct of the study, a survey was done on the areas where yam bean is commonly grown (Table 1).

The experiment was conducted in three sites of Ilocos Norte, wherein each represents three soil series commonly grown to yam beans and are representative of the entire province.It was laid out in a Split-Plot Design in each site with fertilizer treatments (F) in the mainplot and the yam bean genotypes (G) in the subplot. The total area for each site was 750 m^2.

Selected tubers of the different genotypes were planted to produce seeds, 6 months before the establishment of the experiment.

During the early vegetative stages of the crops, slight presence of thrips was observed, so Tamaron® insecticide was sprayed using the recommended dosage to prevent the multiplication and spread of the pests.

Harvesting was done by manually pulling or uprooting the roots by hand or digging tools.

Table 1. Volume of production, area and yield of yam bean in Ilocos Norte (January-June, 2008-2009)

PRODUCTION (mt)		AREA (ha)		YIELD (mt ha^{-1})	
2008	2009	2008	2009	2008	2009
185.27	186.40	24.20	24.30	47.66	47.67

Source:BAS POC Ilocos Norte, 2009

The data used for this experiment and the computation of these parameters were recorded from the pre-establishment of the crop until harvesting. The author utilized the standard formula set by PCARRD 1978 for each. In terms of the energy, the procedure in the analysis and the energy coefficients of the materials and activities were based from the handbook of energy utilization by Pimentel (1980) and from relevant literatures of Mendoza (2007), Mendoza and Samson (2002), and Moerschner and Gerowitt (2000) as cited by Bockhari-Gevao, et al (2005)

Table 2. Some characteristics of yam bean genotypes used in the experiment.

ENTRY	DESCRIPTION
G_1	Green-stalked, brown-colored roots with dark-brown surface color. Medium-sized, monotuberous,semi-round, fairly lobed roots, dentate leaves, flowers light lavender borne in racemes, medium maturing.
G_2	Green-stalked, light-brown and smooth, big root size line without any lobe, flowers are borne alternately with lavender to white in color, big trifoliate leaves borne in just a short vine, late maturing roots.
G_3	Red-stalked, light brown-colored roots, little bit bigger than G_2; lobed roots with dentate leaves, flowers light lavender in color; early maturing roots.
G_4	Dark-green stalk; roots small, a little bit pointed end with strigose hairs; deeply lobed, dark-green leaves; long vines; flowers borne in clusters, deep lavender; medium to late maturing roots.
G_5	Light-green stalk; medium-sized light-brown and smooth, round, monotuberous roots; light lavender flowers borne in racemes.

G: Genotype

Table 3. Energy equivalents of labor, seed and root for yam bean production

INPUT/OUTPUT	ENERGY EQUIVALENT (Mcal/unit)	REFERENCES
Labor (hr)	0.55*	*Pimentel (1980) and Duff (1978)
Seed $(kg)_1$	1.70**	** derived from Pimentel, D. 1980 (ed.)
Root $(kg)_2$	1.14**	Handbook of Energy Utilization in Agriculture

[1]Energy coefficient of yam bean seeds (Mcal/kg)= Total energy input Mcal/kg ha^{-1}
/Total energy output (yam bean yield) (kg ha^{-1})=5475020/3212928=1.7 Mcal

[2]Energy coefficient of yam bean roots (Mcal/kg)=Total energy input Mcal/kg ha^{-1}
/Total energy output (yam bean yield) (kg $ha^{applied}$)=33789543/29715144=1.14 Mcal

Table 4. Energy equivalents of fertilizer, pesticides, machinery and diesel of yam bean production.

INPUT	ENERGY EQUIVALENT (Mcal/unit)	REFERENCES
Nitrogen	14.3	Locheritz, 1980 in Pimentel's Handbook
Phosphorous	1.6	
Potassium	1.6	
Pesticides (L)	7.61	
Machinery (kg)	18	Summarized from the different sources in Pimentel, D. 1980 (ed) Handbook of Energy Utilization in Agriculture by Mendoza (2008)
Diesel (l)	11.88	

Energy input of machinery and direct diesel energy use of yam bean production are 180 Mcal/ha and 172.10 (L ha^{-1}, respectively (BASILIO, 2000).

Combined analysis from a series of split-plot experiments across the sites (five genotypes and four fertilizer levels) was used in this study. Analysis of variance (ANOVA) was used in the analysis of the data. SAS software four windows (6.12 v) was used for the single site and combined analysis of the experiment. Treatments were compared using the Least Significant Difference (LSD) test at the 0.05 to 0.01 probability levels of significance.

RESULTS AND DISCUSSION

Soil and Climatic Characteristics of the Sites

Soil Characteristics

Site 1 (Sarrat, Ilocos Norte). The site (Barangay Cabuloan) is 7 km east of Laoag City. It is bounded in the east by the town of Piddig, in the south by San Nicolas, west by Laoag City and north by Vintar. Aside, it is bounded in the north by a mountain traversing from east to west dividing Sarrat from the town of Vintar and south by Padsan river. The soil type used for the study was identified as Umingan clay loam with particle size distribution of 13.4% sand; 35.8% silt; and 50.8% clay. Based from the pre-planting soil analysis results conducted by the Bureau of Soils Laboratory-Ilocos Norte, the soil physico-chemical properties of the experimental sites are as follows: pH of 6.30; 1.34% organic matter (OM) content; 0.67% (N); 36.08 ppm (P); and 175.51 ppm K). The soil in the experimental site is light textured and generally well-drained soil (Table 5).

Site 2 (Dingras, Ilocos Norte). Dingras is located $18^0$6'33N latitude and $120^0$41'34E longitude. It is 20 km from Laoag City. The study site (Barangay Madamba) is bounded by the towns of Piddig and Solsona in the north; by Nueva Erain the east; in the south by Marcos; and by Sarrat in the west. San Manuel silt loam was identified as the soil type of this site with particle size distribution of 20.4% sand; 58% silt; and 21.6% clay (Table 5).

Site 3 (Bangui, Ilocos Norte). The site is located in the far northern end of the province; bounded in the north by South China Sea; east by the towns of Pagudpud and Dumalneg; west by the town of Burgos; and south by the towns of Vintar. It lies between latitudes $18^0$25' and $18^0$33' N and longitudes $120^0$41' and $120^0$50' E. It is 64 km north of Laoag City. San Lorenzo (the study area) is the barangay at the heart of the town.

Bangui consists of mountainous lands which occupy >50% of the total land area. The agricultural lands are predominantly planted to seasonal annual crops such as rice, corn, garlic, lowland vegetables and some legumes as cowpea, mungbean and yam bean. The soil type of this site was identified as San Fernando clay with
particle size distribution of 28.2% sand; 35.6% silt and 36.2% clay (Table 5).

Table 5. Physico-chemical properties of the soils from the three sites before the experiment in Ilocos Norte, Philippines. 2010-2011.

Soil Property	Site 1 (Sarrat, Ilocos Norte)	Site 2 (Dingras, Ilocos Norte)	Site 3 (Bangui Ilocos Norte)
pH	6.30	6.23	6.41
Organic matter (%)	1.34	0.90	0.72
Nitrogen, N (%)	0.067	0.045	0.036
Phosphorus,P(ppm)	36.08	17.85	12.54
Potassium, K (ppm)	175.51	135.34	148.73
Texture	Light	Light	Light
Particle size (%)			
sand	13.4	20.4	28.2
silt	35.8	58.0	35.6
clay	50.8	21.6	36.2

Source: Soil survey of Ilocos Norte, Philippines (Mangloñgat et al., 1980)

Climatic Characteristics

Generally, Ilocos Norte has a Type 1 climate based on the Corona Classification. Type 1 characterized by two pronounced seasons: dry and wet seasons. However, climatic variables (rainfall, temperature and windspeed) vary across the province (PAGASA, 1998). Data on monthly minimum, maximum and mean temperatures(^{0}C), rainfall (mm), wind speed (ms^{-1}), sunshine (mn^{-1}) in the experimental area during the cropping season (field experimental period) are shown in Table 6.

Site 1 (Sarrat, Ilocos Norte) . The average minimum and maximum temperatures ranged 14.3-23.4 ^{0}C and 33.2-38.0 ^{0}C, respectively. Highest rainfall was recorded in July 2008 (1505 mm) and no precipitation was recorded in December 2009. Wind speed ranged 2-3 ms^{-1} and recorded sunshine ranged 422-647 mn^{-1}. (PAGASA- Laoag City, 2009). There is a slight modification of the climate in this site since Sarrat is bounded by a mountain traversing from east to west.

*Site 2 (Dingras, Ilocos Norte).*Prevailing climatic factors are similar to Site 1, since Site 2 is adjacent to Site 1. However, the absence of mountain (features of topography) around the area makes it better for growing crops since the weather is fair as in Site 1 with two distinct dry and wet seasons.

For Sites 1 and 2, the total amount of rainfall received during the cropping season was 2,997.9 mm with monthly average minimum and maximum temperatures of 20.36 and 35.24 ^{0}C, respectively. The average prevailing wind in Sites 1 and 2 is 3.23 m s $^{-1}$

*Site 3 (Bangui, Ilocos Norte).*The average monthly minimum, maximum and mean temperatures ranged 24.6-28.6^{0}C and 26.2 to 29.9^{0}C, respectively. The highest rainfall was recorded in December with 1879 mm. Prevailing wind speed recorded ranged 5.79 to 12.35 ms^{-1} with recorded average of 8.01 m s $^{-1}$.

The total rainfall received during the cropping period was 3,230.78 mm, with average monthly minimum and maximum temperatures of 26.44 and 28.03 ^{0}C respectively (NWPDC-BBWPP, 2009). While yam bean favorably grow and have high yields at optimum temperatures of 24^{0}C and a well-drained soil (Siemonsma and Piluek, 1993), the climatic factors during the cropping season for the experimental Sites 1 and 2 were within optimum temperature range but within upper limit. On the other hand, the minimum temperature in Site 3 was within the upper limit. In addition, the soil in Site 3 contains high proportion of sand (28.2%) and windy condition with windspeed of 8.01 ms^{-1}. This also contributed to the quick drying of the soil in this site, thus may affect the growth and development of the plants.

Table 6. Climatic data during the experimental period from March 2010 to March 2011. Sarrat, Dingras and Bangui, Ilocos Norte

Year/Month	Temperature (^{0}C)		Rainfall (mm)	Prevailing Wind Speed (ms^{-1})	Sunshine (mn^{-1})
	Minimum	Maximum			
SITE 1 and 2*					
2008 MAR	16.4	35.5	0	2	584.8
APRIL	22.1	36.3	0.1	3	646.8
MAY	23.2	35.6	65.8	3	549.4
JUNE	23.3	38.0	36.2	3	535.2
JULY	22.9	34.2	1505.1	3	363.2
AUG	22.2	34.8	805.6	3	347.7
SEPT	23.4	35.2	478.1	3	450.9
OCT	22.3	35.6	38.5	2	481.6
NOV	20.0	34.4	68.4	3	422.2

DEC.	16.0	34.2	0	3	500.6
2009 JAN	14.3	33.6	Trace	3	464.8
FEB	17.5	35.0	Trace	2	510.0
MAR	21.1	35.7	0.1	3	602.1
SITE 3**					
2008 MAR	27.9	28.05	0	6.89	No record
APRIL	26.22	27.46	Trace	7.56	
MAY	26.54	28.78	0.1	10.02	
JUNE	28.59	29.9	0	5.79	
JULY	24.78	26.67	0	7.01	
AUG	25.01	26.89	5.2	7.89	
SEPT	27.56	28.76	26.4	8.12	
OCT	27.20	29.76	189.56	7.24	
NOV	25.66	26.90	876.12	8.51	
DEC	25.94	28.18	1879.4	8.41	
2009 JAN	24.58	26.17	234	12.35	
FEB	26.01	27.52	20	7.21	
MAR	27.79	29.38	Trace	7.17	

* Source: PAGASA, Laoag International Airport, Ilocos Norte, 2009

**Source: North Wind Power Development Corporation Bangui Bay Wind Power Project, 2009

Days to Germination, Flowering and Maturity of Yam Bean Genotypes

Site 1 (Sarrat, Ilocos Norte). Days to germination in yam bean plants was significantly affected by fertilizer treatment in Site 1 (Table 7). Days to germination in this Site was observed at 4-6 days. Seeds applied with organic fertilizer germinated earlier (4 DAP), followed by the control plants (5 DAP) and the latest to germinate was by those plants applied with inorganic fertilizer. Genotype did not significantly affect days to germination of the yam bean plants. However, Genotypes 1, 2 and

4 germinated 5 DAP while Genotype 3 and Genotype 5 germinated at 6 DAP.

Days to flowering was not significantly affected by fertilizer treatments (Table 7). However, applied with inorganic fertilizer as well as control plants flowered earlier than the other fertilizer treatments. Days to flowering differed with genotypes. Among the genotypes, Genotype 4 flowered the latest (82 DAP) as compared with the other genotypes that flowered 78 (Genotypes 2 and 3) and 79 (Genotypes 1 and 5) DAP.

Fertilizer treatments significantly affected days to maturity. Plants matured the earliest in control treatments, while plants applied with organic fertilizer matured the latest (97 DAP). Among the genotypes, Genotype 3 was the earliest to mature (92 DAP), while the latest to mature was Genotype 4 (99 DAP).

In Site 1, OF application was found out to shorten germination, flowering and maturity. The addition of OF had probably contributed to the improvement of the soil since it is high in clay (Table 5). The porosity has been improved and thus contributed to proper drainage in the soil, in addition to its OM content as source of additional nutrients for proper growth of the plants. For the genotype that flowered the earliest across fertilizer treatments, this could be a genotype characteristics being an early maturing type (98 DAP).

Site 2 (Dingras, Ilocos Norte). Fertilizer treatments significantly affected days to germination of the yam bean plants (Table 7). The plants germinated 4-5 days after planting in plants applied with 50%OF + 50%IF, the earliest to germinate. With regards to genotypes, days to germination was not significantly affected although Genotype 4 and Genotype 5 germinated the earliest (4 DAP), which could be a genotype characteristics.

Flowering was significantly affected by both fertilizer treatments and genotypes. 50%OF + 50%IF application resulted to earliest flowering of the plants with 76 DAP, while the rest of the treatments flowered at the same time (80 DAP). Among the genotypes, Genotype 3 flowered the earliest with 75 DAP while Genotype 5 was the latest to flower (82 DAP)

The days to maturity was significantly affected by both fertilizer ad genotypes. Control plants matured the earliest while those with OF matured the latest with 102 DAP. Among the genotypes, Genotype 3 matured the earliest with 97 DAP and the latest was Genotype 4.

In Site 2, the soil and climatic characteristics favored the performance of the genotypes. That the particle size distribution of sand, silt and clay (20.4, 58 and 21.6% respectively) is just balanced. Such that the use of 50% OF + 50% IF is the best for this type of site with sufficient amount of soil OM that favored the activity of microorganisms and formation of soil aggregates which improved the soil structure favorable for crop growth and development.

Site 3 (Bangui, Ilocos Norte). Days to germination was not significantly affected by fertilizer. The yam bean plants germinated longer (by 3-4 days) as compared to Sites 1 and 2. Genotypes on the other hand significantly affected days to germination. Genotype 1 was the earliest to germinate (8 DAP) while Genotype 2 the latest with 10 DAP.

Fertilizer treatments did not affect days to flowering of yam bean plants in Site 3. Control plants flowered the earliest (82 DAP), while it differed with genotype wherein Genotype 1 flowered the earliest in this site.

Table 7. Days to germination, flowering and maturity of yam bean genotypes grown with different fertilizer treatments at three sites in Ilocos Norte, Philippines. 2010-2011 Cropping season

GENOTYPE	Days to Germination														
	Site 1 (Sarrat, Ilocos Norte)					Site 2 (Dingras, Ilocos Norte)					Site 3 (Bangui, Ilocos Norte)				
	C	OF	50% OF + 50%IF	IF	**Mean**	**C**	OF	50%OF + 50%IF	IF	Mean	C	OF	50%OF + 50%IF	IF	Mean
1	**5**	**5**	**6**	**5**	**5**	**6**	**6**	**4**	**7**	**6 a**	**8**	**8**	**8**	**9**	**8 c**
2	**5**	**3**	**6**	**6**	**5**	**5**	**6**	**4**	**5**	**5 ab**	**9**	**10**	**10**	**10**	**10 a**
3	**4**	**6**	**7**	**6**	**6**	**4**	**7**	**4**	**6**	**5 ab**	**8**	**10**	**9**	**9**	**9 b**
4	**4**	**4**	**5**	**5**	**5**	**5**	**3**	**4**	**5**	**4 b**	**10**	**8**	**10**	**10**	**9 b**
5	**6**	**4**	**7**	**7**	**6**	**5**	**5**	**4**	**3**	**4 b**	**9**	**9**	**9**	**10**	**9 b**
MEAN	**5 bc**	**4 c**	**6 a**	**6 ab**		**5 a**	**5 a**	**4 b**	**5 a**		**9**	**9**	**9**	**9**	
	F: Pr >F=0.0018 ; LSD= 0.96					F: Pr >F = 0.0277 ; LSD = 1.0					F: Pr >F= 0.3151 ; LSD = 0.82				
	G: Pr >F= 0.0617; LSD=1.07					G: Pr > F= 0.1057 ; LSD = 1.24					G: Pr > F= 0.0322 ; LSD=0.92				
	F X G: Pr > F =0.4445					F X G: Pr > F = 0.3190					F X G: Pr > F = 0.4774				
Days to Flowering															
1	79	82	75	78	79 ab	84	84	80	80	82 a	78	83	84	80	81 b
2	77	80	82	73	78 b	80	80	77	82	80 ab	84	84	84	83	84 a
3	73	78	83	77	78 b	76	77	74	74	75 c	84	84	84	83	84 a
4	83	81	84	82	82 a	82	82	80	81	81 a	82	84	84	84	84 a
5	77	82	77	82	79 ab	80	77	71	82	77 c	84	85	84	84	84 a
Mean	78	80	80	78		80 a	80 a	76 b	80 a		82 b	84 a	84 a	83 ab	
	F: Pr > F= 0.2273 ; LSD =1.85					F: Pr > F= 0.0124 ; LSD = 2.65					F: Pr > F = 0.0732 ; LSD =1.57				
	G: Pr > F = 0.0607; LSD = 3.45					G: Pr > F= 0.0033 ; LSD = 2.96					G: Pr > F = 0.0067 ; LSD = 1.75				
	F x G: Pr >F =0.0629					F X G: Pr >F = 0.4163					F X G: Pr > F = 0.6541				

Days to Maturity															
1	95	98	97	97	97 b	100	103	102	102	102 ab	119	119	119	120	119 b
2	94	97	95	94	95 bc	99	102	100	99	100 bc	121	121	121	121	121 a
3	92	93	92	93	92 d	97	98	97	98	97 d	119	121	120	120	120 ab
4	97	103	97	98	99 a	102	108	102	103	104 a	121	119	122	122	121 a
5	92	95	95	93	94 cd	97	100	101	98	99 cd	120	120	121	121	121 ab
Mean	94 b	97 a	95 b	95 b		99 bc	102 a	100 b	100 b		120	120	121	121	
	F: Pr > F = 0.0114 ; LSD = 1.85					F: Pr > F = 0.0170 ; LSD = 1.93					F: Pr > F = 0.3179 ; LSD = 1.15				
	G: Pr > F = 0.0001 ; LSD = 2.07					G: Pr > F = 0.0481 ; LSD = 2.16					G: Pr > F= 0.0481 ; LSD = 1.28				
	F X G: Pr > F = 0.7767					F X G: Pr > F = 0.7221					F X G: Pr > F = 0.5001				

Table 8. Yield (t ha $^{-1}$) and harvest index of yam bean genotypes grown with different fertilizer treatments at three sites in IlocosNorte. 2010-2011 Cropping Season

Within a column (G means) and/or within a row (F means), means followed by different letters are significantly different at 5% level of significance by LS

GENOTYPE	Harvest Index														
	Site 1 (Sarrat, Ilocos Norte)					Site 2 (Dingras, Ilocos Norte)					Site 3 (Bangui, Ilocos Norte)				
	C	OF	50% OF + 50%IF	IF	Mean	C	OF	50%OF + 50%IF	IF	Mean	C	OF	50%OF + 50%IF	IF	Mean
1	0.80	0.79	0.82	0.78	0.80 b	0.83	0.84	0.84	0.83	0.83	0.76	0.73	0.78	0.72	0.72
2	0.81	0,80	0.81	0.78	0.80 b	0.88	0.88	0.79	0.86	0.85	0.78	0.74	0.73	0.72	0.80
3	0.80	0.80	0.84	0.78	0.81 b	0.85	0.87	0.80	0.85	0.84	0.77	0.72	0.74	0.70	0.79
4	0.84	0.83	0.85	0.80	0.83 a	0.85	0.86	0.88	0.83	0.86	0.73	0.73	0.76	0.72	0.81
5	0.81	0.80	0.85	0.84	0.83 a	0.83	0.87	0.81	0.87	0.84	0.76	0.75	0.72	0.73	0.80
Mean	0.81 b	0.80 bc	0.83 a	0.78 c		0.85 ab	0.86 a	0.83 ab	0.85 ab		0.76 a	0.73 ab	0.74 ab	0.72 b	
	F: Pr > F = 0.002 ; LSD = 0.02					F: Pr > F = 0.001 ; LSD fert = 0.02					F: Pr > F = 0.00021 ; LSD fert = 0.03				
	G : Pr > F = 0.0032 ; LSD = 0.02					G: Pr > F = 0.1123 ; LSD gen = 0.02					G: Pr > F = 0.2134 ; LSD gen = 0.04				
	F x G : Pr > F = 0.1899 ns					F x G: Pr > F = 0.1234 ns					F x G: Pr > F = 0.3212 ns				
Yield (t ha $^{-1}$)															
1	50.67	63.33	70.33	49.67	58.50	57.83	60.00	66.50	62.50	61.71	51.67	49.50	33.67	44.00	44.71 a
2	58.33	61.13	58.83	57.67	58.99	63.00	55.00	66.17	59.00	60.79	54.00	45.33	41.33	42.17	45.71 a
3	61.33	55.00	65.50	50.33	58.04	59.00	56.83	63.67	54.50	58.50	46.33	56.70	43.17	41.17	46.84 a
4	47.50	57.17	62.17	58.67	56.38	51.00	59.50	59.17	58.17	56.96	47.50	56.17	47.67	39.50	47.71 a
5	63.67	55.33	57.67	39.73	54.10	58.00	55.00	73.50	72.17	64.67	46.33	57.17	49.67	35.33	47.13 a
Mean	56.3 bc	58.39 ab	62.90 a	51.21 c		57.77 b	57.27 b	65.80 a	61.27 ab		49.17 ab	52.97 a	43.10 bc	40.43 c	
	F: Pr >F = 0.0097 ; LSD = 6.59					F: Pr >F = 0.0441 ; LSD = 6.54					F: Pr >F = 0.0017 ; LSD = 6.52				
	G: Pr >F = 0.6603 ; LSD = 7.37					GP: Pr >F = 0.2637 ; LSD = 7.31					G: Pr >F = 0.9223 ; LSD = 7.29				
	F X G : Pr >F = 0.1235					F X G: Pr >F = 0.6532					F X G: Pr >F = 0.3972				

Harvest Index

Site 1 (Sarrat, Ilocos Norte). Results showed that harvest index (HI) was significantly affected by fertilizer treatments, while genotypes varied significantly, while there are no interaction effects observed (Table 8). The proportion of economic yield to that of biological yield was observed to be highest in plants applied with 50%OF + 50%IF (0.83 kg ha^{-1}) and the lowest was the plants applied with inorganic fertilizer (0.78 kg ha^{-1}). Genotype 4 and Genotype 5 were observed to be the highest in harvest index in this site with 0.83 kg ha^{-1}.

*Site 2 (Dingras, Ilocos Norte).*HI was significantly affected by fertilizer treatments but not with genotypes, while no interaction effects was observed. In this site, the plants applied with organic fertilizer had the highest HI value (0.86 kg ha^{-1}). The lowest was obtained from plants applied with 50%OF + 50%IF with 0.83 kg ha^{-1}. Among the genotypes, the highest HI was obtained by Genotype 4 with 0. 86kg ha^{-1} in this particular site.

Site 3(Bangui, Ilocos Norte) . Harvest index in this sitewas significantly affected by fertilizer treatments but did not vary with genotypes. Unfertilized plants obtained the highest HI among the treatments used with 0.76 kg ha^{-1}, while the lowest was from plants applied with inorganic fertilizer. Among the genotypes, Genotype 4 had the highest HI (0.81kg ha^{-1}), while the lowest was obtained from Genotype 1.

There was no significant interaction effects on the fertilizer, genotype and site. However, HI varied across sites wherein, site was found out to be significant against the other sites with respect to HI. Site 2 produced the highest HI, followed by Site 1, and the lowest was Site 3. This suggest a better partitioning of dry matter to yield in Site 2.

Yield of Yam Bean Genotypes

*Site 1 (Sarrat, Ilocos Norte).*Yam bean yield was significantly affected by fertilizer but not by genotype in this site (Table 14). The application of 50% OF + 50% IF to the plants produced the highest yield (62.90 t ha^{-1}) followed by those applied with organic fertilizer (58.39 t ha^{-1}), the lowest was with inorganic fertilizer (51.21 t ha^{-1}). The genotypes have comparable yields, although Genotype 2 produced the relatively highest yield (58.99 t ha^{-1}) in this site.

Soil in this site is of Umingan type, where balanced proportions of soil particles of sand, silt and clay, an application of 50% OF + 50% IF was found to be favorable. It has a well established effect of organic fertilizer on texture, nutrient/water retention and microbial growth. Combination of OF and IF show immediate availability of fertilizer on variable growth stages. Organic fertilizer provides micronutrients and the other growth factors not normally supplied by inorganic fertilizers (Jones and Wild, 1975).

*Site 2 (Dingras, Ilocos Norte).*Similar trend results as in Site 1 were obtained. Yield was significantly affected by fertilizer but did not vary by genotypes. No interaction effects of fertilizer treatments by genotype. Highest yield was obtained in plots with 50% OF + 50% IF (65.80 t ha^{-1}). With regards to genotype, Genotype 5 had the highest (64.67 t ha^{-1}) in this site.

With San Manuel silt loam type of soil in this site, it has high silt particle which is favorable for root crops, while this soil is low in available N as well as OM, using a combination of organic and inorganic fertilizer worked since OF is needed for the increase in microbial population for the biological N fixing activity of the plant as well as for the improvement of the soil properties and supply of other important nutrients not supplied by inorganic fertilizer.

*Site 3 (Bangui, Ilocos Norte).*Fertilizer treatments significantly affected the yield in this site (Table 8). Plants applied with organic fertilizer alone was observed to have obtained the highest yield (52.97 t ha^{-1}), followed by control plants 49.17 t ha^{-1} while the lowest was from inorganic fertilizer applied plants (40.43 t $ha^{-1)}$. Yield did vary across genotypes, although Genotype 4 and 5 appeared to be adapted to the site and condition. Similarly, genotype by fertilizer interaction was not observed on yam bean yields.

Organic fertilizer worked well in Site 3. Based from the pre-soil analysis, this site is high in sand proportion , and has low OM, N and P. In addition, Site 3 has relatively strong windspeed (8.1 ms^{-1} vs. 2-3 ms^{-1} for Sites 1 and 2), thus the area easily dries

up because it cannot retain moisture longer due to dominant particle size as well as prevailing strong winds in the area. Based on these results, the application of organic fertilizer alone increased the yield in this site. While the improved soil structure, nutrient/water retention and microbial activity had been attributed to OF.

Among the sites, the highest average yield was obtained in Site 2 followed by Site 1 and the lowest was obtained in Site 3. Among the sites, significant difference in yield was observed. However, the interaction effects of fertilizer treatment and genotype was not observed. But, with fertilizer and genotype, there were no significant interaction effects. Based on the results, yield was significantly increased by the application of 50% OF + 50% IF, specifically for Sites 1 and 2, while organic fertilizer application alone was effective in Site 3 which is more prone to water deficit conditions

Table 9 .Summary table of cost and return analysis of yam bean genotypes grown with four fertilizer treatments in three sites of Ilocos Norte Philippines. 2010-2011 Cropping Season.

Geno type	Site 1 (Sarrat, Ilocos Norte)					Site 2 (Dingras, Ilocos Norte)					Site 3 (Bangui, Ilocos Norte)				
	Control	**OF**	**50 %OF + 50 %IF**	**IF**	**Mean**	**Control**	**OF**	**50 %OF + 50 %IF**	**IF**	**Mean**	**Control**	**OF**	**50 %OF + 50 %IF**	**IF**	**Mean**
Total Production Cost (PhP ha^{-1})															
1	47610	52610	56440	60288.2	54237.05	46860	51860	55690	59538.2	53487.05	61360	66360	70190	74038.2	67987.05
2	47274	52274	56104	59952.2	53901.05	46524	51524	55354	59202.2	53151.05	61024	66024	69854	73702.2	67651.05
3	48450	53450	57280	61128.2	55077.05	47700	52700	56530	60378.2	54327.05	62200	67200	71030	74878.2	68827.05
4	47850	52850	56680	60528.2	54477.05	47100	52100	55930	59778.2	53727.05	61600	66600	70430	74278.2	68227.05
5	47274	52274	56104	59952.2	53901.05	47274	52274	56104	59952.2	53901.05	61024	66024	69854	73702.2	67651.05
Mean	47691.6	52691.6	56521.6	60369.8	54318.65	47091.6	52091.6	55921.6	59769.8	53718.65	61441.6	66441.6	70271.6	74119.8	68068.65
Gross Income (PhP ha^{-1})															
1	253350	316650	351650	248350	292500	289150	300000	332500	312500	308537.5	258350	247500	168350	220000	223550
2	291650	305650	294150	288350	294950	315000	275000	330850	295000	303962.5	270000	226650	206650	210850	228537.5
3	306650	275000	327500	251650	290200	295000	284150	318350	272500	292500	231650	283500	215850	205850	234212.5
4	237500	285850	310850	293350	281887.5	255000	297500	295850	290850	284800	237500	280850	238350	197500	238550
5	318350	276650	288350	198650	270500	290000	275000	367500	360850	323337.5	231650	285850	248350	176650	235625
Mean	281500	291960	314500	256070	286007.5	288830	286330	329010	306340	302627.5	245830	264870	215510	202170	232095
Net Income (PhP ha^{-1})															
1	205740	264040	295210	188061.8	238262.95	242290	248140	276810	252961.8	255050.45	196990	181140	98160	145961.8	155562.95
2	244376	253376	238046	228397.8	241048.95	268476	223476	275496	235797.8	250811.45	208976	160626	136796	137147.8	160886.45
3	258200	221550	270220	190521.8	235122.95	247300	231450	261820	212121.8	238172.95	169450	216300	144820	130971.8	165385.45
4	189650	233000	254170	232821.8	227410.45	207900	245400	239920	231071.8	231072.95	175900	214250	167920	123221.8	170322.95
5	271	224	232	138	2165	242	222	311	300	2694	170	219	178	102	1679

	076	376	246	697.8	98.95	726	726	396	897.8	36.45	626	826	496	947.8	73.95
Mean	233808.4	239268.4	**257978.4**	195700.2	231688.85	241738.4	234238.4	**273088.4**	246570.2	248908.85	184388.4	**198428.4**	145238.4	128050.2	164026.35
Return on Investment (PhP return per peso invested)															
1	4.32	5.02	5.23	3.12	4.42	5.17	4.78	4.97	4.25	4.79	3.21	2.73	1.40	1.97	2.33
2	5.17	4.85	4.24	3.81	4.52	5.77	4.34	4.98	3.98	4.77	3.42	2.43	1.96	1.86	2.42
3	5.33	4.14	4.72	3.12	4.33	5.18	4.39	4.63	3.51	4.43	2.72	3.22	2.04	1.75	2.43
4	3.96	4.41	4.48	3.85	4.18	4.41	4.71	4.29	3.87	4.32	2.86	3.22	2.38	1.66	2.53
5	5.73	4.29	4.14	2.31	4.12	5.13	4.26	5.55	5.02	4.99	2.80	3.33	2.56	1.40	2.52
Mean	4.9	4.54	4.56	3.24		5.13	4.5	4.88	4.13		3.00	2.99	2.07	1.73	

Formula : Total cost of production=total cash and non-cash; Gross income=YieldxPrice/kg

Net income = Gross income-Total production cost ; ROI = Net income / Total Production Cost

Cost and Return Analysis

The parameters used were total production cost, gross income, net income and return on investment (ROI) as shown in Table 9. The analysis was done to determine the economic viability of each genotype undervarying fertilizer treatments across all sites. Cash and non-cash cost were recorded and considered as total cost. Pre-land preparation, material and labor costs were included. Gross income was computed by multiplying the total produce in each treatment per genotype with the price per kilogram yield = PhP60per kg. The net income was obtained by subtracting the total production cost from the gross income. The return on investment was also determined per treatment per genotype by dividing the net income by the total cost multiplied by 100. Thus, ROI reflects the amount of return per peso invested for each treatment (Table 9).

*Site 1(Sarrat, Ilocos Norte).*The highest total production costin this site was obtained from theplots applied with inorganic fertilizer (PhP 60,370), while the lowest was the control (PhP 47,692). Among the genotypes used, Genotype 3 incurred the highest (PhP 55,077) total production cost, while Genotype 2 and Genotype 5 were equally the lowest. Genotype 3 is large-seeded, thus less number of seeds are contained per kg, such that heavier weight of planting material is needed to satisfy the seed requirement (e. g. 21,000 seeds per ha^{-1}), more were used in terms of kilogram, thus, higher seed cost. Highest gross income was obtained in plants with 50% IF + 50% OF (PhP 314,500, while the lowest was in IF applied treatment (PhP 256,070). Genotype 2 had the highest gross income (PhP 294,950), while Genotype 5 had (PhP 270,500), the lowest in yield.

Plants applied with 50% OF + 50% IF produced the highest net income (PhP 257879), while the lowest was obtained in IF applied plants (PhP 195,700). Among genotypes, the highest net income was obtained in Genotype 2 (PhP 241049), while the lowest was in Genotype 5 (PhP 216599).

Control plants had the highest ROI (4.9), while the IF applied plants had the lowest ROI (3.24). Among the genotypes, the highest ROI was from Genotype 2 and the lowest was from Genotype 5.

Site 2 (Dingras, Ilocos Norte. Among the fertilizer treatments, the highest total production cost in this site was obtained in treatment with inorganic fertilizer application (PhP 59770), while the lowest was from the unfertilized treatment with PhP 47,092. Among the genotypes, the highest was incurred by Genotype 3 (PhP 54,327), while the lowest was from Genotype 2 (PhP 53,151).

The highest was obtained from plants applied with 50% OF + 50% IF (P329010), while the lowest was with OF application (PhP 286,330). For the genotypes, the highest gross was obtained from Genotype 5 (PhP 323,337) and the lowest was from Genotype 4 with PhP 284800. In this case Genotype 5 had the highest root yield so it had the highest income.

The highest net income per hectare, was obtained in plants applied with 50% OF + 50% IF (PhP 273,088) and the lowest was with OF (PhP 234,238). With regards to genotypes, Genotype5 had the highest net income (PhP 269,436) and the lowest was Genotype 4 with PhP 231,073. High net income in Genotype 5 is due to its high yield while low net income of Genotype 4 was due to its low yield.

The ROI was highest in unfertilized plants (5.13)and the lowest was with IF (4.13). Among the genotypes, the highest was from Genotype 5 (4.99) and the lowest was from Genotype 4 with 4.32.

*Site 3 (Bangui, Ilocos Norte).*Similar to the other sites, the highest total cost of production in this site was obtained from plants applied with inorganic fertilizer (PhP 74,120) and the lowest was with the unfertilized plants (PhP 61,442). Among the genotypes, the highest was incurred by Genotype 3 (PhP 68,827) while the lowest was from Genotype 2 and Genotype 5.

For the gross income, the highest was computed from the plants applied with organic fertilizer (PhP264870) due to higher yield while the lowest was with inorganic fertilizer (PhP202170). Among the genotypes, Genotype 4 got the highest gross with PhP 238,550 while G1 had the lowest with PhP 223,550.

Plants applied with organic fertilizer had the highest net income (PhP 198,428), while the lowest was from the plants applied with inorganic fertilizer with PhP128050 due to the high production cost incurred in their fertilizer treatment.

The highest ROI was obtained from the unfertilized plants (3.00) but is comparable with the plants applied with organic fertilizer (2.99), and the lowest was with inorganic fertilizer (1.73). For the genotypes, the highest ROI was from obtained from Genotype 4 (2.53) and the lowest was from Genotype 1 with 2.33.

Considering the fertilizer treatments, the application of inorganic fertilizer incurred the highest production cost and lowest returns. This is attributed to the high cost of synthetic chemical fertilizer materials used as compared to other locally available fertilizer materials such as organic fertilizer and its cost is minimal. The use of organic fertilizer material usually improve the soil characteristics as well as microbial N fixation of the plant. Application of organic fertilizer alone or in combination with inorganic fertilizer was found to increased yield at lesser cost particularly in Site 3.

On the other hand, unfertilized plants appeared to have comparable with the high results obtained from organic fertilization. This proves that even without added fertilizer, yam bean plants can still produce with returns because this plant being a legume, has the ability to fix for its own food nutrient using the available material from the soil and its environment. However, for purposes of soil improvement especially in the areas which are less productive like in Site 3, the use of OF is favored.

Energy Utilization and Accounting

The parameters used include the data on inputs both direct (e.g. fuel & oil, machineries, fertilizers, pesticides) and indirect (e.g. seeds and labor)as well as the farm operations that include activities from pre-land preparation, fertilization, planting, care and management of the crop, harvesting and post harvest activities considered in man-days as well as man-animal days. This determines the energy cost in producing the yield of your bean genotypes grown under the different fertilizer treatments in each site in terms of energy used in addition to the cost of implementation as well as inputs used. Energy utilization was computed on a hectare-basis and liter diesel oil equivalent per kg of produced (yield).

*Site 1(Sarrat, Ilocos Norte).*Table 10 shows the summary of the result of energy accounting for growing yam bean genotypesunder different fertilizer treatments. Among the fertilizer treatments used in this site, the application of inorganic fertilizer had the highest energy spent per kilogram yam bean produced, with 8.53 L diesel oil equivalent (LDOE kg^{-1}), this was followed by plants applied with 50%OF + 50%IF fertilizer treatment (4.43 LDOE kg^{-1}) and the lowest was with the plants applied with organic fertilizer (2.18 LDOE kg^{-1}).

The high energy spent by using inorganic fertilizer can be attributed to the use of synthetic fertilizers wherein, for a given volume of produce, an expenditure of oil during the manufacture of the production inputs, and the embedded energy cost of machineries and its fuel requirement to perform a specific function were included. To manufacturer 1 kg of N fertilizer for example, would require 1.4 – 1.8 to 2.4 LDOE, this excludes the transport cost from its area of origin to its destination (Pimentel, 1980). Hence, the high cost of this fertilizer material.

*Site 2 (Dingras, Ilocos Norte).*Similar to Site 1, the highest energy spent in this site was obtained in plants applied with IF (7.05 LDOE kg^{-1}), while 50%OF + 50%IF follows with 4.24 LDOE $kg^{-1.}$ The high cost of this fertilizer treatment is attributed to the presence of N fertilizer material which is 50%. The lowest was with unfertilized plants (2.19 LDOE kg^{-1}).

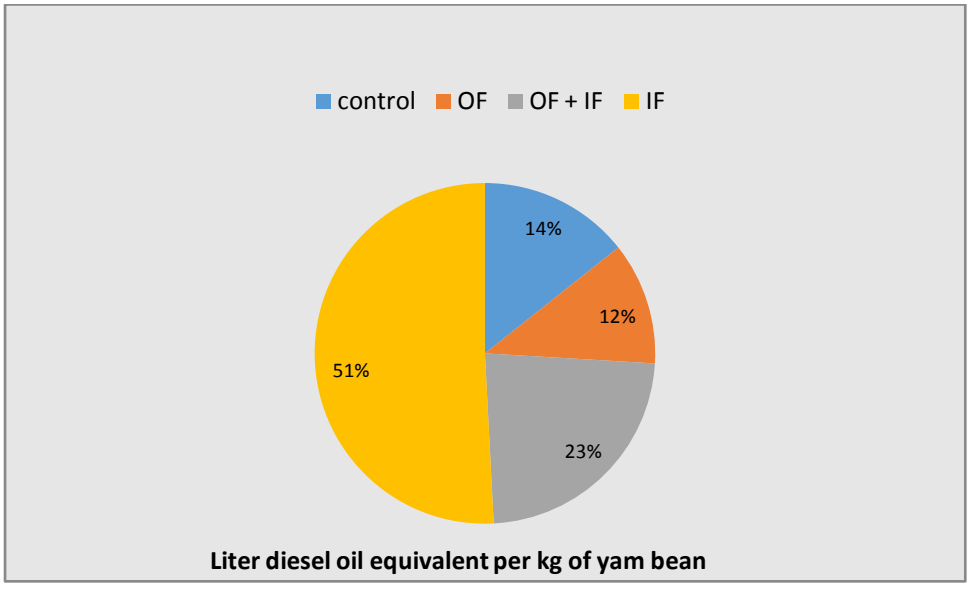
*Site 3 (Bangui, Ilocos Norte).*Generally, this site had the highest energy spent among the three sites used. The high cost in this site is attributed to the additional cost incurred considering the distance of the experimental site to the place where inputs are taken including transport cost and labor in hauling. In addition, the lower overall yield than the other two sites is also a factor of its high energy expenditure. In addition, the quality of the soil based on pre-plant analysis which is lower in some important soil factors as OM, as well as the unusual

climatic condition contributed to lower yield, thus affecting the energy cost of the crop. Among the fertilizer treatments, plants applied with IF had the highest energy expenditure (10.65 LDOE kg^{-1}), while the lowest is the OF applied plants(2.42 LDOE kg^{-1}). The low cost incurred by the plants applied with organic fertilizer alone is due to the availability of this fertilizer material at the different sites. The cost was negligible or even free in Site 3. Also, the soil improvement resulted from application of this fertilizer material as well as its contribution to increasing microbial population to the plant itself for microbial N fixation resulted to increased yield at low energy cost.

Among the genotypes used, Genotype 3spent the highest energy in all the sites while the lowest was Genotype 5.Genotype 3is a large-seeded genotype, therefore higher weight of planting matter is needed to satisfy the seeding requirement which is based on number of seeds per unit area. On the other hand, Genotype 5 has smaller seeds, so lower weight of planting material was used to satisfy the requirement of the area, resulting to lower energy expenditure.

Table 11 shows the specific site and genotype as affected by fertilizer treatments. Generally, based from the results, fertilizer treatments significantly affected the energy utilization of yam bean plants in this experiment. Plants applied with inorganic fertilizer treatment had the highest energy expenditure (8.62 LDOE kg^{-1}). Plants applied with organic fertilizer had the lowest energy spent in yam bean production in terms of LDOE per kg of yam bean produced (1.97 LDOE kg^{-1}) The low cost incurred by the plants applied with organic fertilizer alone is accounted by the availability of this fertilizer material in the different sites. The cost was negligible or even free especially in Site 3.

The application of organic fertilizer had contributed to the improvement of the soil through soil structure improvement as well as the plant itself. Being a legume, yam been has the capacity to fix microbial N for its needs. With the addition of organic fertilizer. microbial population for N fixation in the plant is increased. Among the genotypes used in this site, Genotype 1 was found out to have high yields but lowest in energy expenditure. Genetically, Genotype 1 is small-seeded, thus lesser number of seeds (in terms of weight) and thus lower energy equivalent was used.



This figure shows the energy expenditure of yam bean Genotype 1 grown in Site 1 (Sarrat, Ilocos Norte). The application of organic fertilizer spent only 12% of the total energy expenditure, followed by the plants applied with 50% OF + 50% IF, while the highest was those applied with inorganic fertilizer, with 51% of the total energy expenditure.

With respect to energy productivity in this site, the use of organic fertilizer turned out to be the most productive in terms of yield over the energy used with 0.51 kg per LDOE, while the least productive was observed from plants with inorganic fertilizer (1 liter of oil is PhP 52). On energy intensity, the use of organic fertilizer had the lowest energy intensity (1.97 LDOE per kg).

Energy intensity on the other hand refers to the amount of energy used per unit of activity. In here, the use of organic fertilizer showed the lowest energy intensity (1.97 LDOE/kg), while the highest was with inorganic fertilizer application with 8.62 LDOE/kg). These mean that applying organic fertilizer results to high quality produced at lower quantity of energy spent and lower energy spent for a higher production.

Table 10. Summary table on energy accounting of yam bean grown with four fertilizer treatments in three sites of Ilocos Norte Philippines. 2010-2011 Cropping Season

Total Production Liter Diesel Oil Equivalent (kg^{-1})															
GEN	**SITE 1**					**SITE 2**					**SITE 3**				
	CONTROL	**ORGANIC**	**50% OF +50 %IF**	**INORGANIC**	**MEAN**	**CONTROL**	**ORGANIC**	**50% OF +50 %IF**	**INORGANIC**	**MEAN**	**CONTROL**	**ORGANIC**	**50% OF +50 %IF**	**INORGANIC**	**MEAN**
1	2.45	1.97	3.94	8.62	**4.24**	2.18	2.12	4.17	6.85	**3.83**	2.43	2.56	8.24	9.73	**5.74**
2	2.14	2.06	4.70	7.40	**4.08**	1.98	2.29	4.18	7.24	**3.92**	2.31	2.78	6.69	10.13	**5.48**
3	2.09	2.35	4.27	8.55	**4.32**	2.17	2.28	4.40	7.90	**4.19**	2.77	2.28	6.48	10.45	**5.49**
4	2.66	2.23	4.47	7.31	**4.17**	2.48	2.15	4.70	7.37	**4.18**	2.66	2.27	5.83	10.85	**5.40**
5	1.96	2.28	4.79	10.75	**4.94**	2.15	2.29	3.76	5.92	**3.53**	2.69	2.20	5.57	12.09	**5.64**
MEAN	**2.46**	**2.18**	**4.43**	**8.53**		**2.19**	**2.23**	**4.24**	**7.05**		**2.57**	**2.42**	**6.56**	**10.65**	

Table 11. Energy (LDOE) accounting of yam bean with four fertilizer treatments in Sarrat, Ilocos Norte. 2008-2009 Cropping Season

	Genotype 1							
	Control		Organic (100 %)		50%OF: 50% IF		Inorganic (100%)	
ITEM	LDOE	Percent	LDOE	Percent	LDOE	Percent	LDOE	Percent
A. Seed Production								
Land preparation (4.5*18)/11.414	7.10	5.75	7.10	5.70	7.10	2.56	7.10	1.66
Planting of roots, 5 MD(5*8*.549)/11.414	1.92	1.56	1.92	1.55	1.92	0.69	1.92	0.45
Roots, (30.4*1.14)/11.414	3.60	2.91	3.60	2.89	3.60	1.30	3.60	0.84
Trellising & Cultivation,2 MD (2*8*.549)/11.414	0.77	0.62	0.77	0.62	0.77	0.28	0.77	0.18
Harvesting and threshing (seeds) 10 MD*8*.549	3.85	3.12	3.85	3.09	3.85	1.39	3.85	0.90
B. Plant Crop								
Land preparation (Machinery) (4.5*18)/11.414	7.10	5.75	7.10	5.70	7.10	2.56	7.10	1.66
Fuel	51.00	41.34	51.00	40.96	51.00	18.38	51.00	11.92
Planting, 15 MD (to include basal fertilizer appln.)	5.77	4.68	5.77	4.64	5.77	2.08	5.77	1.35
Seeds, (18 kg*1.7)/11.414	0.25	0.21	0.25	0.20	2.68	0.97	2.68	0.63
Field Lay-out (to include making of plots), 10 MD	3.85	3.12	3.85	3.09	3.85	1.39	3.85	0.90
Fertilizer (fertilizer + hauling), 3 MD			1.15	0.93	1.15	0.42	1.15	0.27
Nitrogen (214.28*14.3)/11.414					134.23	48.38	268.46	62.73
Phosphorous (150*1.6)/11.414					15.11	5.45	30.23	7.06
Potassium (16.66*1.6)/11.414					1.17	0.42	2.34	0.55
Pesticides, Tamaron, 2 lit (2*7.61)/11.414	1.33	1.08	1.33	1.07	1.33	0.48	1.33	0.31
Labor, 2 MD (2*8*.549)/11.414	0.77	0.62	0.77	0.62	0.77	0.28	0.77	0.18
Cultivation/handweeding, 20 MD*.549	7.70	6.24	7.70	6.18	7.70	2.77	7.70	1.80
Irrigation, NIA, 227mcal/11.414	19.89	16.12	19.89	15.97	19.89	7.17	19.89	4.65

Labor, 2 MD*8*.549	0.77	0.62	0.77	0.62	0.77	0.28	0.77	0.18
Harvesting (roots) 20 MD*8*.549	7.70	6.24	7.70	6.18	7.70	2.77	7.70	1.80
Total Root Production LDOE/ha	123.36	100.00	124.51	100.00	277.45	100.00	427.96	100.00
Total Root Production LDOE/kg	2.43		1.97		3.94		8.62	
yield/ha	50.67		63.33		70.33		49.67	
Energy productivity (yield output/energy input)	0.41		0.51		0.25		0.12	
Energy Intensity (energy input/yield output)	2.43		1.97		3.94		8.62	

Legend: LDOE = liter diesel oil equivalent

1 LDOE = 11.414 Mcal

Note: The number of unit indicated in the table is multiplied by the respective energy equivalent as shown below divide by 11.414 to get LDOE

Nitrogen = 14.3 LDOE

Phosphrous = 2.3 LDOE

Potassium = 1.6 LDOE

Labor = 0.549 Mcal

Seeds = 1.7 Mcal

Roots = 1.14 Mcal

Organic Fertilizer applied: Decomposed chicken manure

Nitrogen = 3.23

Phosphorous = 4.27

Potassium = 2.54

Table 12. Energy (LDOE) cost (PhP) of yam bean with four fertilizer treatments in Ilocos Norte. 2010-2011 Cropping Season.*

	Genotype 1							
	Control		Organic (100 %)		50%OF: 50% IF		Inorganic (100%)	
ITEM	LDOE	Cost (P)	LDOE	Cost (P)	LDOE	Cost (P)	LDOE	Cost (P)
A. Seed Production								

Land preparation	7.1	369.2	7.1	369.2	7.1	369.2	7.1	369.2
Planting of roots	1.92	99.84	1.92	99.84	1.92	99.84	1.92	99.84
Roots	3.6	187.2	3.6	187.2	3.6	187.2	3.6	187.2
Trellising & Cultivation,2 MD	0.77	40.04	0.77	40.04	0.77	40.04	0.77	40.04
Harvesting and threshing (seeds)	3.85	200.2	3.85	200.2	3.85	200.2	3.85	200.2
B. Plant Crop								
Land preparation (Machinery)	7.1	369.2	7.1	369.2	7.1	369.2	7.1	369.2
Fuel	51	2652	51	2652	51	2652	51	2652
Planting	5.77	300.04	5.77	300.04	5.77	300.04	5.77	300.04
Seeds	0.25	13	0.25	13	2.68	139.36	2.68	139.36
Field Lay-out (to include making of plots)	3.85	200.2	3.85	200.2	3.85	200.2	3.85	200.2
Fertilizer (fertilizer + hauling)			1.15	59.8	1.15	59.8	1.15	59.8
Nitrogen					134.23	6979.96	268.46	13959.92
Phosphorous					15.11	785.72	30.23	1571.96
Potassium					1.17	60.84	2.34	121.68
Pesticides, Tamaron	1.33	69.16	1.33	69.16	1.33	69.16	1.33	69.16
Labor	0.77	40.04	0.77	40.04	0.77	40.04	0.77	40.04
Cultivation/handweeding	7.7	400.4	7.7	400.4	7.7	400.4	7.7	400.4
Irrigation, NIA	19.89	1034.28	19.89	1034.28	19.89	1034.28	19.89	1034.28
Labor	0.77	40.04	0.77	40.04	0.77	40.04	0.77	40.04
Harvesting (roots)	7.7	400.4	7.7	400.4	7.7	400.4	7.7	400.4
Total Root Production LDOE/ha	123.36	6414.72	124.51	6474.52	277.45	14427.4	427.96	22253.92
Total Root Production LDOE/kg	2.43	126.36	1.97	102.44	3.94	204.88	8.62	448.24

*****Price per liter in Ilocos Norte is PhP52.0

The energy utilization is highest using inorganic fertilizer. Among the fertilizer materials used, the use of nitrogen fertilizer which incurred about 62.73% (which is more than half of the total energy spent), accounted the highest amount of energy bill which means that it is the main fossil fuel energy utilizing agrochemical input in addition to the cost in its manufacture which requires 2.4 LDOE aside from the transport cost incurred (Pimentel 1980). This is then the reason why farmers do not have too much or even negligible net when farming especially with the use of inorganic chemical inputs .

Therefore in order to reduce the energy cost incurred in yam bean production, it is necessary to look into some alternatives like for example the use of organic fertilizer such as decomposed chicken manure. This does not only reduce energy, monetary cost but also improves the soil properties in terms of its water and nutrient holding capacity as well as very useful to the plant especially that yam bean is a legume crop and has the capability to fix microbial N with the presence of added microbes from the organic fertilizer. As seen in Table 19, the energy cost of producing a kilo of yam bean using organic fertilizer is only 1.97 LDOE, with energy productivity of 0.51. In Table 20, it shows that the cost of energy spent using organic fertilizer was only PhP102.44 per kilo of yam bean produced.

The application of 50%OF + 50%IF produced the highest net income in Site 1 (PhP257,978) and 2 (PhP273,088). This is attributed to reduction of cost of fertilizer and high yield under this treatment. Highest net income was obtained in Genotype 2 for Site 1, while Genotype 5 for Sites 2 and 3, which is attributed to the high yields of this variety in these sites. The ROI across sites is constantly highest in unfertilized plants, which reflects low cost of production under low yield levels, while highest ROI was obtained in IF application, although this is within the high yield levels. The application of IF is the most energy consuming in producing yam bean, as reflected in the highest LDOE. The lowest LDOE was obtained in the unfertilized yam bean crop.

SUMMARY AND CONCLUSION

The three selected sites represented the three dominant soil series (Umingan clay loam, San Manuel silt loam and San Fernando clay) in the yam bean growing areas in Ilocos Norte. The four fertilizer treatments used were: control (no fertilizer applied), organic fertilizer (OF-decomposed chicken manure), 50% organic fertilizer (OF) + 50% inorganic fertilizer (IF), and inorganic fertilizer (IF) using the recommended rate in the province which is 35-60-40 kg NPK ha^{-1}. All the fertilizer materials were applied before planting. The five yam bean genotypes designated as Genotype 1, Genotype 2, Genotype 3, Genotype 4, and Genotype 5 were selected based on their availability and initial performance in the area. Initially, these were characterized using available descriptor's list for yam bean.

Six months before the study proper, seed production was done on the five genotypes used. Regular monitoring of the areas was done during the entire duration of the experiment. The data gathered were: pre-plant soil analysis (pH, organic matter and nutrient status of the soils, climatic characteristics before planting and throughout the duration of the study; agronomic parameters which include data on days to germination, flowering and maturity; root characteristics which include root length, diameter, root fresh and dry weights; shoot characteristics consisting of number of branches, shoot weight, and shoot dry weight; growth parameters which include crop growth rate, dry matter production and harvest index; yield; plant nutrient concentration and uptake, nutrient-use efficiency, energy utilization analysis and accounting; and, cost and return analysis.Climatic data were taken from two sources: from the PAGASA, Laoag International Airport and North Wind Power Development Corporation-Bangui Bay Wind Power Project.

Based on the soil analysis the study sites have varying properties. Sites 1 and 2, have almost similar in their soil and climatic characteristics in terms of P and K, while Site 1 have high OM and have clayey soil texture unlike Site 2 which has silty soil texture. Site 3 on the other hand is generally sandy, have the lowest OM and appears to be more vulnerable to drought considering the

erratic rainfall patterns and the slightly higher wind speed during the growing season.

Site 1 (Sarrat, Ilocos Norte). The application of 50% OF + 50% IF however, had the best performance in this site. Plants applied with combined OF and IF had the highest yield (62.9 t ha^{-1}). Thus, the combination of OF and IF produced the highest biomass, had the best biomass partitioning to yield, and had the best conversion of absorbed nutrient (N and P) to yield formation in this site.

Among genotypes, Genotype 1 performed-well in this site. Although Genotype 1 had the best yield (58.99 t ha^{-1}) in this site, Genotypes 4 and 5 showed good performance, i.e., Genotype 4 (56.38 t ha^{-1}) had the highest HI.

Plants applied with 50% OF + 50%IF produced the highest net income (PhP 257,879), while the lowest was in IF applied plants (PhP 195,700). Genotype 2 produced the highest net income (PhP 241,049) while the lowest is Genotype 5 (PhP 216,599). The lower net income obtained in Genotype 5 was attributed to high cost of the seeds, in spite of its relatively high yield. In terms of ROI, unfertilized plants had an ROI of 4.9, with no cost for fertilizer input, but relatively within the low yield levels. On the other hand, the application of inorganic fertilizer (IF) produced the lowest ROI (3.24). The 50% OF + 50% IF had ROI of 4.56, while producing a high yield level. Among the genotypes, the highest ROI was obtained in Genotype 2, while the lowest was in Genotype 5.

With respect to the energy spent, plants applied with inorganic fertilizer spent the highest with 8.53 LDOE, while the lowest was with OF (2.18 LDOE). Among the genotypes, Genotype 5 incurred the highest with 4.94 LDOE, while the lowest was Genotype 2 (4.08 LDOE).

Site 2 (Dingras, Ilocos Norte) Plants applied with 50% OF + 50% IF were the earliest to germinate, flower and mature. This fertilizer treatment also produced the heaviest root weight (65.80 t ha-1), all translated to high yield of this treatment in Site 2.

The highest net income was obtained from plants applied with 50% OF + 50% IF (PhP 273,088), while the lowest was from plants applied with OF (PhP 234, 238). Genotype 5 had the highest net income (PhP 269,436).

The highest ROI was obtained from unfertilized plants (5.13) while the lowest was from plants applied with inorganic fertilizer (1.73). Plants applied with inorganic fertilizer spent the highest energy with 7.05 LDOE while the lowest was in unfertilized plants (2.19 LDOE). Among the genotypes, Genotype 3 had spent the highest energy with 4.19 DOE, while Genotype 5 the lowest with 3.53 LDOE.

Site 3 (Bangui, Ilocos Norte). Organic fertilizer application (OF) was observed to be the best among fertilizer treatments. The application of 50% OF + 50% IF also produced good yield (43.10 t ha-1) in this site compared with IF and unfertilized control. While this site is prone to water stress (sand texture, uneven rainfall distribution within the growing season and windy environment), the application of OF alone appears to improve yield as supported by relatively high biomass production, allocation of dry matter to the economic yield, K uptake (as an osmolyte) and high conversion of absorbed P to yield formation. Genotype 4 had the highest yield in this site (47.71 t ha^{-1}), which suggests that this genotype may have the tolerance to adverse conditions, like Bangui, Ilocos Norte.

The plants applied with organic fertilizer had the highest net income (PhP 198, 423) while the lowest was from the plants applied with inorganic fertilizer (PhP 128,050). The high net income from the plants applied with inorganic fertilizer is attributed to no cost of fertilizer material while for inorganic, the fertilizer material cost very high. The highest ROI was obtained from unfertilized plants (3.00) and plants applied with organic fertilizer had the lowest ROI of 1.73.

The highest energy in this site was spent by plants applied with inorganic fertilizer (10.65 LDOE), while the lowest was from plants applied with organic. For the genotypes used, Genotype 1 spent the highest energy (5.74) while the lowest was spent by Genotype 4 with 5.40 LDOE.

Based on the combination of experimental variables, namely fertilizer treatments and genotypes grown in three sites with varying

edaphic and climatic characteristics, the following generalizations and conclusions were derived from the results:

The application of 50% OF + 50% IF produced the highest yam bean yield in Sites 1 and 2 with relatively good soil characteristics and climatic conditions. The application of OF in Site 3, which is characterized by sandy texture, uneven rainfall, windy condition or in general drought prone areas, produced the highest yield which is supported by the growth and efficiency parameters.

None of the test genotypes had consistent performance (yield) across sites. When the best fertilizer treatment is considered per site, Genotype 1 in Site 1 and genotype 5 in Site 2 performed with application. For Site 3 (drought-prone) Genotype 5 produced the highest yield, as reflected on the growth and nutrient use efficiency parameters. Thus genotype 5 is adapted to favorable as well as unfavorable environments in coupled with appropriate fertilizer application.

The application of 50% OF + 50% IF produced the highest net income in Sites 1 (PhP 257,978) and 2 (PhP 273,088). This is attributed to reduction of cost of fertilizer and high yield levels this treatment. Highest net income was obtained in Genotype 2 for Site 1 while Genotype 5 for Sites 2 and 3, which is attributed to the high yield of this variety in these sites.

The ROI across sites is consistently highest in unfertilized plants, which reflects low cost of production under low yield levels while the highest ROI was obtained in IF application, although this is within the high yield levels.

The application of IF is the most energy consuming in producing yam bean, as reflected in the highest LDOE for this fertilizer practice. The lowest LDOE was obtained in the unfertilized yam bean crop.

Generally, it can be concluded that yam bean production in different growing sites with varying edaphic conditions vary the productivity, cost and return analysis and energy utilization, and as was observed the use of different materials with yam bean genotypes could be grown to particular fertilizer regime.

In Ilocos Norte, with the varying soil types accompanied by unpredictable climatic condition in scattered areas, the use of either organic fertilizer or a combination of organic and inorganic fertilizer can give good returns in the improvement not only the soil condition but also the income of the Ilocanos. Moreso, yam bean crop is a manageable crop and it grows well with these kind of fertilizer materials as was proven by this experiment. In the grass roots of the province, most of the farmers are unable to finance their farming activities, using the available fertilizer material like organic which is just within their vicinity.

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Proceedings of the 3rd International Conference on Agriculture and Forestry, Vol. 2, 2016, pp. 99-107
Copyright © TIIKM
ISSN: 2362-1036 online
DOI: https://doi.org/10.17501/icoaf.2016.2109

FSM GIANT SWAMP TARO SALINITY TOLERANCE EVALUATION

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Abstract

Giant swamp taro (*Cyrtosperma chamissonis* or *C. merkusii* Schott) is an important crop at atolls and mountainous islands in Micronesia. However, some dwellers abandon their taro patches damaged by recurrent wave surges and salt-water intrusion. We addressed this issue about threatened food security and impacts of climate change through a research endeavor funded under Tropical and Subtropical Agricultural Research Grant /United States Department of Agriculture. We focused on collection and evaluation of various cultivars of *Cyrtosperma* seedlings grown under fresh saltwater swamp for two years. We collected forty three cultivars from Chuuk and Pohnpei states of the Federated States of Micronesia. After morphological characterization of their petioles, leaves and corms, we identified 15 different groups. We determined percentage survival, mean sucker number, monthly mean corm size and leaf damages of these groups. Furthermore, two popular cultivars underwent time-series soaking in the ocean water with mean salt water concentration of 56,228 parts per million or ppm (5.6%). Determining root losses, P and K of this taro seemed a promising practical evaluation method for salt tolerance. Both cultivars lost 50 % of their roots at 28-hour soaking, started increasing phosphorus (P) removal from their tissues at 30 hours of soaking and absorbed potassium (K) from the soak water starting at two hours and onward. Afterwards, all groups soaked in ocean water with an average of 49, 928 ppm (5.0%) for seven hours showed different magnitudes of losses in root number, cuts in intact roots and biomass.

Keywords: giant swamp taro, atolls, food security, salt tolerance, time-series soaking, ppm, biomass losses

INTRODUCTION

Giant swamp taro *(Cyrtosperma chamissonis* or C. *merkusii* Schott) is an important crop at atolls and mountainous islands in Micronesia. It is referred to as the "potato of the Pacific". It offers a continuity of food to people in low lying atolls throughout the years. However, the Federated States of Micronesia situated at 6^0 55' North longitude and 158^0 11' East latitude with four states (Chuuk, Kosrae, Pohnpei and Yap) is directly vulnerable to sea level rise that causes salinization and coastal erosion. According to

Brown (2014), global average sea level rise is about 3.2 millimeters (mm) per year but tropical western Pacific had 12 mm per year sea level rise between 1993 and 2009.

Quick fix such as building seawalls to keep water out from the taro patches was not effective. In fact, some dwellers abandon their taro patches damaged by recurrent wave surges and salt-water intrusion. Such condition threatens food security in those affected areas. Hezel (2011) noted that normally two years of rainfall are required to flush out saline contamination in taro patches and another three years for taro growth from planting to harvesting..

Thus, the College of Micronesia-Federated of Micronesia conducted a collaborative research funded for two years in September 2011 to August 2013 with the American Samoa Community College (ASCC) and the United States Department of Agriculture

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(USDA)/ Agricultural Research Service (ARS), United States Pacific Basin Agricultural Research Center (US PBARC) to improve taro productivity in the Pacific. The COM-FSM worked on giant swamp taro salt tolerance evaluation under this funding for two years and continued the study up to early 2014 to find out which cultivars could withstand effects of sea level rise. Other collaborators focused on other taro production issues.

This research worked on the premise that salt tolerance is an inherent ability of plants to withstand the effects of high salt concentration in the root zone or in the leaves without significant adverse effects (Torabi, 2014).

MATERIALS AND METHODS

Collection

Thirteen cultivars from Pohnpei (6^0 51'North longitude and 158^0 13' East latitude) and 30 cultivars from Chuuk 7^0 25' North longitude and 151^0 47' East latitude) were collected. Yap had burrowing nematode problems and Kosrae was close to Pohnpei so no collection was performed there. Ten corms for each cultivar were obtained from producers.

Mild Salinity Evaluation

Ten corms of each cultivar spaced at 1 meter (m) by 1 m were planted in non-replicated rows. Ten plants represented one cultivar. For more than two years, the growth and performance of the young seedlings were monitored monthly at a swamp with an average salinity of 1,300 ppm (0.13%).

The growth parameters measured were plant height, number of stalks and leaves, monthly increment of corm diameter, leaf damages, leaf width and length, and seedling survival and number of suckers in each plant.

Monthly increment of corm diameter was determined from three plant samples uprooted after two years. The middle portion of the corm was measured. Average corm diameter among sample plants was divided by 24 months to obtain the monthly corm increment.

The seedling survival rate was based on the 10 seedlings in each cultivar collected and maintained at the swamp. Surviving original plants were counted and divided by 10 plants and values multiplied by 100 to determine the percentage survival rates.

The number of suckers was counted using the first suckers that were produced by the surviving original plants.

Plant height, number of petioles and leaves were direct measurements.

Morphological Characterization

After two years, the 43 cultivars of giant swamp taro were compared for their similarities and differences in color of leaves, petioles and corm flesh and presence of some structures like spines in the petioles and cataphylls (leaf-like) underneath the leaves.

Sea Level Rise Evaluation

In addition to evaluation in swamp for mild salinity, mimicry of the effects of sea level rise was conducted in two stages through soaking in pure sea water.

The first stage was soaking at 5.6% salinity the two popular cultivars Fanan and Simiten for the time-series soaking experiment (0 to 52 hours at 2-hour intervals) to determine the shortest possible time for significant cultivars' responses to soaking in high salinity levels of water. Three plants in each cultivar were used for this experiment. Nutrients available in the soak water before and after soaking using LaMotte Fertility Kit were determined. The plant biomass (entire plants), root number and length and corm were measured before and after soaking.

From the results of the first experiment, 7- hour soaking was selected for evaluating all cultivars under high water salinity level averaging 53,000 ppm (5.3%). Soak nutrients and plant parts affected before and after soaking were determined.

Statistical Analysis

Excel Analysis ToolPak kit was used for the Analysis of Variance (ANOVA) of growth parameters. LSD

was employed for comparison of means of plant parts and soak nutrients before and after soaking.

RESULTS AND DISCUSSION

Cultivar Characterization

Fifteen cultivar groups were identified from 43 local giant swamp taro cultivars collected from Chuuk and Pohnpei states (Table 1). A manual with detailed description of the color of stalks, leaves and corm flesh and presence of special structures like was prepared and distributed to local communities in Chuuk and other states of the FSM (Ragus and Sonis, 2015).

Table 1. Grouping and morphological traits of 43 local cultivars.

Groups	Local cultivars	Morphological traits
1	Peremiong (1)	Green stalks, light green leaves and orange corm flesh
2	Pwonon(1)	Light green stalks with thick spines, green leaves and yellow corm flesh
3	Fanan, Lirow, Mortlock,Ngangie, Powell, Weito (6)	Yellow green stalks with red, purple and black spots, yellow green leaves and dark yellow corms
4	Harry 1, Pwetepwet (2)	Stalks with shot spines, yellow at upper and lower and green with brown spots in the middle portion, light green leaves and dark yellow corm flesh
5	Simiten, Unknown (2)	Pink and yellow stalk base, upper base green and light orange, light green purplish streaks for upper stalk, green leaves and yellow corm flesh
6	Fanan, Simiten (2)	Light yellow stalks with black, green and black spots, green leaves and dark yellow corm flesh
7	Pachon, Sari(2)	Stalks, green at upper, dark green at lower and yellow and blue at base, green leaves and yellow corm flesh
8	Fanan, Kemesek and Parotorot (3)	Stalks, reddish brown inside and red outside, light green leaves and dark orange corm flesh
9	Leongmwar, Simiten, Weito, Simiten (4)	Stalks, light brown inside, pink outside with spines and yellow base with black dots, light green leaves and yellow corm flesh
10	Alengaleng (Weno and Pohnpei), Manikoko, Salengwalek (4)	Stalks, green at upper and black wavy bands above base and black base, green leaves with leaf-like structures underneath and dark yellow corms
11	Pwetata, Tigerall (2)	Stalks, green with black and yellow bands, black base, light green leaves and orange corm flesh
12	Pulapwech , 2 unknown names (3)	Green stalk streaked with red and with spines, green leaves, yellow corm flesh
13	Harry 2, Lepachon, Manikoko, Pulamwariw (4)	Spiny stalks, green upper, light green lower, black base, light green leaves and dark yellow corm flesh
14	Anechimo, Simiten (Weno and Pohnpei), Unknown (4)	Stalks, black at lower and green at upper, light green leaves and yellow corm flesh
15	Fonon, 2 unknown names Unknown (3)	Stalks, yellow with red streaks for upper and purple dots at middle, green leaves and yellow with red streaks corm flesh

Swamp Performance of Cultivars

Aintablian (2011) reported the United States Geological Survey of what constitutes saline water such as low salinity (1,000-3,000 ppm), moderate salinity (3,000-10,000 ppm) and high salinity (10,000-35,000 ppm).

The 15 cultivar groups responded to low water salinity in the swamp at different magnitudes in terms of growth parameters such as monthly increment of corm diameters, survival, leaf damages and sucker formation (Tables 1,2, ,3 and 4). However, the responses were not statistically significantly in the swamp with an average of more than 1,000 ppm

(1%). Plant height, number of leaves and stalks were also non-significantly different.

Most of the cultivars collected grew slowly. However, few were fast growers (Table1). Typical symptom of salt injury is growth reduction expressed in slow corm diameter increase due to inhibition of cell expansion.

Table 2. Monthly corm diameter increase of 15 cultivar groups in a Chuuk swamp (2011-2014).

Rating	Monthly corm increase (cm/month)	Groups	Percentage distribution (%)
Poor	<1	1,6,7,9,11,12,13,15	53.4
Fair	1.0-1.9	2,4,5,8,10	33.3
Good	>2	3,14	13.3

Only two out of 15 cultivar groups had good survival rate of 80-100 percent due to daily exposure to high tide (mean of 0.8 m) lasting for 6-8 hours (Table 2). Majority of them demonstrated 60-79 % survival. This trend indicated varietal differences in growth vigor of the giant swamp taro.

Table 3. Percentage survival rates of 15 cultivar groups in a Chuuk swamp (2011-2014).

Rating	Survival rates (%)	Groups	Percentage distribution (%)
Poor	<60	1,4,5,6,9,12	40.0
Fair	60-79	2,3,7,8,10,14,15	46.7
Good	80-100	11,13	13.3

All plants sustained leaf damages at various magnitudes (Table 3). However, sixty percent of these cultivars showed slight burning of leaf edges and tips. Accumulation of salt ions in plant tissues frequently causes toxicity manifested to plants by chlorosis and necrosis of leaf tissues (Torabi, 2014)

Table 4. Percentage leaf damages of 15 cultivar groups in a Chuuk swamp (2011-2013).

Rating	Leaf damages	Groups	Percentage distribution (%)
Poor	Entire population with damaged leaves	7	6.7
Fair	Slight to full damages of several plants	5,8,9,10,13	33.3
Good	Slight damages of some plants	1,2,3,4,6,11,12,14,15	60.0

Approximately 80% of the population produced 1-2 suckers per plant, which was an optimum number for good productivity to reduce competition for space, light and nutrients (Table 4).

Table 5. Mean sucker number of 15 cultivar groups in a Chuuk swamp (2011-2014).

Rating	Mean sucker number	Groups	Percentage distribution (%)
Poor	>3	9	7.0
Fair	2-2.9	4,2	13.0
Good	<1-1.9	1,2,3,5,6,7,8,10,11,12,13,15	80.0

Level Rise Mimicry Experiments

Time-series Soaking

Fanan and Simiten lost their roots at different hours of soaking and magnitudes (Figure 1). Critical loss of their roots started between 6-8 hours of submergence in water salinity of more than 5%. As soaking progressed, both of them had sustained root injuries resulting to root losses.

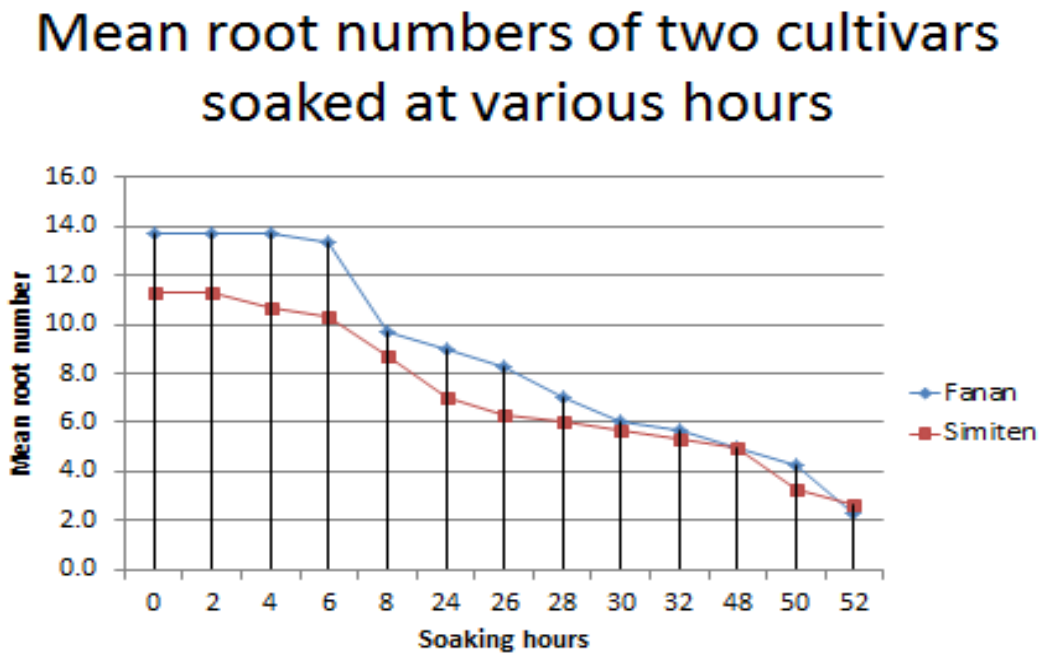

Figure 1. Mean root number losses of Fanan and Simiten at 0-52 hour soaking in seawater

Both Fanan and Simiten exhibited same trend of potassium absorption from the soak water that lost more than 50% of its potassium content at 2-hour soaking (Figure 2) Afterwards, the potassium contents of the soak water decreased slightly indicating that the root integrity of both cultivars was impaired due to root injuries. This phenomenon happened due to the survival instinct of the plants to absorb potassium under salt stress to exclude sodium from the plant cells (Wang et al). High cytosolic K+/Na+ ratio is one key determinant to salt tolerance of plants (Maathuis and Amtmann 1999).

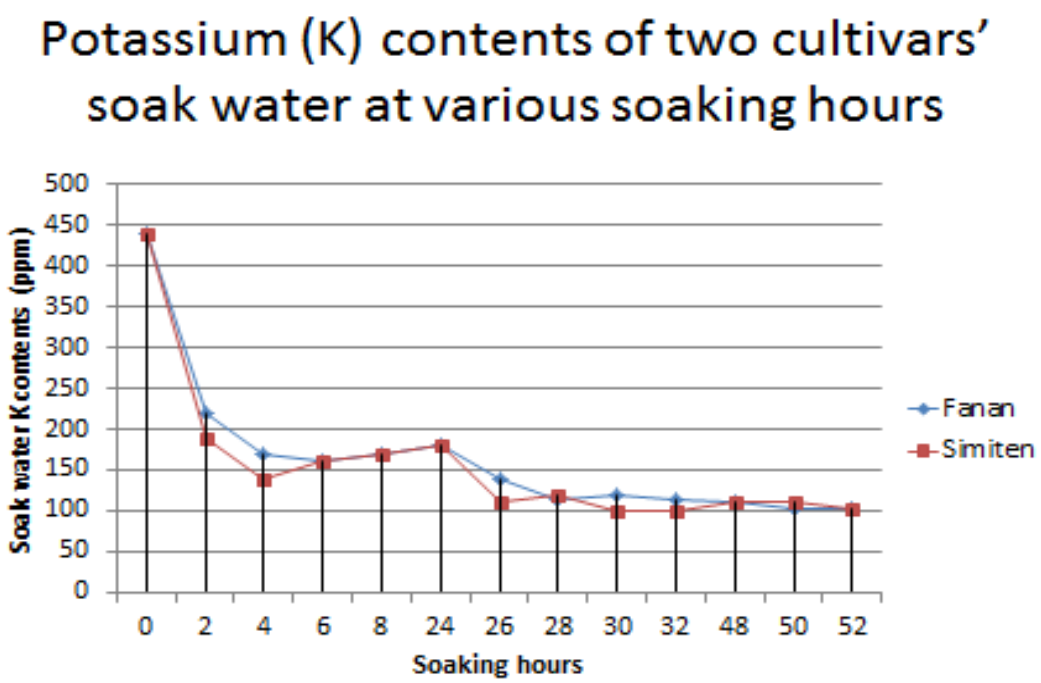

Figure 2. Potassium contents of soak water from 0-52 hours of soaking

Fanan and Simiten released phosphorus from injured roots slowly within24 hours. At 26 hours, phosphorus leaching increased, peaked at 28 hours and levelled off at 30 hours up to 52 hours. Plants respond to salt stress by the production of Responsive Oxygen Species (ROS) such as superoxide, hydrogen radical and hydrogen peroxide (Yadab et al 2011, Shabala and Cuin, 2008). Degradation of macromolecules in the cells such as membrane lipids, protein and nucleic acid results when ROS fail to be inactivated (Mittler, 2002). Such a process probably explained the leaking of phosphorus from the injured plants. Phosphorus performs as the structural element in nucleic acids and phospholipids.

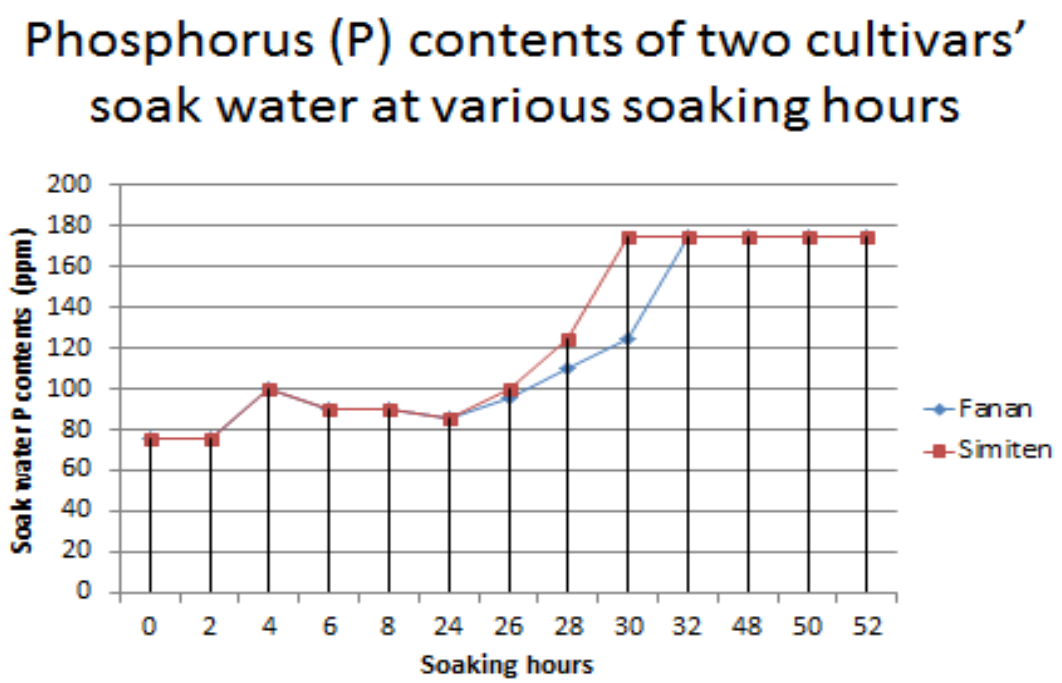

Figure 3. Phosphorus contents of soak water during 0-52 hours of soaking

Seven-hour soaking

Mean root number was significantly affected among the plant parts soaked for seven hours in seawater (>5%). In the biomass, the stalks and leaves though scalded remained intact. However, the root system was heavily damaged (Table 5). Under high salinity, plants suffer osmotic and ionic stress due to the salts accumulated at the outside of the roots and those accumulated at the inside of the plant cells (Horie et al 2012).

Table 5. Means of root length, root number, biomass and corm diameters of 15 cultivar groups before and after 7-hour soaking in undiluted sea water (2014)

Parameters	Before soaking	After 7-hour soaking
Mean root length (cm)	19.2	17.3^{ns}
Mean root number	65.9	56.1^{*}
Biomass (kg)	0.8	0.7^{ns}
Corm diameter (cm)	15.0	13.4^{ns}
$t_{(0.05)}$	2.14	

Forty seven percent of the cultivar groups with 0-10 root losses were considered good while those with more than 20 root losses were rated poor (Table 6).

Table 6. Root number losses of 15 cultivar groups at 7-hour soaking (2014)

Rating	Number of roots lost	Groups	Percentage distribution (%)
Poor	>21	1,2,7,14,15	40.0
Fair	11-20	8,13	16.3
Good	0-10	3, 4,5,6,9,10,11,12	46.7

SUMMARY AND CONCLUSION

This research dealt on collection and evaluation of local swamp taro cultivars from two states of the FSM for salt tolerance for more than two years.

The collected 43 cultivars bearing different names from different states and villages were grouped into 15 cultivar groups after morphological characterization.

The giant swamp taro seedlings showed variable adaptability in growing under a mild saline swamp . These seedlings demonstrated their inherent capabilities to withstand mild salt stress based on survival, leaf damages, sucker number per plant and monthly corm diameter increase for two years.

High salt stress using soaking in undiluted seawater (>5%) to mimic effects of sea level rise in plant parts of giant swamp taro revealed the protective mechanism of the giant swap taro in a prolonged exposure to high water salinity. The two cultivars had different timing in accumulating potassium to exclude excessive salts entering their plant parts. The release of phosphorus differed in both cultivars suggesting the existing variation in disintegration of cell membranes in extreme water salinity stress.

The time series (0-52 hours) and the 7-hour soaking in sea water with at least 5% salinity level consistently indicated that root number losses could be a practical selection criterion for salt tolerance in giant swamp taro.

The different salinity responses of the local cultivars demonstrated the existence of variation in the FSM gene pool. Two cultivar groups (3 and 11) were potentially salt tolerant for the FSM based on the sea water soaking experiments.

Emerging issues regarding salt tolerance of giant swamp taro need further exploration.. These are: the tensile strength and structure of root systems of cultivars at different growth stages and salinity levels; nutrient translocation at different plant parts at various salinity concentration, plant ages and water salinity levels, corm yield, eating and storage qualities of cultivars at varying salinity concentration and upland adaptability trials.

ACKNOWLEDGEMENTS

The authors acknowledged the funding of the two-year collaborative project called “Sustainable Taro Production under high Salinity in the Pacific” Accession No. 58-5320-0-264 under Tropical-Subtropical Agricultural Research TSTAR/National Institute of Food and Agriculture (NIFA)/United States Department of Agriculture (USDA).

Special thanks were extended to our project collaborators: Dr. Daniel Aga (American Samoa Community College, ASCC), Dr. Tracie Matsumoto (USDA, Agricultural Research Service (ARS), United States Pacific Basin Agricultural Research Center (US PBARC), Emily Ilaoa (ASCC), Dr. William Sakai (University of Hawaii (UH) at Hilo) and Aufa Areta (ASCC).

Gratitude and appreciation were expressed to the following for continuing support: Dr. Singeru Singeo and Ric de Vera (COM-Land Grant), Vice President Jim Currie, Chuuk CRE Coordinator Mike Abbe, Yosko Kim and Kathryn Bisalen (COM-FSM CRE; Mereseni Seniloli (formerly at the Secretariat for Pacific Community); Innocenti Penno (deceased) and Sabrino Robert (Chuuk Department of Agriculture), Valentine Chipen (former CRE Agriculture Extension Agent); Wesney Nakayama (Chuuk Conservation Society); Jacinta Francis (Conservation Society of Pohnpei); Chuuk and Pohnpei taro farmers and Mesewin Sonis (swamp land owner)

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Proceedings of the 3rd International Conference on Agriculture and Forestry, Vol. 2, 2016, pp. 108-115
Copyright © TIIKM
ISSN: 2362-1036 online
DOI: https://doi.org/10.17501/icoaf.2016.2110

STATUS OF ORGANIC AGRICULTURE RESEARCH AND DEVELOPMENT PROGRAMS IN THE BICOL REGION, PHILIPPINES

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Abstract

A study was conducted to determine the status of the organic agriculture (OA) research and development (R and D) programs in Bicol Region, Philippines. Specifically, it aimed to conduct inventory of R and D projects on organic agriculture, determine the information needs of OA stakeholders and identify research gaps and propose strategies to enhance the OA R and D programs. Secondary data was gathered on OA researches undertaken and survey was conducted to 149 stakeholders to know their information needs. Data gathered showed that 46 projects were implemented and most of the researches conducted were on production aspect. Highest percentage (34%) recorded in terms of information needs of the stakeholders were on demand and supply. Research gaps identified were absence of a whole research chain on organic agriculture for a specific commodity, lack of a research with component on developing a centralized, web-based information system, and inadequate research on policy and governance on OA. Recommendations included the strengthening of research programs with holistic approach, development of a web-based OA information system, conduct of research on governance, policy processes on OA and strengthening of financial support from government and private institutions and intensification of information dissemination campaign on organic agriculture.

Keywords: organic agriculture, organic farming, organic growers, research and development

INTRODUCTION

The Philippine agriculture contributes 17 percent to the country's gross domestic product, employing 33 percent of the country's labor force. Agricultural commodities such as palay and corn production for 2015 were lower by 4.31% and 3.24%, respectively, compared to the 2014 levels. The decrements were attributed to the lower area harvested and yield brought by insufficient water supply, dry spell/drought, and adverse effects of typhoons (Philippine Statistics Authority, 2016).Likewise, In a report made by Cabigas and Morala (2011), it stated that this sector accounts for more than half or an estimated 66 percent of the country's poorest. The deteriorating condition of the environment has contributed to increasing vulnerability of the agriculture sector particularly to extreme weather events. Pre-dominance of chemical-intensive farming has contributed to at least 33 percent of the country's greenhouse gas emissions.

In the Bicol region, intensive use of chemical fertilizers has caused high acidity in paddy fields. Farmers had to increase the amount of chemical fertilizer in order to secure certain yield. Thus the inputs of chemical fertilizers have increased over time causing further acidity of soil and soil erosion (Ara, 2002).In the rice industry, conventional method of farming requires chemical fertilizers, pesticides and herbicides. Though touted for its high yields, this production system is believed to enhance soil degradation, pollution, chemical residues in food and loss in biodiversity (Mendoza, 2002). It also intensifies the farm household's actual and physiological burden on high-cash capital expenses

(Mendoza 2003).With the multitude of adverse impacts of conventional agriculture and the pressing problems facing the agriculture sector, it is essential to push for the implementation of alternative method such as organic agriculture.

Organic crops are one of the most important needs for Filipino farmers. They provide the needed nutritive value as well as food security not only to farmers but to consumers as well. Scientific studies also indicate the need for more organically grown crops in the diet to help suppress heart disease, cancer and other diseases.

Hence, the signing of Republic Act No. 10068 known as the Philippine Organic Agriculture Act, on June 16, 2012 was considered by many as a landmark legislation which provided for the development and promotion of OA in the Philippines. It is a culmination of long years of development efforts mostly by non-government, community based organizations and private groups pushing for agriculture sector reforms around ecologically sustainable, environment friendly and safer production systems, availability of safer and more nutritious staples and food and increased farm productivity and income opportunities for Filipino farmers (NOAP, 2012).

The attributes of organic agriculture is indeed, favorable to the community and environment. Because of this, there had been a growing concern to strengthen organic agriculture. For instance, market share of organic and partially organic rice accounts for 0.9 percent of the rice from irrigated land. But the number of adopters has been increasing dramatically (Ara, 2002). Large scale production for organic crops is now being encouraged during these times when farmers as well as consumers are becoming conscious of the adverse effects of using pesticides and fertilizers in farms.

This growing interest on OA is well supported by some government agencies (Briones, 2011). In 1997, the Philippines Council for Agriculture, Forestry, Fisheries and Natural Resources Research and Development (PCARRD) sponsored a national consultation workshop on OA where speakers from organic producers in the private sector and members of International Federation of Organic Agriculture Movements (IFOAM) were invited to interact with government researchers. PCARRD is just one of the many organizations which had shown interest and generated voluminous information on OA which need to be gathered and made available systematically to OA stakeholders.

While organic farming is definitely creating waves in the agriculture sector, there are setbacks which had been initially identified in its implementation. In a research study conducted by ElsWynen, several problems were noted that cause problems for the advancement of research in organic agriculture. One of them is absence of networks by researchers in organic agriculture. In addition to this, other concerns and issues were the present structure of research funding; the different requirements in organic agriculture leading to rather expensive research; lack of a united front by the organic sector; relative lack of good researchers and inadequate structure to foster them (by good supervision of potential researchers and peer review); and lack of policies which encourage research in organic agriculture directly or indirectly.

These setbacks should not become the reason for researchers to discontinue and be disenchanted on OA. Bicol Region, Philippines which is the locale of this study has a great potential for organic agriculture. The region's total agricultural area is891, 955 hectares, and 5% of this is targeted to be utilized for organic agriculture. Report revealed that seventy-four percent (74%) of organic rice production and 44% of the country's over-all production of other organic crops come from Bicol region (Department of Agriculture, 2015).

The platform for OA implementation is indeed, very promising. However, a dearth of information on consumer/market demand, input resources, commodity pricing, R & D interventions and other relevant information on organic products in particular and organic agriculture in general has been identified. Access to these information is limited and more often than not, unavailable and incomplete. Likewise, there is a need for a network of information and stakeholders on organic agriculture do not know where to start to obtain it.Cognizant of this situation, there is a need to make information especially on R &

D initiatives on organic agriculture readily available, hence, this study.

OBJECTIVES

This study aims to:

1. conduct inventory of R & D projects on organic agriculture

2. determine the information needs of stakeholders in organic agriculture

3. identify research gaps and propose strategies to enhance the R & D program on organic agriculture in the Bicol region

METHODOLOGY

A survey was conducted to OA stakeholders such as farmers, organic growers and local government officials to determine their information needs on organic agriculture. A survey-questionnaire was prepared for this purpose and questions on the communication media preferred by farmers and other stakeholders in disseminating OA information were likewise included.

An inventory of R & D initiatives and projects on organic agriculture was also conducted. Secondary data was gathered from educational institutions, agencies, non-government organizations (NGOs) and private organizations (POs) on researches, initiatives and interventions undertaken related to organic agriculture.

RESULTS AND DISCUSSION

A survey was conducted to gather data needs and information from organic agriculture stakeholders. The place of study is in Bicol Region, Philippines (Figure 1).Organic agriculture is pushed by various sectors in this region and it is spearheaded by the Department of Agriculture (DA). In fact, the DA eestablished within the vast agricultural property that the Pecuaria Development Cooperative Inc. (PDCI) is tending in Barangay Lapigna, Bula, Camarines Sur the one-hectare demo farm has been planted to organic and aromatic rice varieties called JM2 and Basmati (Philippine News Agency, 2012).

Figure 1.Map showing the Location of the Project Site, Bicol Region, Philippines

Table 1shows the respondent's profile from the four provinces in the Bicol Region. Sixty (60) percent and 40% of the respondents are males and females, respectively. Majority of the respondents (30%) belong to age 51-60 years old, 25% with age range 31-40 years old, 20% and 19% belong to ages 61-70 and 41-50 years old, respectively. In terms of occupation, about half of them (60%) are farmers and the remaining respondents are either government employees or involved in other sources of livelihood like fishing, carpentry and domestic work.

Table1. Demographic Profile of Respondents

	Number	%
A. Sex		
Male	89	60
Female	60	40
Total	149	100
b. Age		
71 – above	2	1
61-70	30	20
51-60	45	30
41-50	28	19
31-40	37	25
below 30	7	5
Total	149	100
c. Occupation		
Farmers	89	60
LGU/Govt. Employee	51	34
Others	9	6
Total	149	100

Fifty three percent of the respondents come from the province of Camarines Sur and the rest come from Camarines Norte, Albay and Masbate (Table 2).These respondents are farmers and community residents who are involved either directly or indirectly in organic farming activities. Likewise, results revealed that the highest percentage (34%) recorded in terms of information needs of the stakeholders was on demand and supply(Table 3). Respondents revealed that they are willing to adopt organic farming but the problem is, they do not have the information where lies the great demand for organic produce in the region. Market for organic products is not yet stable and therefore, there is not sufficient guarantee that farmers' produce can be disposed within a particular period of time. It is therefore, essential to carefully consider product stabilization in order for farmers to secure their source of income. This is further supported by the report of Ara (2002) that product stabilization with enough technical support and farmers' education and appropriate marketing system for organic rice are necessary for the development of organic farming in the Philippines. Likewise, markets, not production, increasingly drive agricultural development. Value addition & product differentiation is becoming increasingly

Table 2. Distribution of Respondents by Province

Province	Number	Percent
Camarines Sur	79	53
Camarines Norte	25	17
Albay	24	16
Masbate	21	14
Total	149	100

important to ensure increase in income, reducing malnutrition/poverty and for competing in the global market. This is further supported by a study made by Bhatta, et. al in 2009 wherein it revealed that before beginning cultivation of organic crops, their marketability and that too at a premium over the traditional and modern produce has to be assured. Inability to obtain a premium price, at least during theperiod required to achieve the productivity levels of the conventional crop is a setback in Nepal. High prices of these products remain a major deterrent for consumers.

Focus should not only be given to marketing of products but policy implementation should be carefully considered as well. In a study made by Tamayo, Castro and Lim (2013), it emphasized the interconnectedness of the various stakeholders of organic agriculture which includes farmers themselves, the retailers/marketers/merchandisers, and the finally consumers. According to them, all these sectors must be given due attention in the crafting of the law for organic agriculture. Institutionalizing organic farming is making organic agriculture as the mode of farming which can be a good agenda yet may come as a very costly policy as it will alter the socio-economic conditions of the farmers, while local demand for organic foods may not grow in the same proportion as the production of organic foods itself.

On one hand, the least identified information needs of OA stakeholders were on the need for profile of Experts/researchers which only recorded 10%. Respondents preferred that information on OA be disseminated through broadcast media and fora/symposia which got the highest percentages of 34% and 28%, respectively (Table 4).

Table 3. Information Needs of Stakeholders in Organic Agriculture

Category/Aspect	Total	%
A. Production	37	25
B. Marketing	46	31
C. Demand and Supply	51	34
D. Profile of stakeholders	15	10
TOTAL	149	100

Table 4. Preferred Communication Media on Organic Agriculture

Communication Media	Total	%
A. Online/Internet	33	15
B. Broadcast (Television/Radio)	75	34
C. Print (Newspapers, Magazines/Flyers/Brochures)	36	17
D. Fora/Conferences/Symposia	62	28
E. Others (Cellphone)	14	6
TOTAL	220	100

Table 5. Organic Agriculture R & D Projects, Bicol Region, Philippines

Systems Flow	Number	%
A. Production	25	54
B. Marketing		
Demand and Supply	4	9
Promotion	5	11
Profile of OA stakeholders	4	9
C. Processing	8	17
TOTAL	46	100

In other countries, the role of media in enticing farmers to turn to organic agriculture is also very crucial. For instance, production of training manuals and making them accessible to farmers is a welcome step towards their appreciation of organic farming. Aleading research institute in Europe named the Switzerland's Research Institute of Organic Agriculture (FiBL) prepared an African Organic Agriculture Training Manual to improve access of African farmers to markets, especially to the organic market. Organizations involved in training in organic and sustainable agriculture are invited to use the new training materials and contribute to their further improvement.Likewise, Hossain (2012) also noted in their study in Bangladesh that media (both electronic-television and radio and print-newspapers) play important roles in increasing awareness of farmers and consumers. Similarly, in China, most organic food production is managed by smallholder farmer organizations which are not well organized and managed. Most of the farmers do not understand the essence of organic production. They only know that no chemical inputs are allowed in organic production, the economic aspects attract them to cooperate with the companies (Qiao, 2011).Given this scenario, the role of media in making the farmers appreciate better organic farming is likewise, very important. Also, there is a popular perception in the world about "good farming" that is extremely emotionalized (the feelings of the topic and the aspects shown) and romanticized and the media and advertisements play a major role (Rahmann et.al, 2009).

In this study, a total of 46 R & D projects were identified. Table 5 shows the priority list of OA R & D projects conducted based on commodity system flow. Most of the researches conducted were on production aspect which included studies on cropping system, crop improvement, soil, pest management, weed control, productivity performance of organic crops grown such as rice, sweet sorghum, lettuce, stevia. Funding of projects generally comes from the

Department of Agriculture and DA – Bureau of Agricultural Research and academic institutions.

In a similar fashion, the development of organic farming in Korea focused on projects that aim at gaining economic benefits from producing organic products with high value-added tax, limit to the maximum the use of chemical complex including chemical fertilizer and agrochemicals to protect and improve the agricultural ecology and sustainably develop the agricultural production (Development of Organic Farming in the DPR Korea, 2008). Furthermore, in a project report prepared by Elm Farm research Centre in 2003, cropping systems & crops have the overwhelming majority of projects in the United Kingdom, funding and intensity of research. Livestock systems & livestock follow this. These two production orientated topics are followed by information & dissemination and soil &nutrient cycling. The other topics receive considerably less resources, with environment, sustainability & conservation having relatively few expensive and long running projects, resulting in much lower research intensity.

Based on the above data gathered, additional researchable areas and research gaps were identified:

1.A whole research chain on organic agriculture which will include inputs, production, marketing, processing and support mechanism for OA.

2.While there are numerous researches which are location-specific (i.e. municipality or province), these information are difficult to access by other stakeholders. A research with a component on developing a centralized, web-based information system is essential.

3.A research on policy and governance on OA assessing the ability of the policy-makers and local government officials to implement them at the local and regional level.

CONCLUSION AND RECOMMENDATIONS

There is voluminous information available regarding organic agriculture research and development initiatives locally and globally. At the regional level, most of the researches focused on the production aspect of organic crops. On the other hand, the information needs of OA stakeholders which should be given priority attention are on marketing aspect especially on the demand and supply side of OA products. Likewise, the preferred communication media for disseminating this information is through conduct of fora and symposia and through broadcast media, either by radio or television. Research gaps identified include a whole research chain on OA, development of a centralized web-based information system and a research on effective implementation of policy and governance of OA programs at the local and regional level.

Based on the results of the study, the following strategies are recommended:

1.Intensify R & D initiatives which will extend through the whole research chain putting more focus along the areas of marketing and processing of organic products and developing new markets as well as market network at the local, regional and national level.

2.Conduct research on governance, policy processes as it relates to the implementation of organic agriculture program.

3.Continue the conduct of inventory survey and mapping of relevant information on organic agriculture which is crucial in the data content build-up of a centralized organic agriculture database/information system at the regional and national level

4.Establish an on-farm research in order to generate more information for organic farmers

5. Develop a user-friendly and easy-to-use website and information system for marketing organic products and accessing information on organic farming and agriculture.

6.Establish and maintain a database of accredited organic farm growers to include both the local and national growers, sellers and producers who are into organic farming and development.

7.Strengthen financial support from institutions such as the Department of Agriculture (DA) and Department of Agriculture-Bureau of Agricultural

Research (DA-BAR) for the conduct of researches on market and processing of organic products.

8.Intensify information dissemination campaign and awareness on organic agriculture using broadcast and print media and the conduct of fora/symposia that will serve as a good venue for information exchange among OA stakeholders.

ACKNOWLEDGEMENT

The authors are grateful to the Central Bicol State University of Agriculture headed by then University President Atty. Marito T. Bernales, Ph.D. for allowing them to conduct this project. Likewise, they are grateful to Intervida Foundation, Philippines and the Department of Agriculture Region 5, Philippines for providing them the budget for this research.

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Proceedings of the 3rd International Conference on Agriculture and Forestry, Vol. 2, 2016, pp. 116-126
Copyright © TIIKM
ISSN: 2362-1036 online
DOI: https://doi.org/10.17501/icoaf.2016.2111

POLLEN SPECTRUM AND PHENOLOGY OF STINGLESS BEE (*Tetragonula biroi* Friese) PLANTS

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Abstract

The study was conducted to determine the pollen sources and bloom pattern of *Tetragonula biroi* Friese plants in Camarines Sur, Philippines. Floral resources within the 300-meter phenology transect were identified. EstimateS software was used for the analysis of rarefaction and pollen richness. A total of 111 plant species were suitable for meliponiculture in the lowland ecosystem and only 42 species in the upland ecosystem. Among the bee plants, 53% non-seasonal, 35% seasonal and 15% with intermittent flowering. *Cocos nucifera* was the major pollen sources with 19-73% occurrence in the samples. Pollens of *Ceiba pentandra* , *Mangifera indica* , *Elaeis guineensis* , *Pterocarpus indicus* , *Syzygium spp.* , *Persia americana, Areca catechu, Muntingia calabura,* and *Citrus spp.* were dominant to secondary pollen sources, while the rest were minor pollen sources. Pollen spectrum showed a linear relationship with the bloom pattern. Interpolation with pollen spectrum and flowering plants plotted against time showed that both pollen diversity and abundance of blooming plants increased during the 12-month study period in the lowland ecosystem. No significant relationship was noted between the diversity of the foraged pollen and the bloom pattern. Rarefaction curve and pollen richness were higher in May than the rest of the months.

Keywords: bloom pattern, pollen, stingless bee, *Tetragonula biroi*

INTRODUCTION

The rich and diverse floral resources, warm and favorable climate of the Bicol Region are essential elements for beekeeping. The region is geographically located at the southeastern end of Luzon archipelago, Philippines, with a total land area of roughly 17,632.5 sq km. Bicol region's 50% land area is agricultural, 30% grassland, 13% forestland, and the remaining are devoted to miscellaneous uses. The Philippine flora is at least 13,500 species and on the botanical survey conducted by Haribon Foundation in 1991, 1300 species of plants are recorded in Mt. Isarog alone.

Beekeeping in the region started in the hunting of wild bees *Apisdorsata* , *Apiscerana* and *Tetragonula (Trigona)biroi*, all are native bees in Bicol. Local beekeepers cultured native bees for honey and pollen production, and crop pollination. The culture of *Apis mellifera* and *A. cerana* in hive boxes were adopted later by some beekeepers in the provinces of Albay and Camarines Sur (Mostoles et al., 2006; PCAFNRRD, 2007).

For the past decade, *Tetragonula biroi* Friese captured the interest of local beekeepers and recognized the potential of this species in beekeeping. The Regional Apiculture Center-Bicol (RAC-Bicol) at the Central Bicol State University of Agriculture introduced *T. biroi* and studied the culture of the bees. The technology of keeping *T. biroi* was then established and disseminated through the conduct of local training, national symposia, and conventions. The cultural management practices and the technology of raising the stingless bees are cheaper

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and very simple than other bee species (Ruiz et al., 2003; Mostoles and Ruiz, 2004).

Feral colonies of stingless bees are abundant in the region and many beekeepers are encouraged to culture the stingless bees because they are freely hunted from the forest, they do not get stings, hive manipulation is easily learned, and the bees also produced honey, pollen, and propolis. Honey from *T. biroi* has been claimed by several beekeepers in the region to be an effective cure for asthma and other respiratory illness.

Stingless bees are generally polylectic and forage on a variety of plants that provide some pollen and nectar. Some bee species are known to use floral resources from more than a hundred taxa over a course of several seasons in a given habitat (Wilms, et al., 1996). The important aspect considered in beekeeping is the ample sources of nectar and pollen. Pollen is the protein-rich food, vital in the development of the brood to maintain colony strength and reproduction while nectar provides the energy for flight, foraging, and other hive activity (Grogan and Hunt, 1979; Roubik, 1989; Kevan, 1995; Buchmann and Nabhan, 1996). Identification of plants visited by stingless bees for pollen and nectar and their bloom pattern is useful in the selection of sites suited for meliponiculture in the region.

Therefore, the main objectives of this study were (1) to identify the pollen sources of stingless bees in Camarines Sur, (2) determine the spectrum of the pollen types and their value to *T. biroi*, and, (3) determine the relationship between the diversity of foraged pollens and the phenology of stingless bee plants. The outcome of this study is useful in the promotion, establishment and development of meliponiculture as a sustainable beekeeping industry in the Bicol Region.

MATERIALS AND METHODS

New colonies of *T. biroi* in traditional hives of coconut shell were set-up at lowland and upland ecosystems of Pili and Naga City , Camarines Sur. The lowland site is an urban areas located along the national highway at CBSUA, San Jose, Pili, Camarines Sur, (13º 34’ 59” N; 123º 15’ 41” E) and Del Rosario, Naga City, Camarines Sur (13º 37’ 8.9”N; 123º 14’ 28.7” E) . The upland site is located at Mount Isarog Natural Park (MINP) at Curry, Pili, Camarines Sur (13º 37’ 19.3” N, 123º 14’ 29.4” E, 278 mASL), and Panicuason, Naga City (13º 39’ 54.7” N; 123º 19’ 46.0” E, 297 mASL). An elevation above 100 masl, with slightly sloping to rolling topography and a slope of equal or greater than 18% was considered an upland ecosystem, while in the lowland ecosystem the elevation is below 100 masl, the topography is flat or almost level (Asia Forest Network, 2007). The climatic condition in Camarines Sur is generally humid and hot particularly during the dry season months (February to May). Months of June to January is the wet season with September and October the wettest, while February and April are the driest. The average temperature is between 26.5 to 27.0º C. The presence of flowering plants in the study sites was the primary consideration for setting up the colonies.

Flowering Phenology

Availability of floral resources in the four selected sites was determined within the 300-meter phenology transect that crisscrossed through the bees’ colonies. Flowering plants that fall within the 300 m radius were identified and monitored whether the bees visited those plants. Only those plants observed to be visited by the bees were recorded and their bloom period was determined. For large trees, binocular was used to confirm the presence of the flowers.

Pollen Sampling

Pollen samples were collected from the pollen pots and the curbiculae of the returning foragers. Returning pollen foragers were captured at the hive entrances using a sweep net at three different time periods: 1) morning (between 7:00 a.m. and 10:30 a.m); 2) mid day (between 10:30 a.m. and 2:30 p.m.); 3) afternoon (between 2:30 p.m. and 5:00 p.m.) and the pollens were collected from the bees’ hind legs, and stored in the refrigerator. Pollen load sampling was carried out in the lowland ecosystem due to the survival, growth and reproduction of the colonies. Likewise, samples of pollen were collected from the newly formed pollen pots every two months both in the lowland and upland ecosystems. These pollen pot samples were obtained from the previously placed halve coconut shells that served as the bees’ new

hives so as to avoid obtaining samples from the old stored pollen.

Acetolysis

Pollen treatment and analysis was performed at the Laboratory Facility of the Research Division at Central Bicol State University of Agriculture following the method of Erdtman, (1952) modified by Darmouth College Electron Microscope Facility.

Individual pollen samples were placed in 10 ml centrifuge tubes and rehydrated by adding distilled water, 2/3 of the volume of the tube followed by centrifugation for 5 minutes at 500 rpm. The water was decanted and 5 ml of glacial acetic acid was added for washing the samples. Recentrifugation was done and the glacial acetic acid was decanted. Two ml of acetolysis fluid was added to the pollen samples, stirred and then placed in a boiling water bath for 10 minutes. The pollen samples were cooled down after andrecentrifuged at 500 rpm for 5 minutes and acetolysis fluid was decanted. Samples was again washed in 5 ml glacial acetic acid, centrifuged and decanted. Pollen was rehydrated with two to three washes of distilled water each followed by centrifugation. After washing, glycerin was added twice the volume of the samples, stirred with a spatula and was kept for pollen identification and analysis.

Characterization and Identification of Pollen

This procedure determines the pollen types present in the samples. Pollen types refer to the plant species producing such type of pollen and the basis was on certain pollen grain character and not the taxonomical identity of the plant. To facilitate identification of pollen types, the method by De Klerk and Joosten (2007) wasadopted. There is no coherent and widely accepted pollen nomenclature.

Identification and morphological characterization of pollen were facilitated by light microscopy using the binocular compound microscope. Some technical monographs, books and other reference materials such as of Kiew and Muid (1991); Roubik and Patino (2003) were consulted to facilitate identification. Fresh pollens were also collected from the flowers, acetolyzed and examined under the microscope and were compared with the pollens collected. Photomicrographs of representative pollen types were taken.

Quantitative Pollen Analysis

The quantitative pollen analysis determined the pollen spectrum which gives the relative proportion and the importance of the different pollen types. This was done by counting 300 pollen grains per sample using hemocytometer. Percentage occurrence of pollen and its corresponding value to the stingless bees were derived from Louveaux, et al (1978) as follows:

Predominant Pollen (Dp)- represented by more than 45% of the total pollen grains counted
Secondary Pollen(Sp)-16 to 45% of the total pollen grains counted
Important minor pollen(Ip)-3 to 15% of the total pollen grains counted
Minor pollen (Mp)-less than 3% of the total pollen grains counted.

Statistical Analysis

Regression Analysis was used in the computation of data using the Wessa, Free Statistics Software Version 1.1.23-r6, URL http://www.wessa.net .

Rarefaction analysis was used for the computation of monthly percentage occurrence of pollens. Species richness (pollen richness) was used to estimate pollen diversity using the EstimateS Software version 7.5. Persistent URL <purl.oclc.org/estimates>.

Rarefaction techniques are used to quantify species diversity of newly studied ecosystems and for such reason, the technique was applied in this study. Estimating pollen diversity in the two lowland sites is new since no studies have been made on such ecosystem. Rarefaction analysis and pollen richness were computed in the lowland ecosystem to further verify its suitability to meliponiculture.

RESULTS

Tetragonula biroi visited 121 plant species representing 100 genera and 49 families across four sites. Herbs predominate among the plants visited by the stingless bees (35%), followed by trees (31%), shrubs (20%), palms(7%) and vines (7%). A total of 111 plant species visited in the lowland ecosystem

and only 42 species in the upland ecosystem. *Leguminosae* and *Asteraceae* were the highest in terms of genera and plant species visited in the lowland and upland ecosystem. *Palmae, Myrtaceae, Rubiaceae, Malvaceae, Rutaceae, Lythraceae, Apocynaceae, Cyperaceae, Cucurbitaceae, Graminae, Musaceae ,Oxalidaceae* and *Sapotaceae* have more than two species visited by stingless bees.

Density of Plants and Bloom Pattern

The majority of the plants (53%) blooms throughout the year, 35% were seasonal, and 15% with intermittent flowering behavior. The months of January to May had the highest number of plants in bloom which peak in March with 75%. The secondary flowering period was observed from July to August with 64% - 69%; and low number of flowering from October to December with only 58%. The monthly density of species that bloom differed in both ecosystems due to the species variation. At the lowland ecosystem, the higher density was recorded at CBSUA than at Del Rosario.

In Camarines Sur, the flowering season begins in January coinciding with the intense flowering of some important fruit trees such as *Mangifera indica, Persia americana, Averrhoa bilimbi, Ceiba pentandra,* palms and shade trees. A succession of the flowering was observed from January until May and becomes intense from February to May. This flowering season is the called honey flow season by beekeepers in the Philippines indicating that one or more major nectar sources are in bloom and the weather is encouraging for the bees to fly and collect nectar and pollen in large quantities. For *T. biroi* more honey pots and pollen pots are formed by the bees during these months. In contrast, the dearth period follows after the main flowering season commencing from June to December coinciding with the wet season. This period was unfavorable for the stingless bees since they relied solely on the natural sources of pollens and nectar from their surroundings. Aside from limited food resources, rainfall prevented the bees to forage. Dearth period adversely affected the colonies of stingless bees' set-up in the upland ecosystem particularly during the last six months of establishment. There was no or very little pollen was brought to the hive and likewise none or very few new pollen pots and honey pots formed. The coconut shells placed in the colony to serve as the new hive of the bees were empty indicating that the bees have not gathered enough food. The frequent rains, low temperature and strong breeze weaken the bees and death of some of the colonies was observed. According to Chandrasekaran, et al, (2010) in the upland, temperature decreases by 1.8ºC for every 300 meters above sea level. The stingless bee's colonies were set up to nearly 300 m ASL and the temperature was observed to be almost 2 degrees lowered than the lowland ecosystems. These conditions (low temperature and rainfall) hindered the foraging activities of the stingless bees, prevented them from flying outside the hive to search for food. Bloom pattern, therefore, is very important as this determined the honey flow season and the dearth period of the bees.

Pollen Spectrum

T. biroi collected pollens from 43 families and 84 plant species or 69.4% of the total number of plants visited by stingless bees across all sites. A total of 61 pollen types were identified at the CBSUA with 59 in the pollen loads and 54 in the pollen pots. The pollen types identified at CBSUA represents 49% of the total plants visited by stingless bees across all sites. In Del Rosario, 47 pollen types found in the pollen loads and 39 in the pollen pots which represents 39% of the total number of identified plants in all sites. However, several pollen types were found in the pollen pots but not found in the pollen loads such as *A. bilimbi, A. carambola, Samaneasaman, Veronica peregrine* and *Zea mays*. Likewise, *Cyperus kyllingia, Ipomea triloba, Lagerstroemia speciosa, Momordica charantia, Tecomastans,* and *Manilkarazapota* were found in the pollen loads. For the upland ecosystem, 33 pollen types identified at Curry while Panicuason had 22 with 3 unidentified pollen types. Pollens of 37 plants visited by the stingless bees were not observed in the collected pollen samples. These plants either produced very little pollen, or very few were gathered by the bees, thus, these were under-represented in the collected samples.

Eighty-four percent of the pollen types were minor pollens (Mp) and important minor pollens (Ip).

Their occurrence in the samples was 0.33% to 2.9%. These pollens were occasionally or rarely collected

by stingless bees. Though their occurrence was very small, it was found out that during the rainy season and dearth period, these pollens sustain the food requirements of the bees.

Only 16% of the pollens collected were secondary to predominant pollens. These pollens were the major pollen sources of the stingless bees because of their higher percentage occurrence in the samples. It means that bees regularly visited those plants to collect pollens. The predominant pollen types such as *Cocos nucifera, Ceiba pentandra, Syzygium samarangensi, Pterocarpus indicus, Elaeis guineensis* and *Mangifera indica* accounted for 7% of all the pollen types. Although most of these plants were non-seasonal, bees collected enormous amounts of pollens during their bloom period.

Pollens from *Asteraceae, Leguminosae, Palmae, Myrtaceae, Cyperaceae, Graminae, Musaceae, Cucurbitaceae* and *Balsaminaceae* were present in the pollen samples collected from all sites. *Cocos nucifera* pollens were present in all sites which constituted 19-24% of the pollens from May to November and 47-73% from June to October. Likewise, pollens of the following plant species, namely; *Ceiba pentandra*, *Mangifera indica*, *Elaeis guineensis* ,*Pterocarpus indicus*, *Syzygium spp*., *Persia americana*, *Areca catechu* and *Citrus spp*. were dominant to secondary pollen sources in the lowland ecosystem. On the other hand, *Citrus spp.* and *Muntingia calabura* were the dominant pollen sources in the upland ecosystem. The lists of some pollen types, their forage value and bloom period is shown in Table 1.

Table 1.Pollen types, forage value and flowering period of T. biroi plants in lowland and upland ecosystems of Pili, and Naga City, Camarines Sur. Notes: Dp= predominant pollen (> 45%); Sp = secondary pollen (15%-45%); Ip= important minor pollen (3%-15%); Mp = minor pollen (< 3%).

Pollen Types	Family	Habit	Forage Value	Flowering Period
Areca catechu	Arecaceae	tree	Sp-Dp	July-August
Artemisia vulgaris	Asteraceae	herb	Mp	February -May
Artocarpusheterophyllus	Moraceae	tree	Mp-Sp	All year round
Averrhoabilimbi	Oxalidaceae	tree	Mp-Ip	April-May
Bidenspilosa	Asteraceae	herb	Mp-Ip	All year round
Canariumovatum	Burseraceae	tree	Mp-Sp	February-May
Ceibapentandra	Bombaceae	tree	Sp-Dp	December-January
Citrus spp.	Rutaceae	shrub	Mp-Sp	Feb- September
Cleome rutidesperma	Capparidaceae	herb	Mp-Ip	All year round
Cocosnucifera	Arecaceae	tree	Sp-Dp	All year round
Delonixregia	Leguminosae	tree	Ip	May-July
Elaeisguineensis	Arecaceae	tree	Mp-Sp	January-April
Gliciridiasepium	Leguminosae	tree	Mp-Ip	February-April
Impatiens balsamina	Balsaminaceae	herb	Mp-Ip	All year round
Jatrophaintegerrima	Euphorbiaceae	shrub	Mp	All year round
Mangiferaindica	Anacardiaceae	tree	Mp-Sp	December-March
Muntingiacalabura	Tiliaceae	tree	Sp-Dp	All year round
Persia americana	Laureaceae	tree	Ip	February-March
Pterocarpusindicus	Leguminosae	tree	Dp	February-March
Solidagovirgaurea	Asteraceae	herb	Mp-Ip	all year round
Syzygium spp.	Myrtaceae	tree	Mp-Dp	April-June
Talinumtriangulare	Portulaceae	herb	Mp-Ip	All year round
Veitchiamerrillii	Arecaceae	tree	Mp-Sp	All year round

Relationship of Bloom Pattern* to *the Diversity of Foraged Pollens

The diversity of pollens collected by stingless bees showed a linear relationship with the bloom pattern. Interpolation of foraged pollens and flowering plants plotted against time showed that both pollen diversity and abundance of blooming plants increased during the 12- month study period in the lowland ecosystem as shown in Figures 1&2.However, results indicated that the diversity of the monthly foraged pollen and was not affected by the monthly bloom pattern.

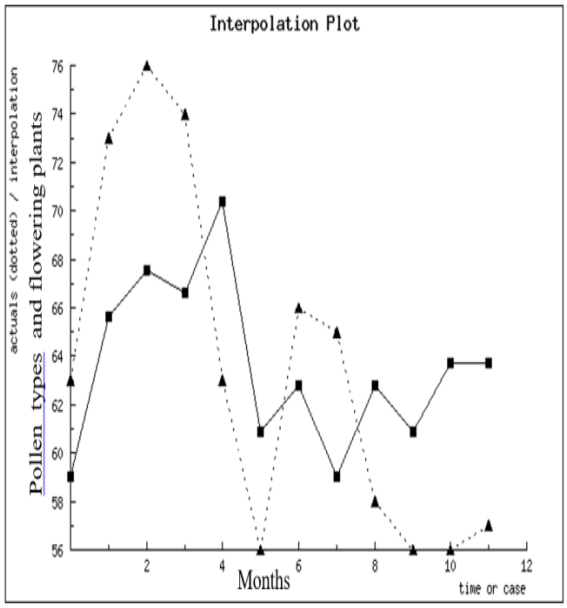

Figure 1.Interpolation of pollen types and flowering plants plotted against time at San Jose, Pili, Camarines Sur. ■–flowering plants ▲-pollen types

Pollen richness was higher in San Jose during the first part of the year (January to May) than the later part except in September which had the highest species richness and the greatest variability (95% confidence limits of 28.88 to 95.36). Species richness was lowest in August and October. The lower 95% confidence limits for the 12 months sampling overlaps and were generally below the computed mean richness, except in November (Table 2).The species richness in Del Rosario started to rise from February to April reaching its peak in May, followed by a drastic reduction in June (Table 3).

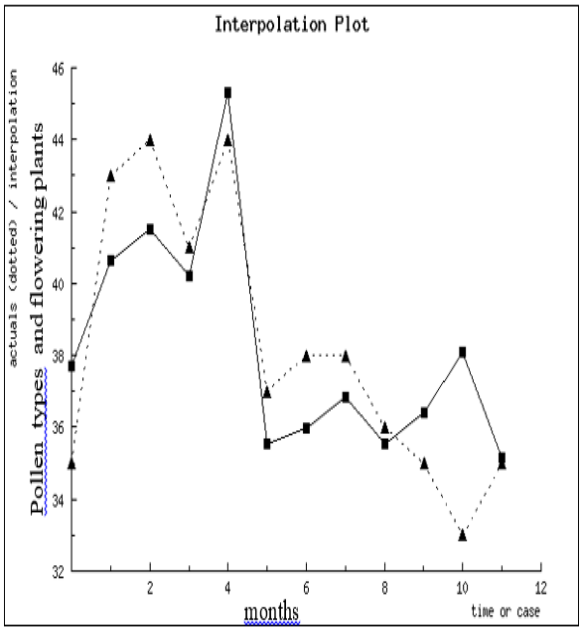

Figure 2. Interpolation of pollen types and flowering plants plotted against time at Del Rosario, Naga City, Camarines Sur■ –flowering plants ▲-pollen types

The months with overlapping confidence intervals were observed in February, March, and April which mean that these months have similar pollen richness. Regressing pollen richness with bloom pattern did not show significant differences in the lowland ecosystem. Likewise, analysis of the F-values obtained in both sites showed non-significant differences at 1% and 5% level.

*Table 2. Monthly species richness at San Jose based on Chao estimate. Notes: *Chao= Chao 2 richness estimator (mean among 6 runs), log-linear confidence interval lower and upper bounds. Months with overlapping confidence intervals, having common letters, are not significantly different at 5% level.*

Months	Mean *(Chao2)	95% Confidence Limits		Difference
		Lower	Upper	
January	22.67	21.26	31.57	ab
February	33.18	32.27	40.98	a
March	29.79	29.09	34.24	a
April	30.00	27.67	40.37	a
May	33.56	32.27	40.98	a
June	33.67	22.24	33.54	ab
July	26.80	24.53	38.78	ab
August	20.33	20.07	24.67	b
September	42.67	28.88	95.36	a
October	22.40	23.03	27.27	b
November	26.00	26.00	30.08	ab
December	27.00	25.33	37.15	ab

*Table 3. Monthly species richness at Del Rosario, Naga City based on Chao estimate. Notes: *Chao2 = Chao 2 richness estimator (mean among 6 runs), log-linear confidenceinterval lower and upper bounds. Months with overlapping confidence intervals, have common letters, are not significantly different at 5% level.*

Months	Mean *(Chao2)	95% Confidence Limits		Difference
		Lower	Upper	
January	13.00	13.00	15.70	C
February	20.36	20.03	24.46	B
March	21.95	21.12	28.63	B
April	20.33	19.18	28.72	B
May	31.00	31.00	37.11	A
June	5.22	5.01	9.38	E
July	9.67	9.05	18.33	Cd
August	11.5	11.04	17.14	Cd
September	8.00	8.00	10.37	De
October	10.00	10.00	12.56	D
November	14.00	14.00	16.66	C
December	7.00	7.00	9.07	E

DISCUSSION

More than one hundred plant taxa were visited by *T. biroi*in four selected sites. The majority of the plants visited by the bees were cultivated species and common in the province. As such, their availability is not a problem as these can be grown easily and establish in the potential beekeeping sites.

No difference in the blooming period noted between lowland and upland ecosystems. The observed similarity in the blooming pattern was probably because of little distinction in the climatic condition. Both ecosystems showed a peak of flowering from February to May which coincided with the dry season. As such, it is the honey flow season or pollen season of the stingless bees with nectar and pollen sources abundant and readily available. The difference in the density of the species that flowered every month between the two ecosystems may be influenced by the kinds of flowering plants growing in such areas affected by topography or slope, seasonality of the species and the change in the cropping system because of the change in season.

The bloom period clearly affected the foraging activity of the stingless bees. Stingless bees showed a very active foraging in the dry season when the majority of the flowers bloom. The effective foraging distance is likely between 50-150 meters depending upon the floral resources available and probably the level of disturbances in the area where colonies are located. Stingless bees did not show special preference to the morphology of a flower as various flower types, colors, sizes and scents were collected with pollens (Figure 3). Stingless bees having a minute body of 3-5mm is an advantage because it could forage and /or enter the corolla of the medium to large flowers and explore efficiently for nectar or pollens.

Palms which are abundant in the province are very important pollen sources of *T.biroi*. Palms forage value to *T. biroi*are minor to dominant pollen sources. The coconut was the major pollen source as their pollens were present in all the samples collected from

Figure 3. Cultivated and feral pollen sources of T. biroi having tiny and small flowers (a) *Veronica peregrina*(b)*Ocimumbasilicum*(c)*Solidagovirgaurea* (d)*Bidenspilosa*(e) *Oxalis sp.* (f) *Cleome rutidesperma*.

all sites, and were always encountered during monthly sampling. Major pollen sources during the short blooming period include *Ceibapentandra, Ptercarpusindicus, Syzigium spp., Elaeisguineensis, Areca catechu, Citrus spp.* and *Delonixregia*.

These plants were also considered secondary to dominant pollen sources during certain months of the year including other species of *Leguminosae, Asteraceae, Myrtaceae, a*nd *Rutaceae* families.

Pollen spectrum is dependent on the kinds and number of flowering plants available in the vicinity of the colonies with a minor consideration on the preferences of the stingless bees. The abundance of flowering plants preferred by stingless bees influenced the diversity of the foraged pollens.

Rarefaction curve and pollen richness in the lowland ecosystem was higher in May than the rest of the months. Marked differences in species richness were noted in June and September. The higher 95% confidence limits from February to May signifies that stingless bees frequently visited flowering plants and collected higher amounts of pollens. The overlapping of the lower 95% confidence limits during the 12 months sampling showed that the pollens gathered have a common foraged value to the stingless bees.

CONCLUSION

The analysis of stingless bee pollens enhanced our knowledge of the *T. biroi* botany. Majority of the plants visited by the bees were cultivated species. As such, their availability is not a problem as these can be grown easily and establish in the potential beekeeping sites. Knowledge of the major flowering period is the ideal time to divide the colonies because of the abundance of their food sources. Moreover, the palynological composition of the pollen loads and the pollen pots described the local flora surrounding the beehive and this provides an indication of the biodiversity of the area.The results of this study guidethe beekeepers in determining areas suitable for meliponiculture.

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Proceedings of the 3rd International Conference on Agriculture and Forestry, Vol. 2, 2016, pp. 127-134
Copyright © TIIKM
ISSN: 2362-1036 online
DOI: https://doi.org/10.17501/icoaf.2016.2112

INFLUENCE OF ELEVATION ON HONEYBEES *Apis mellifera syriaca* (HYMENOPTERA: APIDAE) FLIGHT ACTIVITIES AND ITS IMPACT ON FRUIT SET AND QUALITY OF WATERMELON (*Citrullus lanatus*, CUCURBITACEAE)

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Abstract

A field experiment was conducted to monitor the flight activities of the worker bees of *Apis mellifera* syriaca and their impact on pollination of watermelon *Citrullus lanatus* as affected by the growing area elevations. The experiment composed of three treatments, the control (covered plants); in which the plants were caged before flowering to prevent any contact with insect pollinators, the second treatment the plants were left opened to permit contact with honeybees (uncovered plants) and the third treatment the plants were supplementary pollinated with pollen from other plant (hand pollination). The results of this experiment showed that the viability of female flower stigmas lasted mostly to the early hours of the day at 11:00 am for flowers produced in Madaba (780 m above sea level), and lasted to the afternoon of the day at 14:00 pm for flowers produced in Wadi Araba, Al Safi village (350 m below sea level). In general fruit set, seed set, number of fertile seeds, fruit weight, and fruit sugar content were significantly higher in uncovered followed by supplementary pollinated then covered plants while fruit length and fruit circumference were significantly higher in uncovered followed by covered and finally supplementary pollinated plants. Furthermore, fruit set, seed set, fruit weight, fruit circumference, and fruit total soluble solids percentage was significantly higher in plants grown above sea level than below sea level. Honey bees play an important role in the production of high quality and quantity of watermelon fruits for plants grown above or below sea level.

Keywords: Honey bees, Watermelon, Elevation, Pollination, *Apis mellifera*, Flight activity, Fruit set, Jordan

INTRODUCTION

Watermelon (*Citrullus lanatus*, Cucurbitaceae) is annual vining vegetable crop belongs to Cucurbitaceae family (Davis and Meinert 1965). It is one of the most common types of melon in Jordan. Watermelon planted during winter in the Jordan valley and during summer in the high lands and desert areas under open field irrigated conditions. Most vine crops produce both staminate and pistillate flowers separately on the same plant, the plants are referred to as being monoecious. Flowers of watermelon are staminate (male), perfect (hermaphroditic), or pistillate (female). Pistillate flowers have an inferior ovary, and the size and shape of the ovary is correlated with final fruit size and shape (Rubatzky and Yamaguchi, 1997). In many varieties, the pistillate or perfect flowers are born at every seventh node, with staminate flowers at the intervening nodes. However, the hermaphrodite flowers of watermelon do not pollinate themselves adequately without the aid of bees.

Using of honeybees in pollination of melons in commercial fields is well known and valued method (Bohart, 1970) Because honeybees can perform well

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under diverse climatic conditions and multiplying their numbers in relatively short time; the colonies can be sited when and where its needed to satisfy pollination requirements (Mann, 1953). Cucurbit vegetable crops, such as watermelon require insect pollination for fruit set, which is usually achieved by placing honeybee (*Apis mellifera*) colonies in the field. Bees forage on cucurbit flowers for nectar and pollen grains that picked up from staminate flowers on the body hairs and rubbing off during successive visits to pistilate flowers (Mussen and Thorp, 1997). Many researches concentrated on the significant of using local race of honey bees *Apis mellifera* as pollinators in triploid watermelon (Stanghellini et al., 1998). Alan (2005a b) reported that the honeybees *Apis mellifera* races are important pollinators of triploid watermelon and female flowers require multiple honeybees or other wild bees visitations after visiting staminate (or male) flowers for pollination and fruit set and pollination. Also, increased number of bee visits for triploid watermelon had a strong positive effect on fruit set and yield (Stanghellini et al., 1998). Early pollination and subsequent fruit set will give rise to early harvesting and thus premium prices, particularly for the earlier melons cultivars. Melons produced from insect pollinated fields tended to be sweeter, larger and more uniform in size comparing with covered plants of no insect pollinators (Bodnar, 1987).

The roles of local race of honeybees *Apis mellifera* syriaca as pollinators for watermelon production under semiarid Mediterranean condition in Jordan are not yet evaluated. *Apis mellifera* syriaca, is a native bee in the east of Mediterranean region and one of the oldest honeybee races (Ruttner, 1988) and well adaptive to the local semiarid environmental conditions (Al-ghzawi et al., 2001; Zaitoun 2000; Zaitoun and Vorwohl, 2003). It has the capability to pollinate different flowers of fruit trees, medical plants and vegetable crops grown in Jordan (Zaitoun and Al-ghzawi, 2007; Zaitoun et al. 2008; Al-ghzawi et al., 2009 a b c; Zaitoun et al. 2009; Al-ghzawi et al., 2014 a b). Therefore; the main objectives of this study were to investigate the role of Syrian honeybees in pollination of watermelons grown under two different elevations at 780m above sea level and at the lowest point of the world near the Dead Sea in Jordan**.** The role of the bees will be evaluated against covered treatment and hand pollinated treatment. Moreover different fruit and seed quality characteristics will be used as parameters for pollination efficiency and success.

MATERIALS AND METHODS

Site description

This experiment was conducted during 2012/2013 growing seasons at two different locations. The first one located in Madaba, (31°43" N, 35°48" E with 780 m above sea level). It characterized by semiarid Mediterranean condition with of mild rainy (225 mm) winters and dry hot summers. The second one located in Wadi Araba, Al Safi village near the Dead the lowest point in the world (31°32" N, 35°28" E with 350 m below sea level). As an average of the last 10 years, the area has a mild winters with a mean temperature of the coldest month (December) around 11°C, warm summers with a mean warmest month temperature (July) around 42°C. The rain period mainly during November to March months and the mean annual precipitation is 70 mm.

Bee colonies

Four hives of *Apis mellifera* syriaca were introduced and placed at the field border at the beginning of the flowering stage. Each hive was established in a standard one-story with 10- frame Langstroth hive. The hives have similar number of worker bees, brood combs, stored food, and supplied continuously with water and protected from sunlight. All management practices including feeding, supering and swarm prevention was carried out. The same hives were used in both locations, that they were moved to the first location under sea level in October 2012 and migrated to the second location in April 2013.

Experimental plant

A commercial watermelon hybrid (Samara f1/SAKATA) was used in these experiments. Seeds were planted in trays containing peat moss in 1/11/2012, for planting under sea level, and 1/3/2013 for planting above sea level. In each location, three raised beds (blocks) were prepared and mulched with polyethylene plastic mulch after drip irrigation system has been installed. When transplants

were reached the first true leaf stage, twelve transplants were transplanted into each treatment with 120 cm between plants.

Pollination treatments

For the pollination studies, three beds were randomly selected. Each bed contain twelve plants, it was divided into three pollination treatments: the control (covered plants); in which the plants were caged before flowering to prevent any contact with insect pollinators, the second treatment the plants were left opened to permit contact with honeybees (uncovered plants) and the third treatment the plants were supplementary pollinated with pollen from other plant (hand pollination). As usually, each plant has one fruit.

Stigma receptivity

To determine at which developmental stage flowers had receptive stigmata, 3% hydrogen peroxide was placed on the stigma of flowers. Bubbles are produced when the mucus exuded by a receptive stigma contacts hydrogen peroxide (Dafni, 1992). Stigma viability was tested during pollination period by randomly a signing twenty four pistilate flowers from each covered and uncovered sub plot. Twelve flowers of from each treatment were freshly picked at half open growth stage at different time intervals within day, 8:00, 11:00, 14:00 and 17:00 o'clock. The other twelve flowers were picked the next day at opened stage on same previously assigned time of the day. A small drop of 3% hydrogen peroxide was applied to stigma which placed under dissecting microscope (Olympus optical company, Japan), waiting few minutes for the presence of a bubbling action as an indication of stigma viability.

Data recording

Fruits were harvested at August 2013 for first location and at April 2013 for the second location. Fruits length, circumference and weight for all treatments were recorded. Moreover, total numbers of seeds, fertile seeds and sterile seeds were recorded. Sugar content (^{o}Brix) was estimated by refractometer (Fernando G., Own work).

Statistical analyses

This experiment was planed as Split-plot Randomized Complete Design (RCBD) with four-replications. The locations were assigned to main plots and the pollination treatments were assigned as subplots. Data were analyzed by analysis of variance (ANOVA) using SAS. Least Significant Differences (LSD) was used to comparisons between means of locations, treatments and interaction at 0.05 probability level.

RESULTS

In both experiments, the pollination treatments x locations interactions were significant at ($P\leq 0.05$). The main effect of pollination treatments and locations were significant for all fruit parameters shown in Table 1 and Table 2.

Location1 (Madaba, 780m above sea level) recorded higher average values with significant difference compared to Location2 (Wadi Araba, Al Safi village near the Dead Sea the lowest point in the world). Thus, in location1 the average fruit length (44 cm) was higher than that for plants grown in location2 (30.0 cm).

Concerning pollination treatments; fruits grown under open pollination were the longest (62 cm and 40 cm), followed by cover treatment (40 cm and 30cm) and hand pollination (30 cm and 20cm) for location 1 and location2 respectively. Furthermore, fruit diameter in location1 (37 cm) were superior to that grown in location2 (20.3 cm).

Regarding pollination treatments open pollinated plants had the highest fruit diameter (37 cm and26 cm) followed by fruit under cover treatment (32 cm and 19), fruit diameter were the lowest when plants were hand pollinated (28 cm and 16cm) for location1 and location2 respectively.

Significant differences were recorded for fruit weight at ($P\leq 0.05$) among location and pollination treatments (Table 1) Fruit weight in location1 (7.4kg) were higher than that grown in location2 (4.3kg). Moreover, the pollination treatments x locations interaction were also significant at ($P\leq 0.05$). Furthermore, the cover treatment fruit weight recorded the lowest values (3 kg and 1.2 kg)

compared with the hand pollination treatment (4.4 kg and 7.4 kg) and open pollination recorded the highest values (10.2 kg and 7.4 kg) for location1 and location2 respectively.

Sugar content was also affected significantly by location and pollination treatments, fruits grown in location1 had higher sugar content value (13.6 ^{0}Brix) than that grown in location2 (7.1 ^{0}Brix). In addition, fruit grown under open pollination treatment had higher sugar content (19 and 10 ^{0}Brix) followed by hand pollination (14 and 7 ^{0}Brix) and the least was cover treatment (8 and 4.5 ^{0}Brix) for location1 and location2 respectively.

Table 2 shows significant difference in all seeds parameters between pollination treatments and locations at ($P \leq 0.05$), pollination treatments x locations interaction were significant in the two experiments. Fruit grown in location1 produced higher seeds number per fruit (268 seeds) than that grown in location2 (98.3 seeds). Fruit grown under open pollination produced (313) seeds per fruit, followed by hand pollination (142) seeds per fruit and fruit under cover treatment (94) seeds per fruit.

Moreover, in location1 fruit produced in average (220 fertile seed per fruit) higher than that grown in location2 (74.3 fertile seeds per fruit). Also, fruit grown under open pollination had produced higher fertile seeds per fruit (294), followed by hand pollination (124.5) and cover treatment (23.5). Moreover, fruit grown in location1 produced (47 sterile seeds per fruit) higher than that grown in location2 (24 sterile seeds per fruit) and cover treatment produced higher sterile seeds per fruit than other pollination treatments**.**

The results showed that the viability of female flower stigmas lasted mostly to the early hours of the day at 11:00 am for flowers produced in Madaba (780 m above sea level), and lasted to the afternoon of the day at 14:00 pm for flowers produced in Wadi Araba, Al Safi village (350 m below sea level).

DISCUSSION

The present experiments proved that *Apis mellifera syriaca* is efficient pollinator of *Citrullus lanatus*. Watermelon like other Cucurbitaceae requires insect vectors such as honeybees to increase fruit set and yield quality. This result agrees with many researchers who found that honeybees are important pollinator of triploid watermelon (Alan, 2005a b; Stanghellini et al., 1998) and of muskmelon (Al-Ghzawi et al., 2007; Bohn and Mann, 1960). Honeybees increase yield mainly by increasing fruit number, fruit set and decreasing abortion rate (Alan, 2005 a b; Stanghellini et al., 1998). Alan (2005 a) reported that the increase in fruit set rate by honeybees under open pollination treatment 80% compared with plants under cover treatment, this result may be attributed to presence of honeybees lead to decrease abortion rate in watermelon. Moreover, the same result was recorded in other cucurbitaceous like muskmelon (Al-Ghzawi et al., 2007; Bohn and Mann 1960). It seems that honeybees are not only successful in pollination process itself but also transfer viable high quality pollen grains which affect positively post pollination-process. Stephenson (1981) and Lee (1988) mentioned that fruit-set among flowers within inflorescences is not influenced only by pollination success but also by post-pollination processes such as variation in the quality of pollen arriving at flowers, pollen germination activity, pollen tube growth, and development of fertilized seeds. Also, fruit set is influenced by the time of flowering during the different months of the year.

In addition, this study showed that elevation seems to play role in pollination process success; fruit length, circumference, weight, number of seeds per fruit, number of fertile seeds per fruit and fruit sugar content were higher at 780m above sea level (location1) compared to the second location at the lowest point of the world (location2). Since studies about elevation effect on pollination is rare, it's difficult to compare our results with others. Further work should be done to explore pollination elevation relation.

Fruit length and fruit circumference were higher in open pollination treatment followed by covered treatment and the least were recorded in hand pollination treatment in both elevations. But, fruit weight, number of seeds per fruit, number of fertile seeds per fruit and fruit sugar content were the highest under open treatment followed by hand pollination treatment and then cover treatment. Sterile

seeds recorded the highest value in the cover treatment and the least in the open treatment. These results in agreement with other researchers, Alan (2005 a) and Stanghellini et al. (1998) they reported that the fruit weight and number increased under open pollination than that under low or no visitation, also lead to increase fruit yield per hectare. Bodnar (1987) reported that muskmelons produced from insect pollinated fields tended to be sweeter, larger and more uniform in size comparing with covered plants of no insect pollinators. Stanghellini et al. (1998) detected high positive correlation between seed number and fruit size of muskmelon Also, strong correlation between presence of honeybees and muskmelon yield were registered (Al-Ghzawi et al.; 2007; Bohn and Mann 1960). These results may attributed to efficient pollinators (honeybees) leading to large number of pollen grains transfer to stigmas of pistilate flowers causing high percentage of fruit setting (Bodnar, 1987), or result of increases in growth and development in the ovary then increase in fruit size after fertilization (Rubatzky and Yamaguchi, 1997).

In this study fruit weight was higher in uncovered fruits than covered plants with significant differences. This proves again the positive pollination effects of honeybees. It is known that Increasing in fruit size related usually to fertilization, and sometimes to pollination alone, by stimulating the floral parts causing a rapid cell division that leads to differentiation of fruit parts, and trigger fruit growth by hormone production (McGregor S. E. 1976). Other factor play a role in the size and weight of fruit are the size and number of seeds produced in the fruit. Reduction of seed size and number reduces fruit size (Mizrahi et al., 1997) Also; Low fruit weight compared to the large fruit size in cover treatment of this study can be explained on the base of poor seed set as discussed by Jones et al. (1998).

In addition, sugar content was affected by pollination treatments, i.e. sugar content was higher under open pollination treatment then hand pollination treatment compared to cover treatment this agrees with findings in other cucurbits; Bodnar (1987) reported that muskmelon produced from insect pollinated fields tended to be sweeter, larger and more uniform in size comparing with covered plants of no insect pollination.. Denney (1992) mentioned that the taste qualities and soluble solids accumulation that contain mainly sugars may be explained by seed – controlled hormonal level

In conclusion, honeybees *Apis mellifera* syriaca and elevation from sea level are playing significant role in pollination and yield of watermelon grown under semiarid conditions, this role should be enhanced to ensure higher visitation rates to watermelon flowers. Studies concerning pollination of watermelon and factors affecting it are very scarce. Further studies should be made to explore the role of honeybees in pollination of *Citrullus lanatus* in order to get high quantity and quality yield.

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APPENDIX

Table 1: Length, diameter, weight and 0Brix of watermelon fruit under all pollination treatments.

† 1, 2,3, Fisher's Least Significantly Difference to compare between location means, treatment means, or treatment x location interaction .

Location	Treatments	Parameter			
		Length cm	Diameter cm	Weight kg	^{0}Brix
Location 1					
	Open	62a	37a	13.0a	19.0a
	Cover	40b	32b	3.0c	8.0c
	Hand pollination	30c	28c	6.2b	14.0b
Location 2					
	Open	40a	26a	7.4a	10.0a
	Cover	30b	19b	1.2c	4.5c
	Hand pollination	20c	16c	4.4b	7.0b
Main effects					
	Location 1	44a	32a	7.4a	13.6a
	Location 2	30b	19b	4.3b	7.1b
	Open	51a	31a	10.2a	14.5a
	Cover	35b	25b	2.1c	6.3c
	Hand pollination	25c	21c	5.3b	10.5b
LSD (0.05)[1]		2.2	1.0	0.4	0.5
LSD (0.05)[2]		1.2	1.1	0.3	0.7
LSD (0.05)[3]		1.6	1.3	0.5	0.7

Table 2: Effects of pollination treatments on seeds of watermelon grown at two different locations and as affected by pollination treatments.

† *1, 2,3, Fisher's Least Significantly Difference to compare between location means, treatment means, or treatment x location interaction*.

Location	Treatments	Parameter		
		Seeds number	Fertile seeds	unfertile seeds
Location 1				
	Open	471.0	451.0	20.0
	Hand pollination	193.0	174.0	19.0
	Cover	138.0	36.0	102.0
Location 2				
	Open	155.0	137.0	18.0
	Hand pollination	91.0	75.0	16.0
	Cover	49.0	11.0	38.0
Main effects				
	Location 1	268.0	220.3	47.0
	Location 2	98.3	74.3	24.0
	Open	313.0	294.0	19.0
	Hand pollination	142.5	124.5	17.5
	Cover	94.0	23.5	70.0
LSD (0.05)[1]		9.2	9.3	4.3
LSD (0.05)[2]		8.0	8.9	4.2
LSD (0.05)[3]		2.4	2.6	2.6

Proceedings of the 3rd International Conference on Agriculture and Forestry, Vol. 2, 2016, pp. 135-157
Copyright © TIIKM
ISSN: 2362-1036 online
DOI: https://doi.org/10.17501/icoaf.2016.2113

VARIETAL TRIAL OF RAINFED RICE GENOTYPES USING DIFFERENT NUTRIENT MANAGEMENTS AT CSU PIAT, CAGAYAN, PHILIPPINES

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Abstract

In the Philippines, rainfed rice is grown on about 1.3 million hectares or 33% of the total rice area of 4 million hectares. With unpredictable weather, highly variable and heterogenous soils, the evaluation of recommended location specific rainfed rice varieties was done at CSU Piat from 2013WS to 2014WS. Treatments were laid out in RCBD with three replications. Twelve sahod ulan varieties were evaluated for yield, yield components and agronomic traits. PSB Rc14 was used as the check variety for rainfed while PSB Rc82 and NSIC Rc222 as farmers preferred variety in the locality. Across seasons, results showed significant differences in yield which is attributed to varietal and genetic differences of materials tested. NSIC Rc284 obtained the highest mean yield (4.2 ton/ha) with medium maturity of 110.67 days. Second highest yielder were NSIC Rc288 and NSIC Rc276 (3.89 and 3.88 ton/ha) with maturity of 94 and 92 days respectively. These are the top 3 selections specifically adapted at CSU Piat condition. These results/selections provide farmers an option of increasing yield and income using the right rainfed variety even in highly variable rainfed ecosystem.

Keywords: Genotypes, rainfed, varieties, yield, yield components

INTRODUCTION

Rainfed lowland rice in Asia covers about 46 million ha or almost 30% of the total world rice area (Maclean *et al.*, 2002). Rainfed lowland rice faces various biotic and abiotic stresses, such as drought, submergence, adverse soil conditions, pests, and weeds. These conditions cause low rice production affecting about one billion people that depends on rainfed lowland rice in South and Southeast Asia. Because of the low and unstable productivity levels, poverty is severe in communities largely dependent on rainfed rice.

In the Philippines, rainfed lowland rice is grown on about 1.3 million ha or 33% of the total rice area of 4 million ha. Important rainfed areas are located in the Cagayan Valley in Northern Luzon, in Iloilo province, and on the coastal plains of Visayas and Ilocos in Northern Luzon. Some of the rainfed environments have favorable conditions for rice similar to irrigated systems but a considerable part is constrained by drought, submergence and limited soil fertility. Even in this condition, rainfed farmers tend to use irrigated varieties in their field due to the norms that it can yield above the average of that of stress tolerant varieties regardless of abiotic stress. The common practices in nutrient management were also patterned in irrigated areas and sometimes tend to have a blanket application rate across farmer's field. The development of stress tolerant varieties for rainfed lowland rice has been given emphasis by breeders for farmers to use in stress-prone environment.

In terms of nutrient management, the continuous development of technology and ICT decision-tool created the Rice Crop Manager (RCM). This was developed by scientists and researchers as a crop management technology for fertilizer recommendation that will reach out farmers especially those in remote areas. Rice Crop Manager (RCM) which follows the principles of site specific nutrient management (SSNM), gives nutrient recommendations required by rice plant in both

rainfed and irrigated ecosystem. RCM is an application that can be accessed via a smartphone or computer with internet connections. RCM provides advice after a farmer answers a series of questions. Then it allows an extension officer to save, print, or send to the farmer's phone via email or SMS the recommendations on nutrient, pest, weed and water managements, depending on the specific variety they used, their yield from the previous season and the site-specific conditions of their field. It puts the power of technology into action by helping farmers decide how to manage their rice crops better.

Moreover, farmers are using irrigated high yielding varieties (HYV) in the rainfed ecosystem with the belief that it can yield above average than stress tolerant varieties in the rainfed environment. This reason is more prone in the risk of crop failure when drought occurs in the early to mid-season. The gap between the yield of stress tolerant varieties and irrigated HYV is large when grown in favorable condition. However, RCM can enhance the yield and nutrient use efficiency of stress tolerant varieties in the rainfed environments. Rainfed varieties can have a comparable yield to high yielding irrigated varieties using RCM in the rainfed environment, hence, this study.

OBJECTIVES OF THE STUDY

Generally, the study aimed to evaluate the effects in the nutrient efficiency, yield and yield components of rainfed lowland rice varieties and high yielding varieties using the Rice Crop Manager (RCM), Rice Crop Manager plus (RCM+), Farmers Practice (FP), and Control (no fertilizer application). Secondly, to determine the best combination of variety and nutrient management options in the rainfed lowland ecosystem.

Specifically, the study aimed to determine the agronomic and yield performance of 12 rainfed lowland rice newly released varieties using different crop managements (i.e. Rice Crop Manager, Rice Crop Manager +, Farmers Practice, and Control) under CSU Piat condition in the following parameters: days to 50% flowering, days to maturity, plant height, tiller number, culm length, panicle length, 1,000 grain weight, and yield (tons/ha).

SCOPE AND DELIMITATION

This study was focused on the evaluation of nutrient efficiency, yield and yield components of rainfed rice tolerant varieties and high yielding varieties using RCM, RCM+, FP, and Control; and to determine the best combination of variety and crop management options in the rainfed lowland. It was conducted at Cagayan State University, Piat Campus specifically in the rainfed experimental farm last August 2014 to January 2015. The data gathered were confined to agronomic, yield components, and yield parameters of the 12 rainfed rice varieties plus 3 checks using four crop managements i.e. RCM, RCM+, FP, and Control.

MATERIALS AND METHODS

Materials

Fifteen diverse rice varieties were used in this study that included 12 rainfed lowland rice varieties i.e. NSIC Rc192, NSIC Rc272, NSIC Rc274, NSIC Rc276, NSIC Rc278, NSIC Rc280, NSIC Rc282, NSIC Rc284, NSIC Rc286, NSIC Rc288, NSIC Rc346, NSIC Rc348 including 3 checks i.e. PSB Rc14, PSB Rc82, PSB Rc222 (Table 1). PSB Rc14 served as rainfed lowland rice check, while, PSB Rc82 served as the most preferred variety by farmers in the locality and NSIC Rc222 served as the high yielding irrigated check.

The following agricultural supplies and equipments were used in the study: fertilizers such as 14-14-14 (N-P-K), 46-0-0 (N-P-K), and 0-0-60 (N-P-K); insecticides such as Karate and Prevaton; handtractor, carabao-drawn disc plough, harrowing equipments i.e. suyod; shovel, panabas, and scythe.

Measuring devices such as piezometers, Automatic Weather Data Logger (AWD), sensitive weighing balance, 200 °C capacity oven, 1.5 meter stick, rulers, sacks, paper bags, cloth bags, net bags, shipping tags, record book, pencils, ballpens, and pentel pens.

Methods

The whole experimental area (4,000 m^2) was laid out following the Split Plot in Randomized Complete Block design with three replications.

The 15 diverse varieties evaluated were assigned as main plots (Factor A) while the four crop managements were assigned as sub-plots (Factor B). Each crop management was replicated thrice while the varieties evaluated were replicated per crop management. The following treatments evaluated were:

FACTOR A = FIFTEEN RAINFED LOWLAND RICE VARIETIES (MAIN PLOT)		
V1 = NSIC Rc192	V6 = NSIC Rc280	V11 = NSIC Rc346
V2 = NSIC Rc272	V7 = NSIC Rc282	V12 = NSIC Rc348
V3 = NSIC Rc274	V8 = NSIC Rc284	V13 = PSB Rc14 rainfed check
V4 = NSIC Rc276	V9 = NSIC Rc286	V14 = PSB Rc82 farmers prefered variety
V5 = NSIC Rc278	V10 = NSIC Rc288	V15 = PSB Rc222 high yielding irrigated

FACTOR B = CROP MANAGEMENTS (SUB-PLOT)	
RCM = Rice Crop Manager	FP = Farmers Practice
RCM+ = Rice Crop Manager+	Control = No fertilizer application

There were 180 plots with dimensions of 4 x 5 meters each plot. Small paddy bunds (6 inches) were constructed to separate each plot (variety) within any crop management. Large paddy bunds (1 meter) were provided to separate Crop Managements (RCM, RCM+, FP, Control) within a replication serving as blocks. Larger paddy dikes were constructed to separate each replication (2.0 m).

To minimize experimental errors, blocking orientation followed the slope soil gradient of the experimental area such that all treatments (Factor A and B) will be exposed to the same environments (Figure 1).

Representative sample (RS) plants for the yield component data were randomly assigned within each plot just beside the grain field area. Each RS plant was marked with stakes with ID number on it to facilitate data gathering. Grain yield were derived from the inner most rows consisting of 125 hill or $5m^2$. Agronomic data such as plant height, culm length, panicle length, and tiller number were derived from the inner rows each plot excluding 0.6 meter end rows.

Data Analysis

All agronomic yield and yield components data were analysed using the Statistical Tool for Agricultural Research specifically the analysis of variance (AnoVa) and comparison between treatment means.

Securing of Planting Materials

The 15 varieties of rice used in this study were provided by the International Rice research Institute (IRRI) and Philippine Rice Research (PhilRice) in collaboration with Cagayan State University (CSU) College of Agriculture at Piat Cagayan.

Land Preparation and Layout

An area of 4,000 m2 was used in this study. The area was thoroughly ploughed and harrowed twice at weekly intervals to hasten the decomposition of weeds and to attain proper soil tilt.

After the field was prepared, it was divided into three equal blocks for the replication with a pathway of two meter between replication. Furthermore, each replication was divided into four equal blocks for the four crop managements i.e. RCM, RCM+, FP, Control. Lastly, the four equal blocks (4 crop managements) were further subdivided into fifteen

equal plots measuring 4m x 5m or 20 m2 each variety.

Seedbed preparation and Sowing of the Seeds

An area of 75 m^2 was utilized for seedbed. It was prepared thoroughly by paddling the area and after which it was levelled. The seedbed was subdivided into 15 measuring 1m x 5m for the varieties. The seedbed was elevated with canals provided around the bed to drain excess water when there is heavy down pour of rain.

The seeds were soaked in clean water for 24 hours and incubated for another 24 hours to ensure good and uniform germination. The pre-germinated seeds were sown properly on the prepared seedbed.

Pulling the Seedling

Seedlings were carefully uprooted 21 days after sowing. The roots were washed and bundled in 12 bundles each seedbed for each varieties.

Transplanting

Before transplanting, the experimental area was leveled and paddy bunds were provided in the lay out to separate each plot (variety) being evaluated.

The seedlings were transplanted at a distance of 20 cm x 20 cm between hills with 2 seedlings per hill. It was transplanted September 03-05 2014.

Water Management

The plants were irrigated as the need arises or when the perch water table met the critical level. Equal amount of water were given per plot to avoid bias and experimental errors.

Fertilizer Application

Commercial fertilizers were applied in blanket application following the soil analysis recommendation (Table 2).

The amount of fertilizer applied at basal for Famers practice was 300 g of 14-14-14 per plot and 300 g of 46-0-0 was applied 30 days after transplanting. During panicle initiation 150 g of urea was applied.

The amount of fertilizer applied at basal for Rice Crop Manager was 300 g of 14-14-14 per plot and 100 g of 46-0-0 was applied 30 days after transplanting. During panicle initiation 150 g of urea was applied.

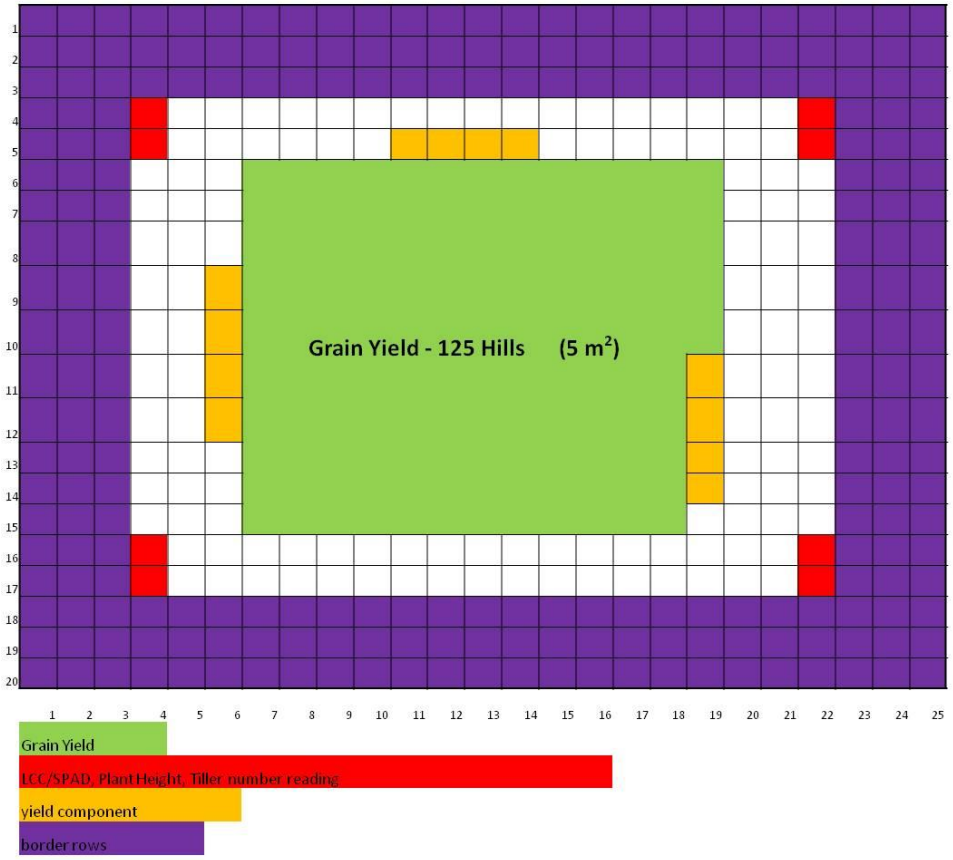
The amount of fertilizer applied at basal for Rice Crop Manager plus (RCM+) was 350 g of 14-14-14 per plot and 150 g of 46-0-0 was applied 30 days after transplanting. During panicle initiation 150 g of urea was applied.

Control of pest and Diseases

Appropriate insecticides were sprayed when insect pests and diseases were observed following the recommendation from the label of the insecticide.

Harvesting

Harvesting was done when 80% of the plants showed signs of maturity. Harvesting was done using scythe. The schematic diagram of the harvest area per plot is shown below:



Threshing

After harvesting, it was threshed manually inside the net bags. The seeds were cleaned with moderate wind to avoid blowing away the half-filled grains.

Drying

The seeds were sundried in the concrete pavement wherein the seeds were placed in a cloth bag to avoid mixing seeds. Furthermore, it was oven dried to attain uniform moisture content of 14%.

Statistical tool used

The Statistical Tool for Agricultural Research was used in the analysis of variance (ANOVA) using 5% and 1% level of significance. The least significance difference at 5% (LSD 0.05) was used to compare treatments.

Data Gathered

Number of days to flower

Number of days to maturity

Average Plant height at maturity (cm) – the height of the plants was taken from the representative sample plants, measured from the base up to tips of the leaves.

Average tiller number – this was done by counting the total number of tillers from each representative sample plant and divided it by twelve (12) to get the average tiller number.

Average culm length (cm) – this was taken from representative sample plants, measured from the base up to the above flag leaf at the lowest attachment of the spikelet

Average panicle length – this was taken from the representative sample plants outside the harvest area, this was done by measuring the above flag leaf at the lowest attachment of the spikelet up to the tip of the most spikelet

Computed yield tons per hectare – all the grains harvested from the harvest area per crop management were weighed and projected in tons/ha.

RESULTS AND DISCUSSION

Number of Days to Flower

The average number of days to flower of the different rainfed rice genotypes across four crop managements tested i.e. Control, FP, RCM and RCM+ is presented in Figure1a. Highly significant differences on average number of days to flower were observed among the different rainfed rice genotypes tested. Results further revealed that among the different rice genotypes evaluated, NSIC RC 348 was the earliest to flower with a mean of 58.33 days after sowing (DAS). This was followed by PSB Rc14 which flowered at 62 DAS. NSIC Rc192, 272, and 274 flowered at 65 DAS. NSIC Rc276 flowered at 68 DAS, while, NSIC Rc282 and PSB Rc82 had flowered similarly at 75.41 DAS. The high yielding irrigated variety (NSIC Rc222) flowered at 76 DAS, followed by NSIC Rc280 and 286 which flowered at 77.41 DAS. However, the longest days to flower was NSIC Rc284 with a mean of 80.91 DAS.

Comparison among treatment means (CATM) shows that NSIC Rc348 is significantly different from all the other rice genotypes. PSB Rc14, NSIC Rc192, 272, 274, 346 and 278 did not show significant difference from each other, though significant difference was noted when compared to the remaining rice genotypes. Likewise, statistical difference was observed between NSIC Rc288 and 278. On the other hand, NSIC Rc282, 222, PSB Rc82, NSIC Rc280 and 286 did not differ significantly with each other, but significant difference was observed when they were compared with NSIC Rc284.

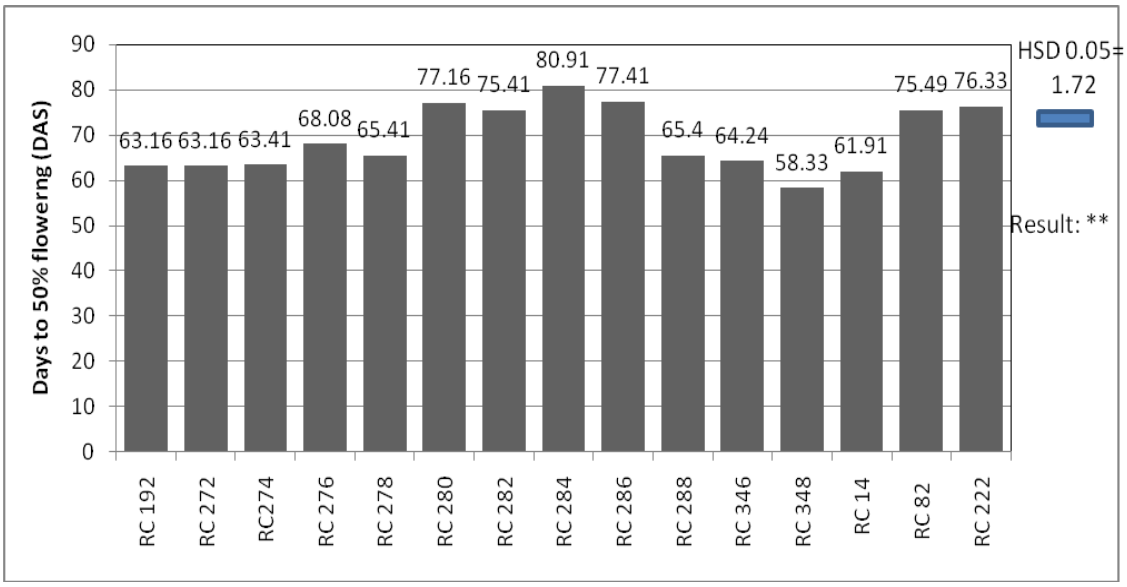


Figure1a: Number of days to flower of the different rainfed rice genotypes across four crop managements i.e. Control, FP, RCM, and RCM+. Where: FP=Farmers Practice, RCM=Rice Crop Manager, RCM+ = Rice Crop Manager plus. CSU-Piat, Cagayan, January 2015.

Figure 1b presents the number of days to flower of the different rice genotypes subjected to different crop managements. Plant exposed to the farmers' practice (FP) was the earliest to produce flowers at 68 DAS, followed by plants in the control treatment and RCM with the same flowering of 69 DAS, and RCM+ with flowering days of 78 DAS. Despite slight differences, analysis of variance showed significant differences between crop management treatments. Similar result was obtained by Chang (____), that application of nitrogen during panicle initiation delayed flowering.

The interaction between variety and crop management revealed significant difference. Results implies that the different rice genotypes responded differently when exposed to the different crop management treatments.

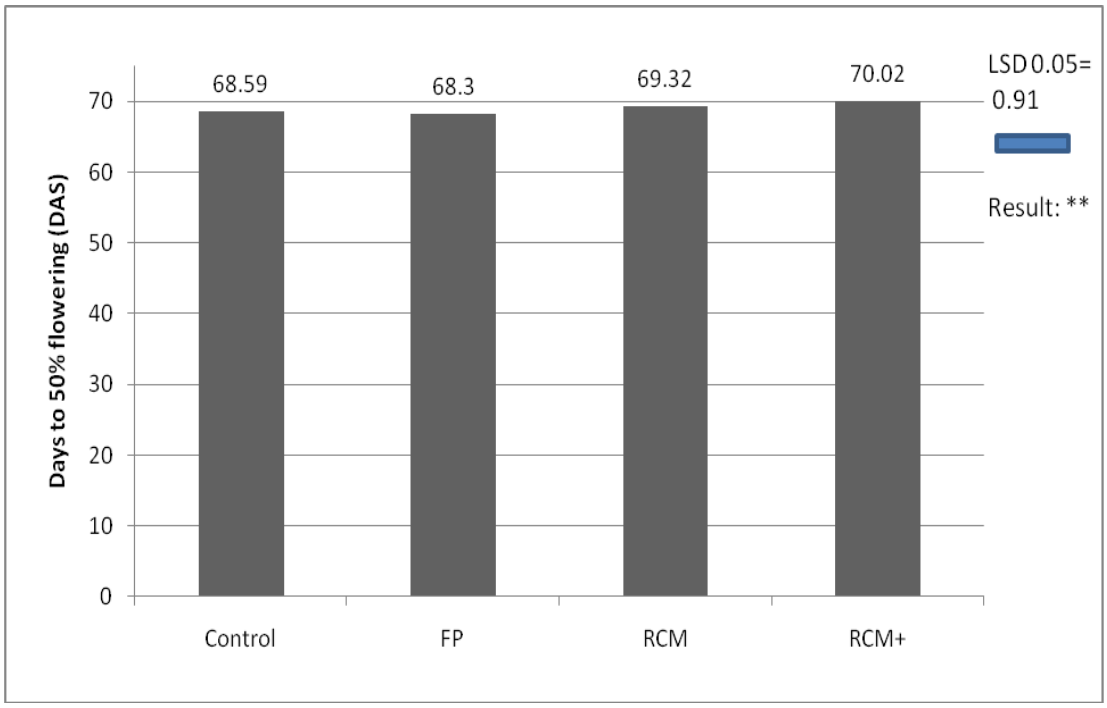


Figure1b: Average number of days to flower of different rainfed rice genotypes subjected to the different crop managements i.e. Control, FP, RCM, and RCM+. Where: FP=Farmers Practice, RCM=Rice Crop Manager, RCM+ = Rice Crop Manager plus. CSU-Piat, Cagayan, January 2015.

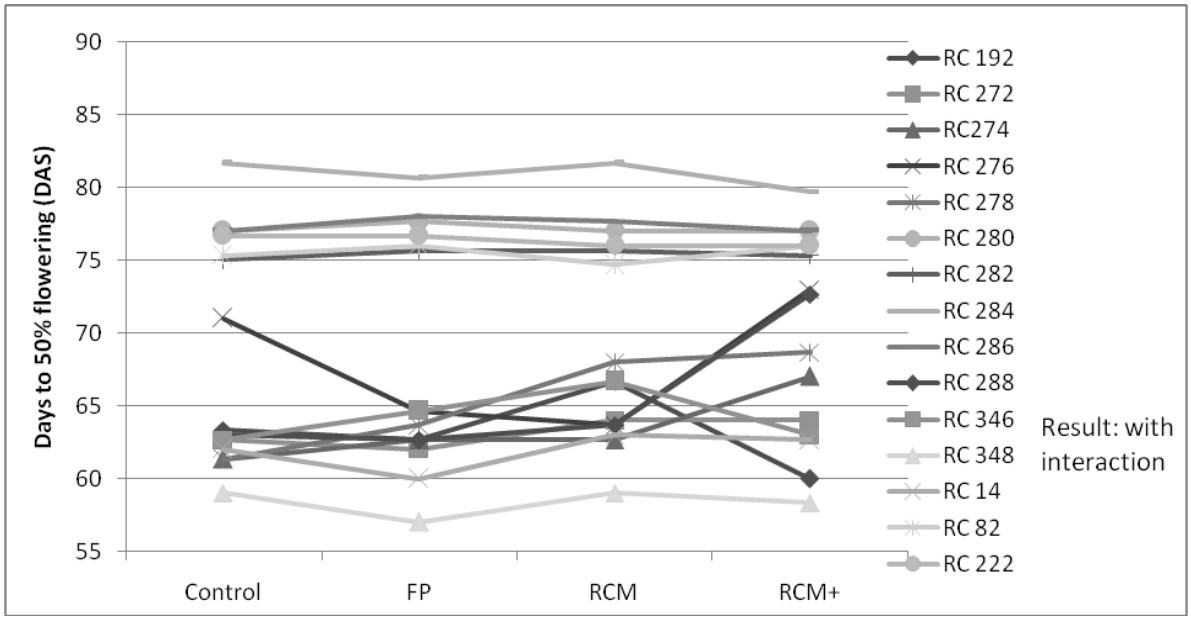


Figure 1c: Interaction of the different rainfed rice genotypes and crop managements on the number of days to flowering.

Days to Maturity (DAS)

The average number of days to maturity of the different rainfed rice genotypes across four crop managements tested i.e. Control, FP, RCM and RCM+ is presented in Figure2a. There exist highly significant differences on average number of days to mature between the different rainfed rice genotypes tested. Results further revealed that among the different rice genotypes evaluated, NSIC Rc348 was

the earliest to mature with a mean of 88.33 DAS, followed by PSB Rc14 (rainfed check) which matured at 92 DAS. In addition, NSIC Rc192, 272, and 274 matured similarly at 95 DAS, and NSIC Rc276 matured at 98 DAS. NSIC Rc282 and the same as PSB Rc82 had matured 105.41 DAS. The high yielding irrigated check (NSIC Rc222) matured at 106 DAS, followed by NSIC Rc280 and 286 that flowered at 107.41 DAS. However, the longest day to mature was exhibited by the rainfed genotype-NSIC Rc284 with 110.91 DAS.

Comparison among treatment means (CATM) with respect to maturity showed that NSIC Rc348 is significantly different from all the other rice genotypes. However, PSB Rc14, NSIC Rc192, 272, 274, 346 and 278 did not show significant difference from each other, though significant difference was noted when compared to the remaining rice genotypes. Likewise, statistical difference was observed between NSIC Rc288 and 278. On the other hand, NSIC Rc282, 222, PSB Rc82, NSIC Rc280 and 286 did not differ significantly with each other, but significant difference was observed when they were compared with NSIC Rc284.

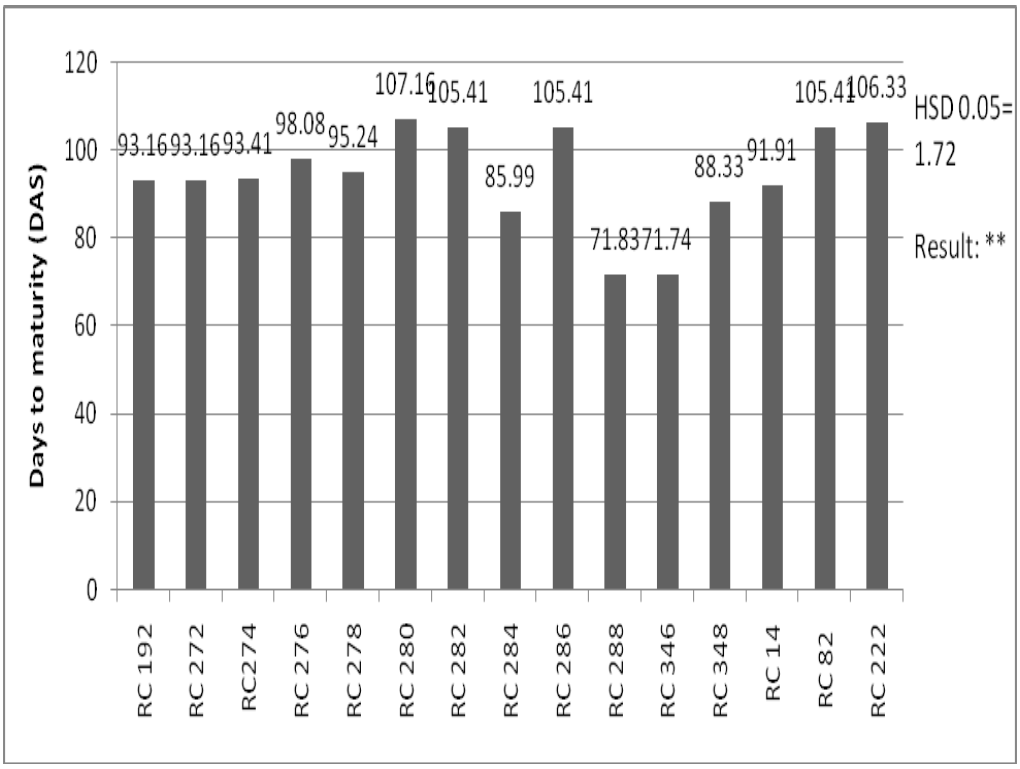


Figure 2a: Number of days to maturity of the different rainfed rice genotypes across four crop managements i.e. Control, FP, RCM, and RCM+. Where: FP=Farmers Practice, RCM=Rice Crop Manager, RCM+ = Rice Crop Manager plus. CSU-Piat, Cagayan, January 2015.

The average number of days to mature of the different rice genotypes subjected to different crop managements is presented in Figure 1b. Plant exposed to the farmers' practice (FP) was the earliest to mature at 98 DAS, followed by plants in the control treatment and RCM with the same maturity of 99 DAS, and RCM+ with maturity of 108 DAS. Moreover, analysis of variance showed highly

significant differences between crop management treatments. Similar result was obtained by Chang (____), that application of nitrogen during panicle initiation delayed flowering and maturity of plants tested.

The interaction between variety and crop management revealed highly significant difference. Results imply that the different rice genotypes responded differently when exposed to the different crop management treatments.

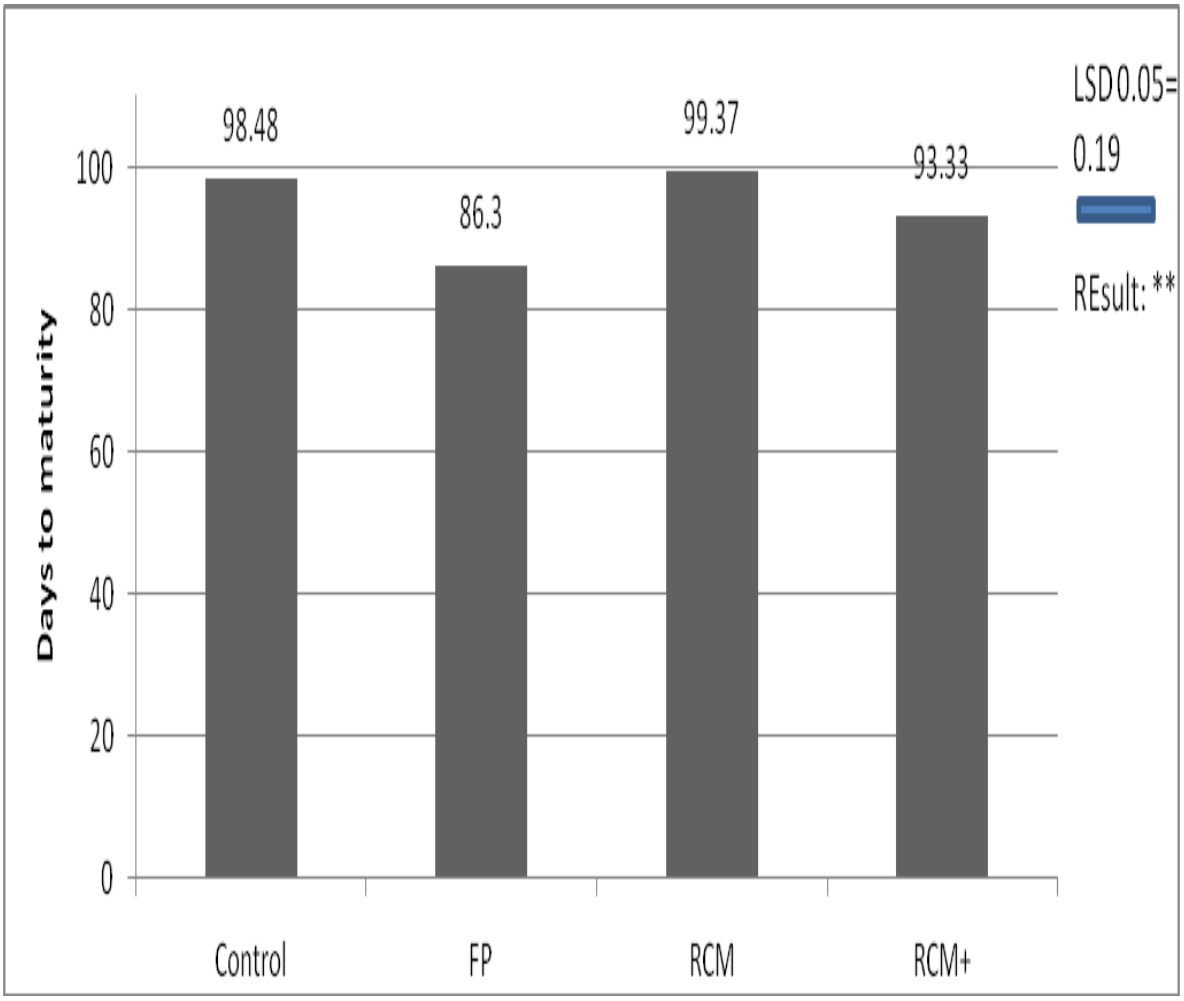


Figure 2b: Average number of days to maturity of different rainfed rice genotypes subjected to the different crop managements i.e. Control, FP, RCM, and RCM+. Where: FP=Farmers Practice, RCM=Rice Crop Manager, RCM+ = Rice Crop Manager plus. CSU-Piat, Cagayan, January 2015.

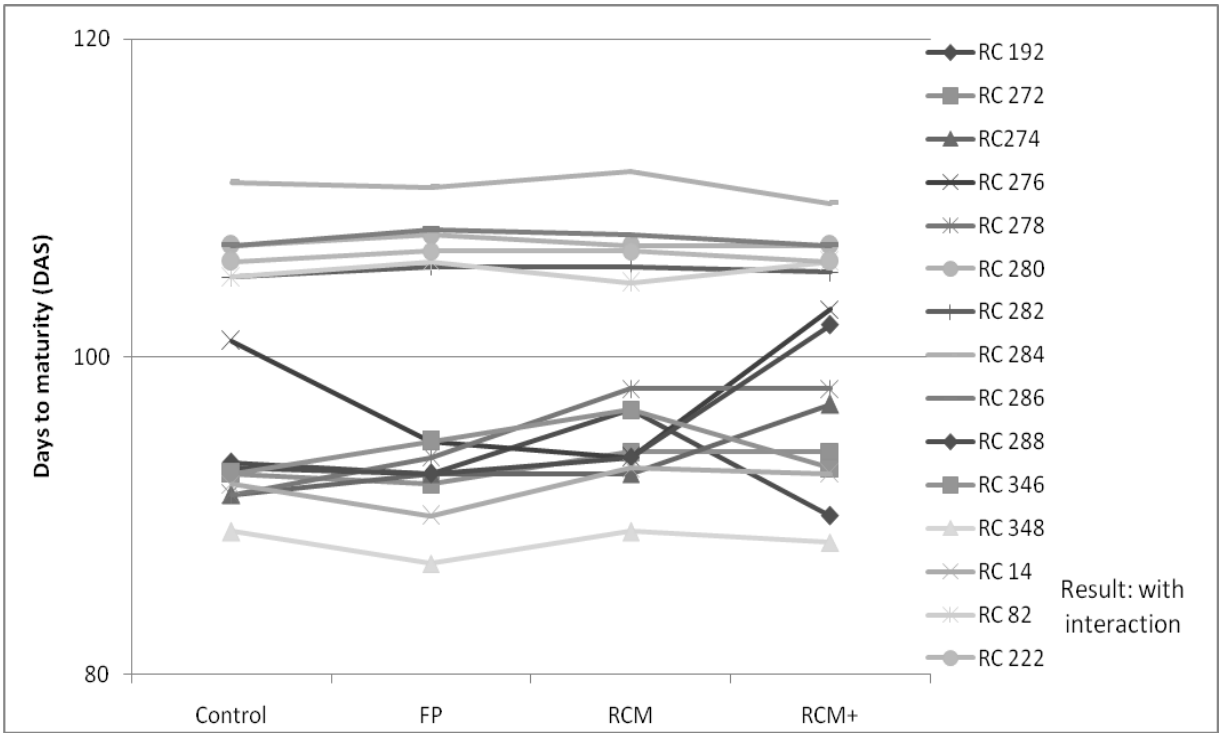


Figure 2c: Interaction of the different rainfed rice genotypes and crop managements on the number of days to maturity.

Plant height (cm)

Figure 3a shows the height of the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 22) across the four crop management (Control, FP,RCM and RCM+). Analysis of variance revealed that there exists highly significant difference among treatment means. NSIC RC 278 recorded the tallest plants with a mean of 95.92 cm. This was followed by NSIC RC 348, NSIC RC 282, and PSB RC 222 with a range of 84.62 cm to 86.19 cm,. Plant varieties NSIC RC 192, NSIC RC 288, PSB RC182, NSIC RC 274,NSIC RC 280, NSIC RC 284, and NSIC RC 286obtained the shortest plants with a range of77.27 cm to 81.47 cm.This observation may be depends on the characteristics and morphology of the plants (IRRI, 2007). It showed that different varieties differ in terms of height because each have their own agronomics characteristic. This result jive with the findings of Bartolome (1998), in his study entitled "The effect of spacing in the yield of two varieties of rice".

Figure 3b shows the height (cm) of the 12 rice genotypes in terms of the four crop management. Analysis of variance revealed no significant difference between the four-crop management. This means that this four crop management has no effect in terms of plant height.

No interaction was obtainedbetween varieties and different nutrient management (Figure 3c). This means that application of fertilizer on the different varieties of rice has no impact.

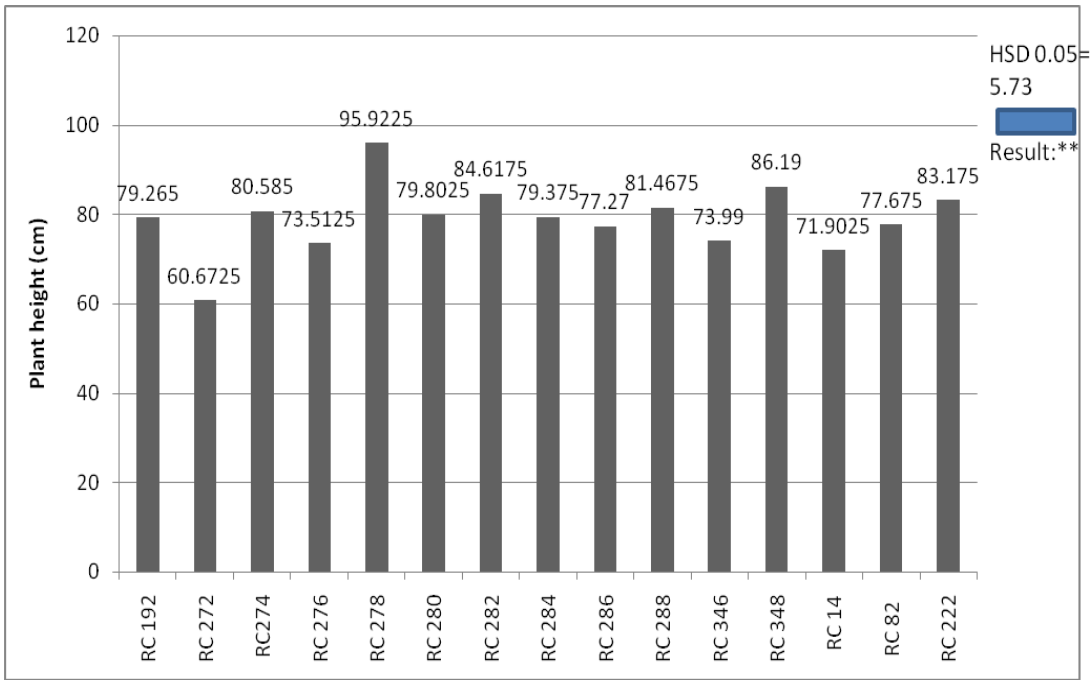


Figure 3a: The plant height performance of the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 22) across the four crop management (Control, Farmers Practice,Rice Crop Manager and Rice Crop Manager+).

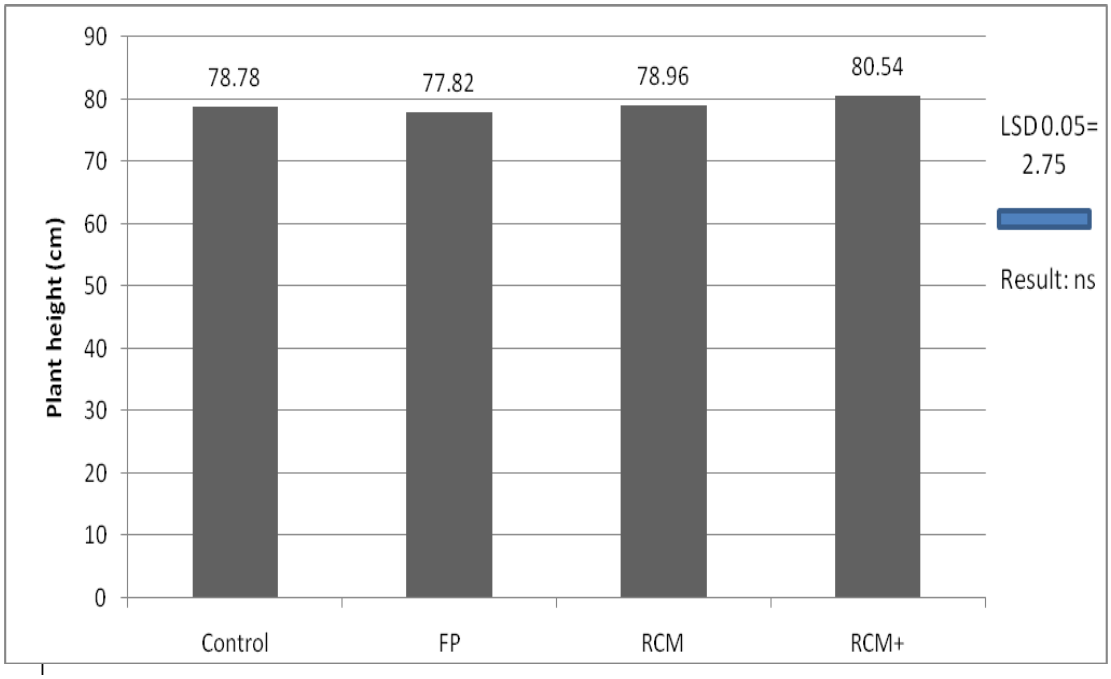


Figure 3b: Performance of the four crop management on plant height across the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 222).Where FP:Farmers Practice, RCM: Rice Crop Manager, and RCM+:Rice Crop Manger plus. height performance of the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 22) across the four crop management (Control, Farmers Practice,Rice Crop Manager and Rice Crop Manager+).

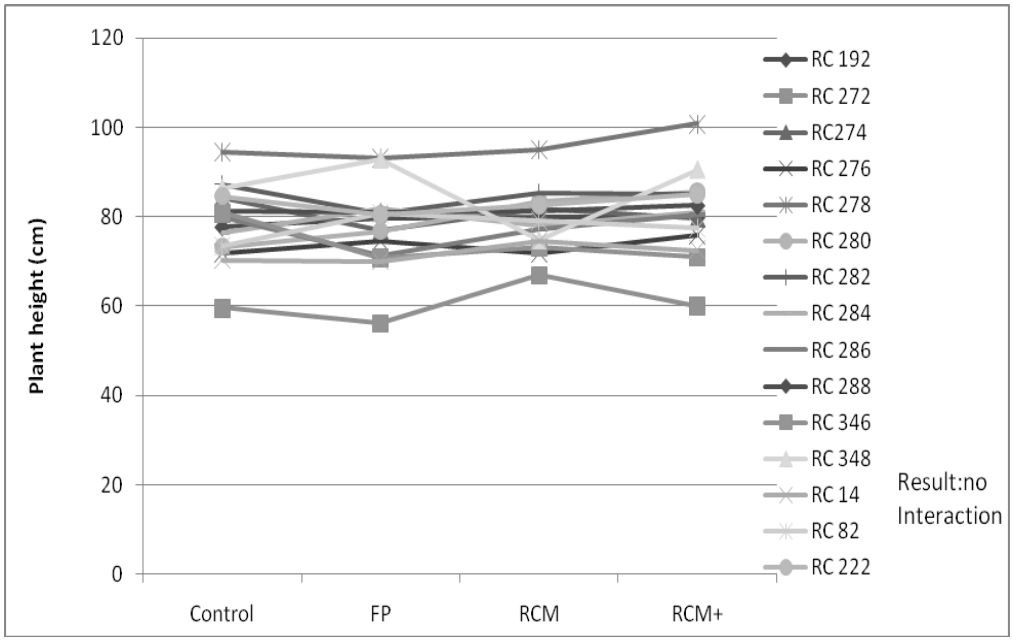


Figure 3c: Interaction of height at maturity of the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 222) to four crop management (Control, Farmers Practice,Rice Crop Manager and Rice Crop Manager+).

Tiller number

Figure 4a shows the average tiller number of the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 22) across the four crop management (Control, FP,RCM and RCM+).Analysis of variance reveals highly significant difference among the varieties tested. NSIC RC 276 (10.21cm)produce the most tiller number. This means that this variety was well adopted to CSU-Piat condition. It was followed by PSB RC 14 (9.37) that placed 2nd. PSB RC 222 NSIC RC 280, NSIC RC 346, PSB RC 82, NSIC RC 278 and NSIC RC 288 placed 3rd ranked with a range of 8.02 to 8.02. NSIC RC 272, NSIC RC282 , NSIC RC 284, NSIC RC 286 and NSIC RC 192 placed 4th rank with a range of 7.9 to 7.12 while NSIC RC 274 and NSIC RC 348 recorded the least number of tillers/plant with a mean of 6.9 and 6.8.

On the other hand, no significant difference between crop management means. This means that the application of different rate of fertilizer has no impact on the number of tillers per plant produced.

Figure 4c shows no interaction existed from varieties to crop management in terms of tiller number of the 12 genotypes of rice tested. This means that different varieties tested follows the same respond to the different crop nutrient management.

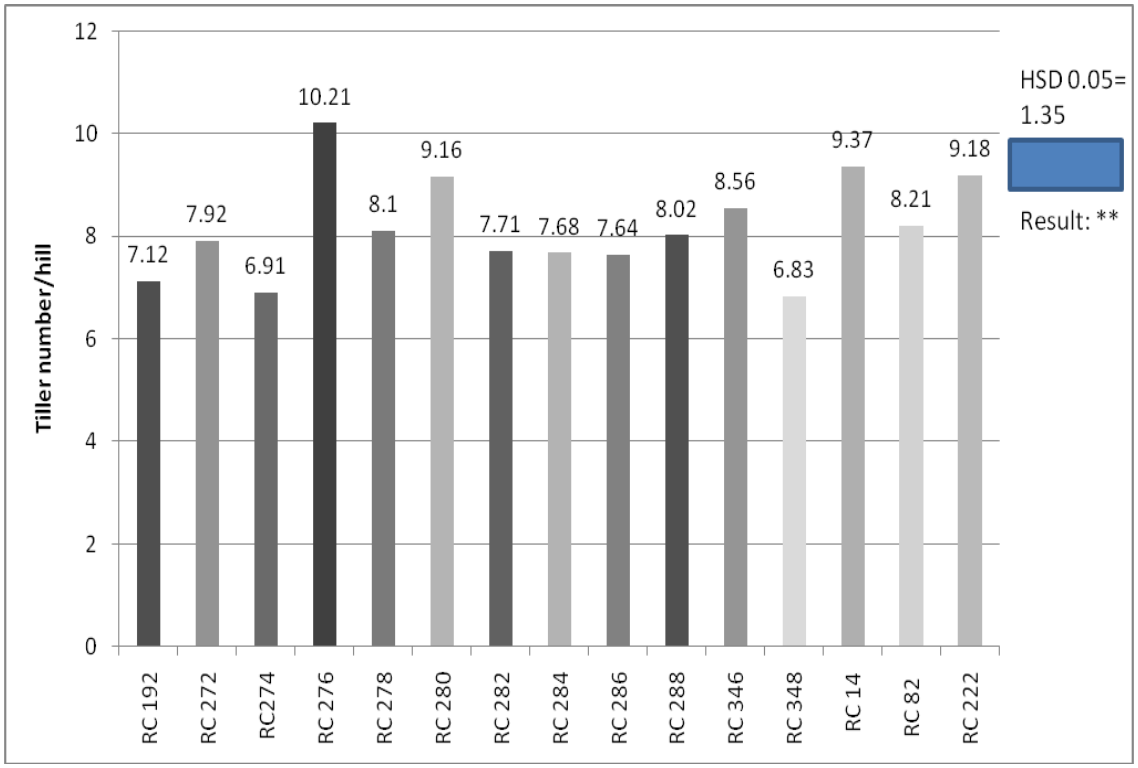


Figure 4a: The tiller number of the 12 rainfed rice genotypes including 3 checks (PSB RC14, PSB RC 82 and PSB RC 22) across the four crop managements (Control, Farmers Practice,Rice Crop Manager and Rice Crop Manager+).

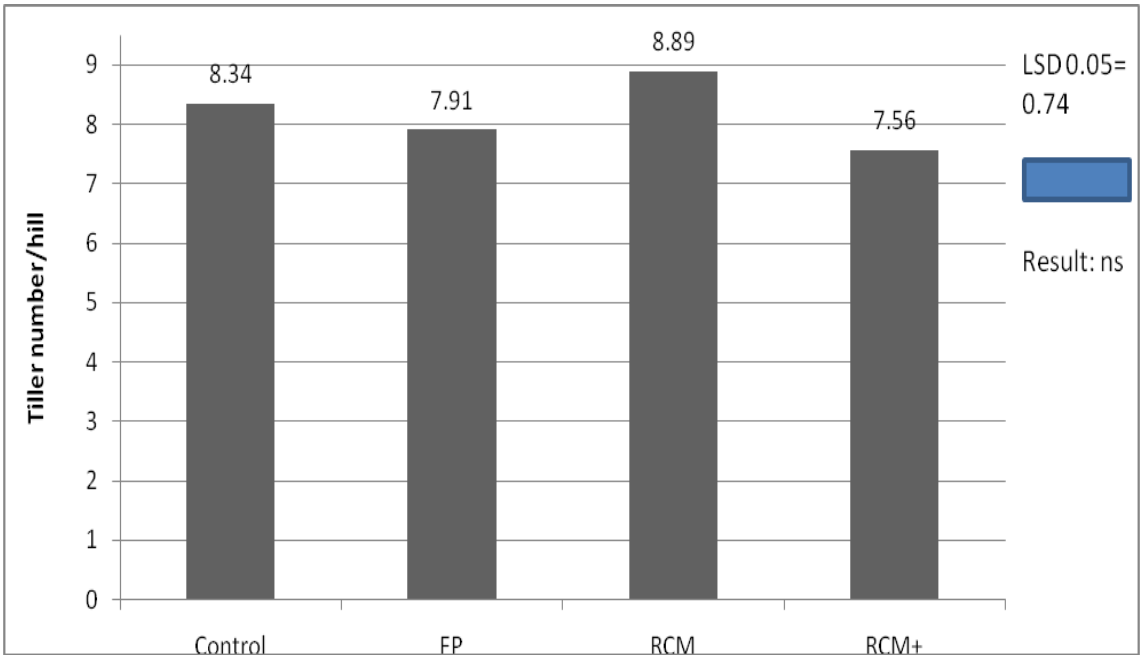


Figure 4b: Performance of the four crop management on tiller number across the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 222). Where FP:Farmers Practice, RCM: Rice Crop Manager, and RCM+:Rice Crop Manger plus.

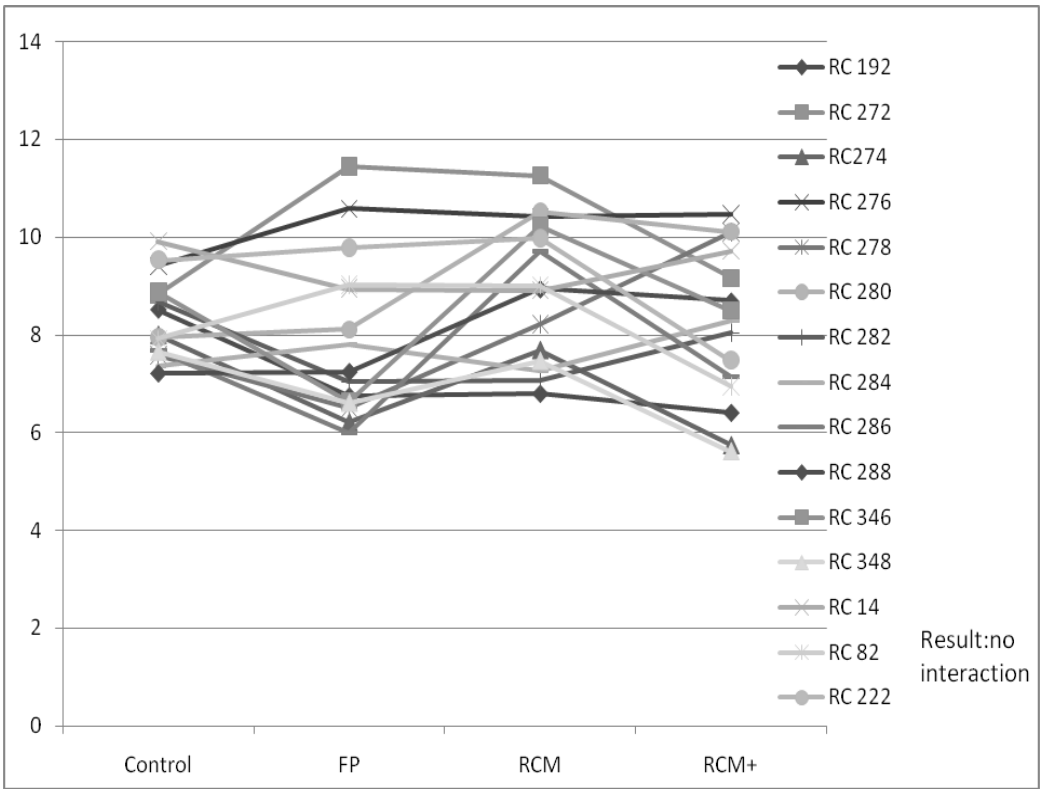


Figure 4c: Interaction of tiller number of the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 22) to four crop management (Control, Farmers Practice,Rice Crop Manager and Rice Crop Manager+).

Culm Length (cm)

Figure 5a shows the culm lengthof the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 22) across the four crop management (Control, FP,RCM and RCM+). Based on the result of the study there exist highly significant difference between the 15 varieties tested. Still this was attributed to the different characteristics of the rice varieties. Based on the comparison among variety means, NSIC RC 278 recorded to have the longest culm length with a mean of 71.81 cm followed by NSIC RC 348 of 64.43cm and NSIC RC 282 of 62.89 that place 2nd and 3rd respectively.4th ranker were NSIC RC 192, NSIC RC 288, PSB RC 82, PSB RC 222 and NSIC RC 280 since no significant difference existed between them.

On the other hand comparison among 4 crop management means revealed that there is no significant difference existed. This means that the rice plant tested respond to all crop nutrient management.

Figure 5c revealed that there is no interaction between variety and crop management. This means that 15 rice varieties follow the same respond to that of the four crop managements tested.

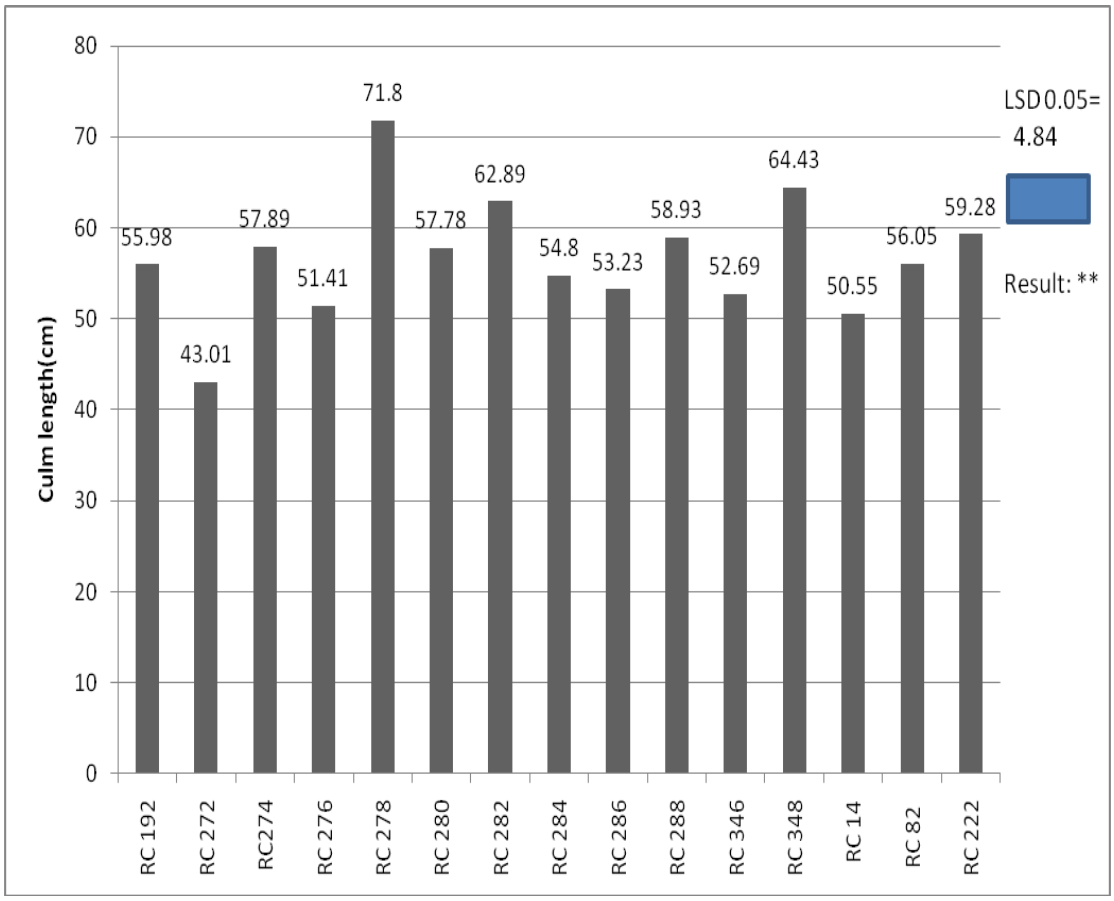


Figure 5a: The culm length performance of the 12 rainfed rice genotypes including 3 checks (PSB RC 14,PSB RC 82 and PSB RC 22) across the four crop management (Control, Farmers Practice,Rice Crop Manager and Rice Crop Manager+).

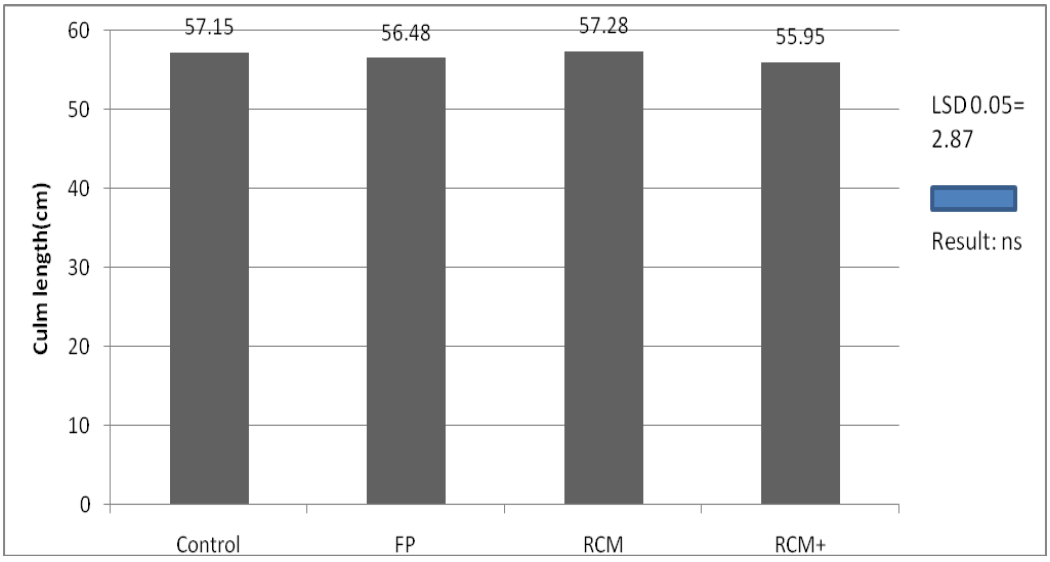


Figure 5b:Performance of the four crop management on culm length across the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 222). Where FP:Farmers Practice, RCM: Rice Crop Manager, and RCM+:Rice Crop Manger plus.

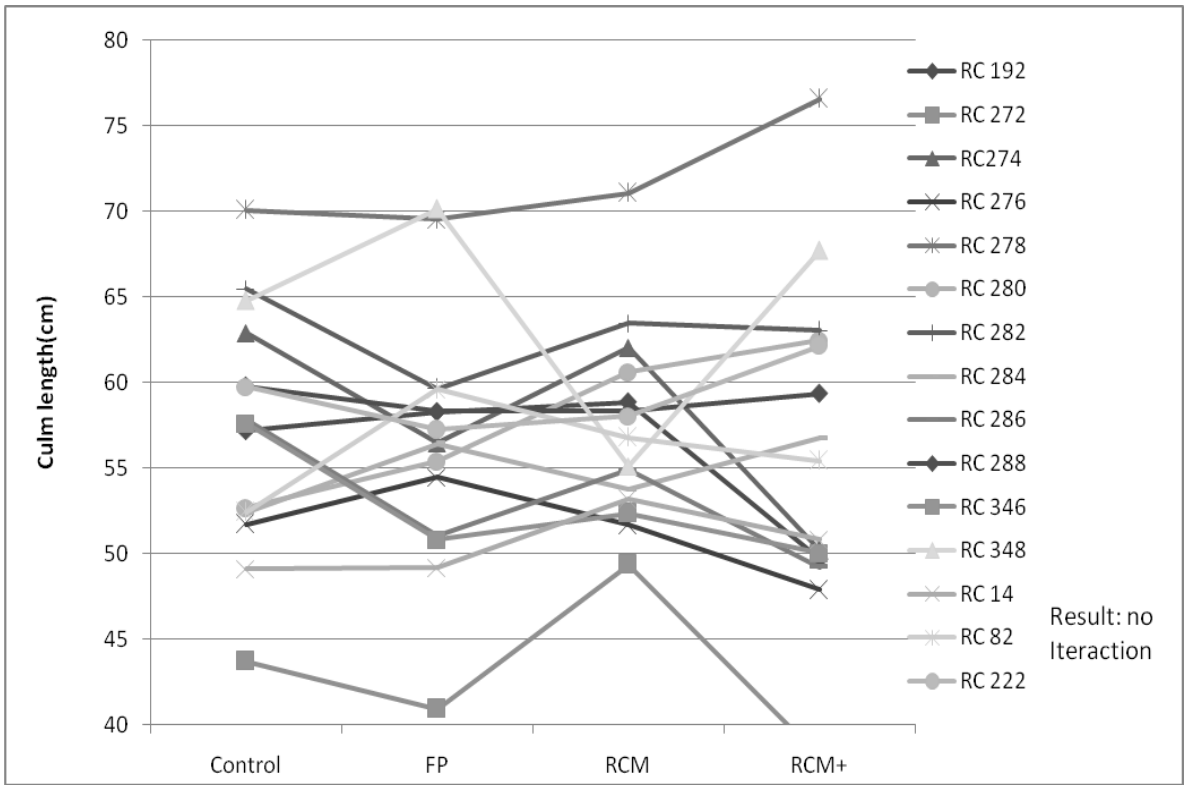


Figure 5c: Interaction of the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 22) to four crop management (Control, FP,RCM and RCM+) on culm length performance.

Panicle Length

Figure 5a shows the average panicle length of the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 22) with four crop management (Control, FP,RCM and RCM+). Analysis of variance reveals that there exist highly significant differences between varieties means. NSIC RC 284, NSIC RC 278 , and NSIC RC 286 obtained the longest panicle of 23.9cm, 24.76cm,24.1 cm, 24.03cm and 23.9cm. This was followed by PSB RC 222, NSIC RC 288,NSIC RC 192, NSIC RC274, NSIC RC276, NSIC RC 280,NSIC RC 282,PSB RC 82, NSIC RC 348, PSB RC 14 and NSIC RC346 with a range of 23.89cm to 21.35cm. The shortest panicle length was recorded by NSIC RC 272 with 17.66 cm. Again the highly significant difference was attributed to the different plant characteristics.

On crop management means, there exist highly significant difference. Plant respond to RCM+ in terms of panicle length with a mean of 24.64. This was followed by control, FP and RCM as second rankersince no significant difference between them. This means that plant with longer panicles of rice were obtained in RCM+. According toYoseftbar (2013) as cited by (wei et al, 2011) that nitrogen can increase the grain yield by increasing the total dry matter production, the number of panicles and the panicle length of lowland rice. Additionally, nitrogen application increases the panicle weight, number of grains per panicle, 1000- grain weight and hence the grain yield of rice (Vennila et al, 2007). Again, no interaction existed between the 15 varieties and crop management.

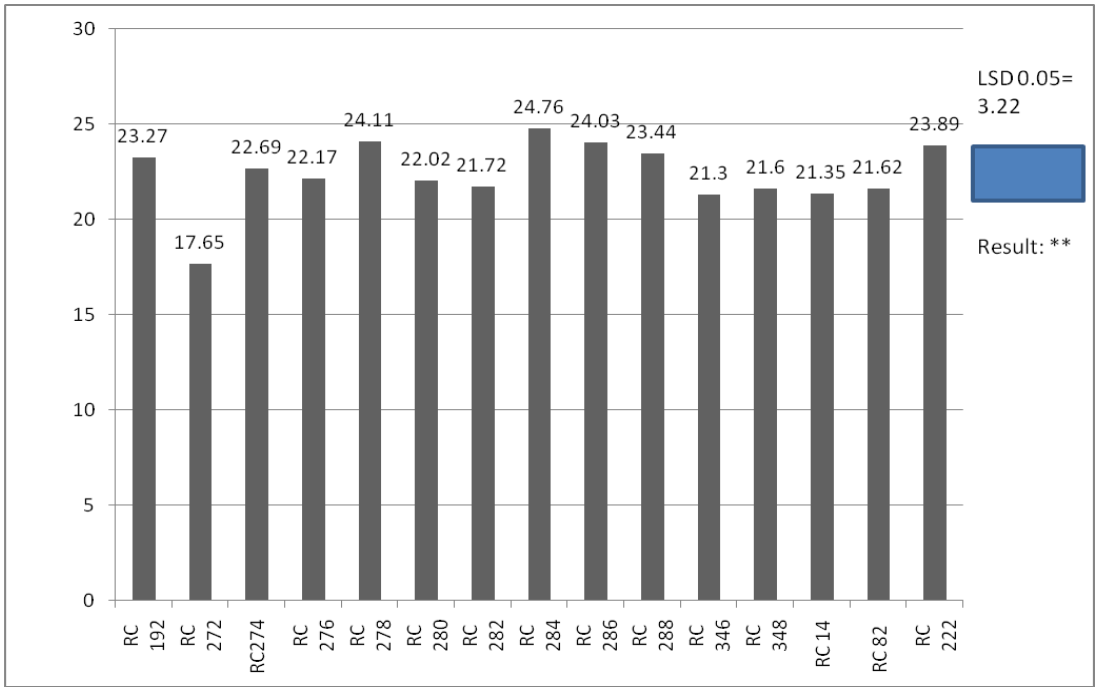


Figure 6a: The panicle length performance of the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 22) across the four crop management (Control, Farmers Practice ,Rice Crop Manager and Rice Crop Manager+).

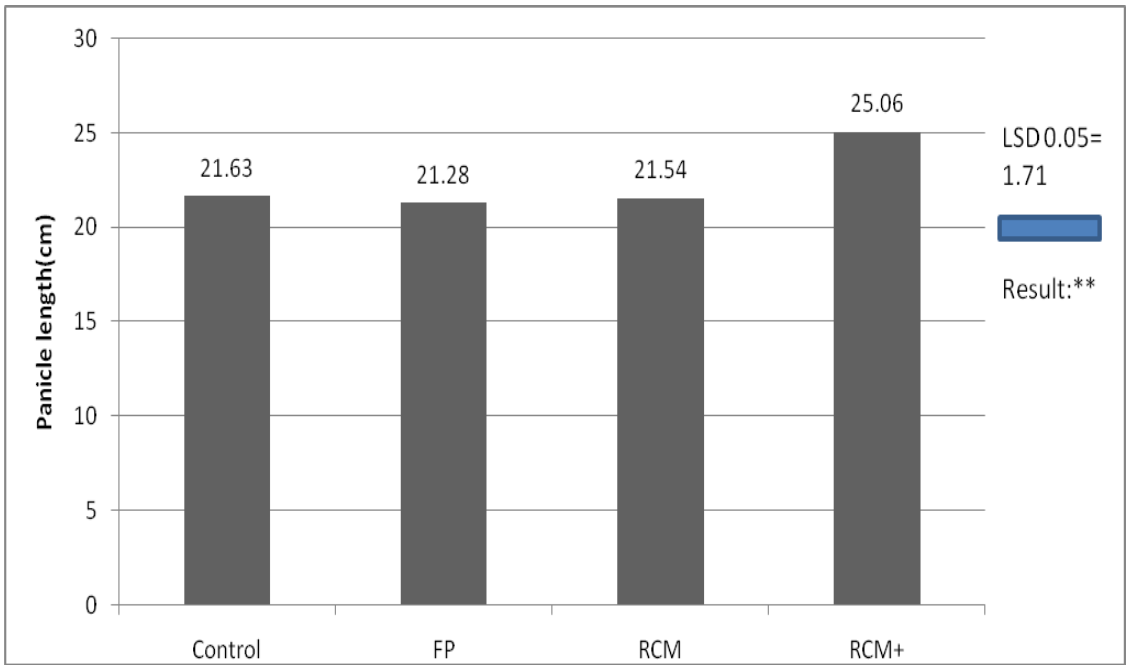


Figure 6b: Performance of the four crop management on panicle length across the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 222). Where FP:Farmers Practice, RCM: Rice Crop Manager, and RCM+:Rice Crop Manger plus.

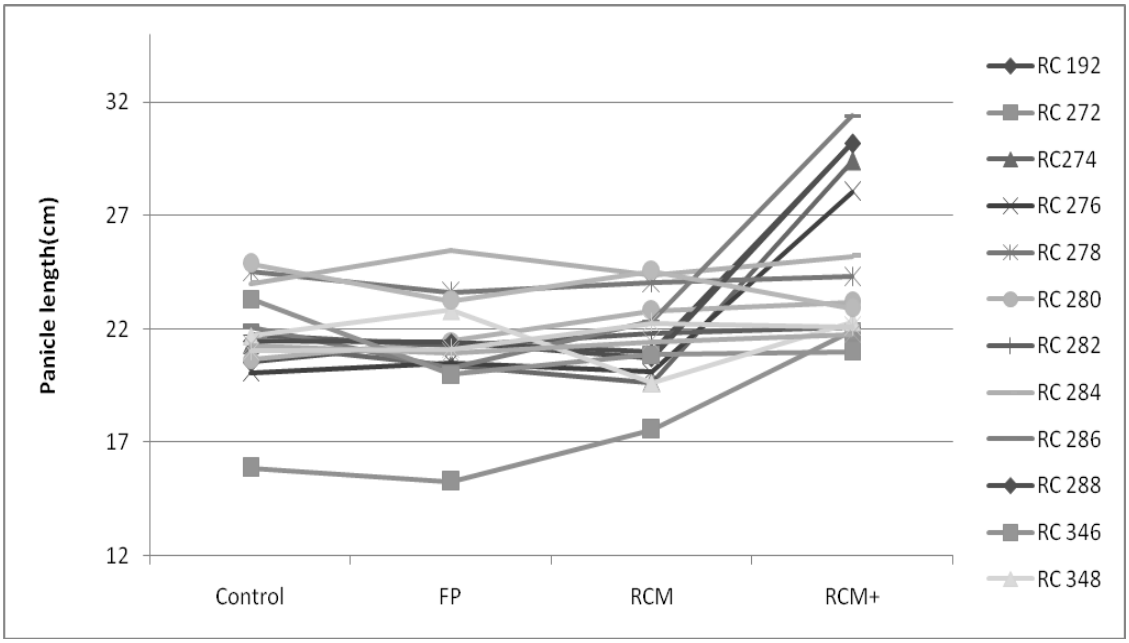


Figure 6c: Interaction of panicle length performanceof the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 222) to four crop management (Control, Farmers Practice, Rice Crop Manager and Rice Crop Manager+).

Yield tons/ha

Analysis and graphs are still on the process…

1000 Grain weight (g)

Figure shows the weight of 1000 grains of the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 222) across the four crop management Control, FP,RCM and RCM+. Analysis of variance revealed that there exist highly significant differences. Among the varieties means, NSIC RC 288, NSIC RC 286,NSIC RC 284, NSIC RC 348 and NSIC RC 278 obtained the heaviest grains ranging from 26.04 to 26.89 grains. This was followed by NSIC RC 346 and NSIC RC 282 of 25.99 and 25.69 grains respectively. Third ranker varieties was recorded from NSIC RC 274, NSIC RC 222, NSIC RC 280, NSIC RC 276 PSB RC 82 and PSB RC 14 of 22.87 to 25.03 grams. NSIC RC 192 obtained 4th placed with a mean of 21.68. NSIC RC 272 has the lightest mean of 20.91.

In terms of crop management means analysis of variance reveals no significant differences. No interaction between variety to crop management was also obtained

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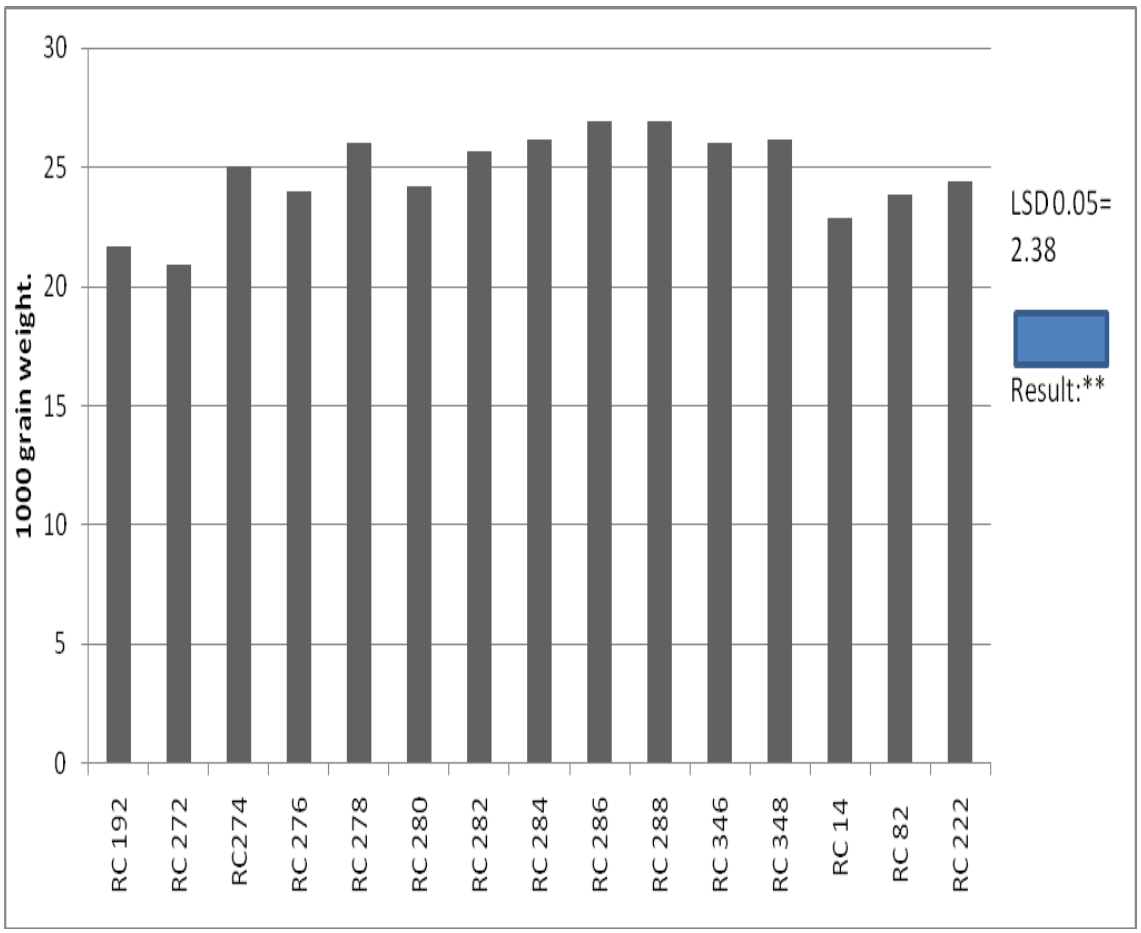

Figure 7a.1000 grain weigth of the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 222) across the four crop management Control, Farmers Practice, Rice Crop Manager and Rice Crop Manager+).

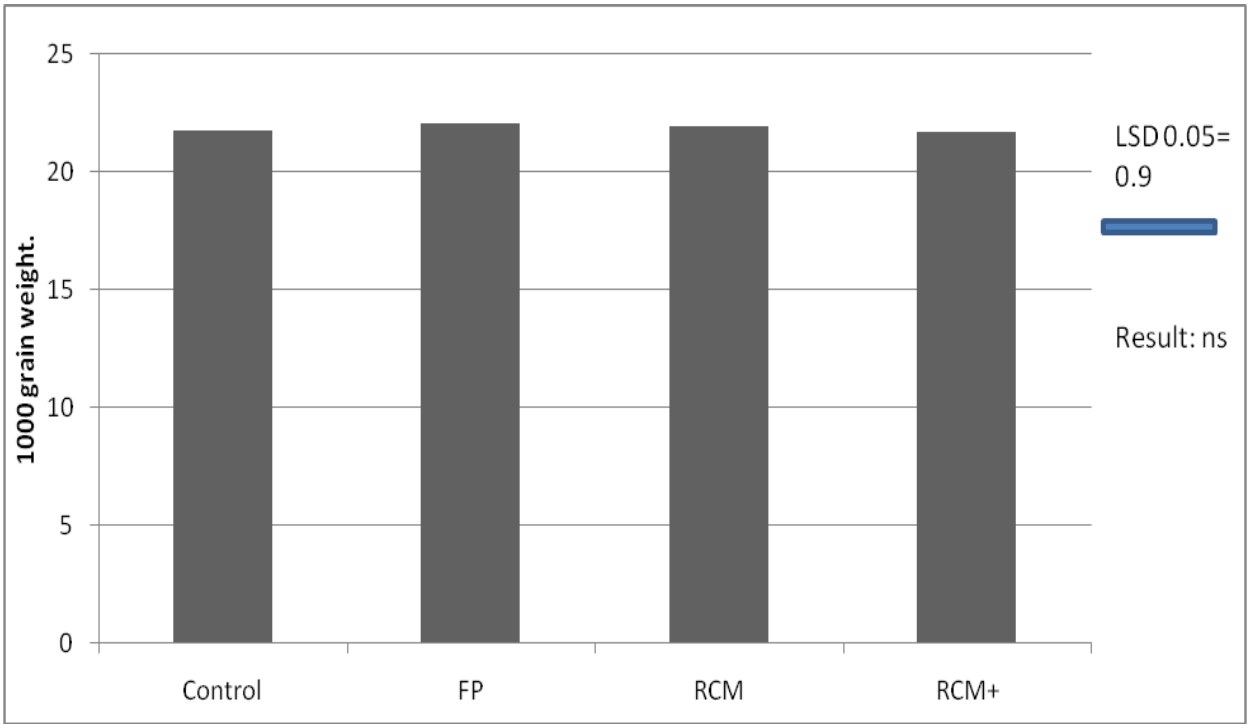

Figure 7a.1000 grain weigthof the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 222) across the four crop management Control, Farmers Practice, Rice Crop Manager and Rice Crop Manager+).

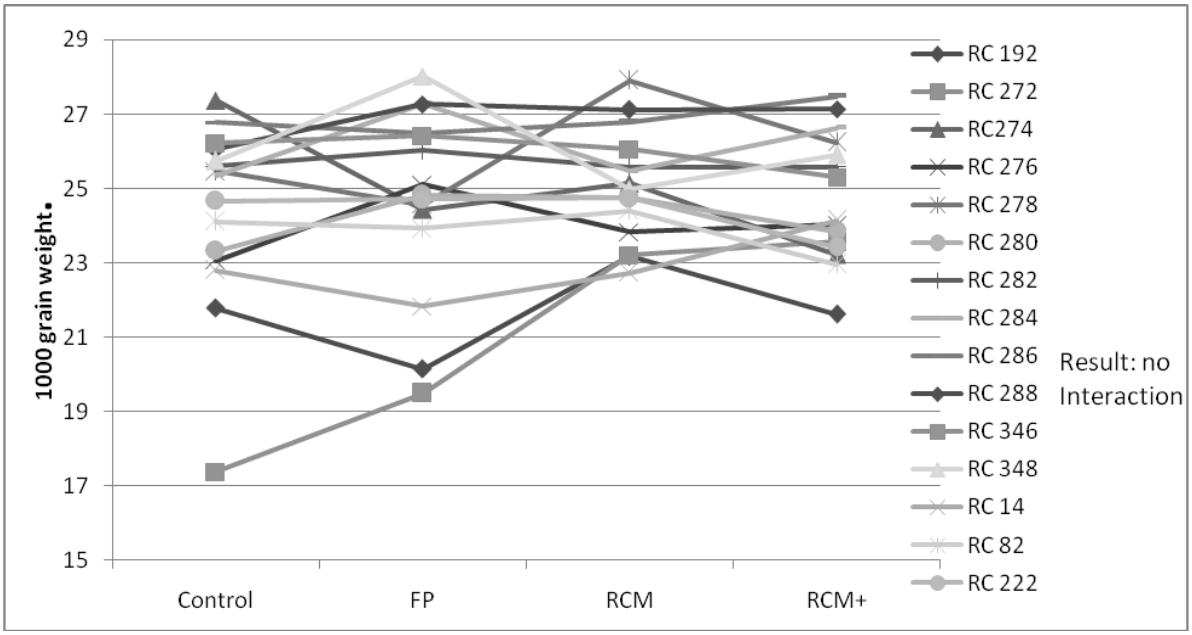

Figure 7c: Interaction of the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 22) to four crop management (Control, FP,RCM and RCM+) on 1000 grain weight.

Percent fertility

Figure shows percentage fertility of the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 222) across the four crop management Control, FP, RCM and RCM+. Based on the analysis of variance, there is no significant differences between variety means. This means that all varieties has almost the same number of fertile seeds.

The same result in terms on the crop management. This means that the different crop management has no bearing in the production of fertile seeds.

No interaction was also obtained the between variety and nutrient management.

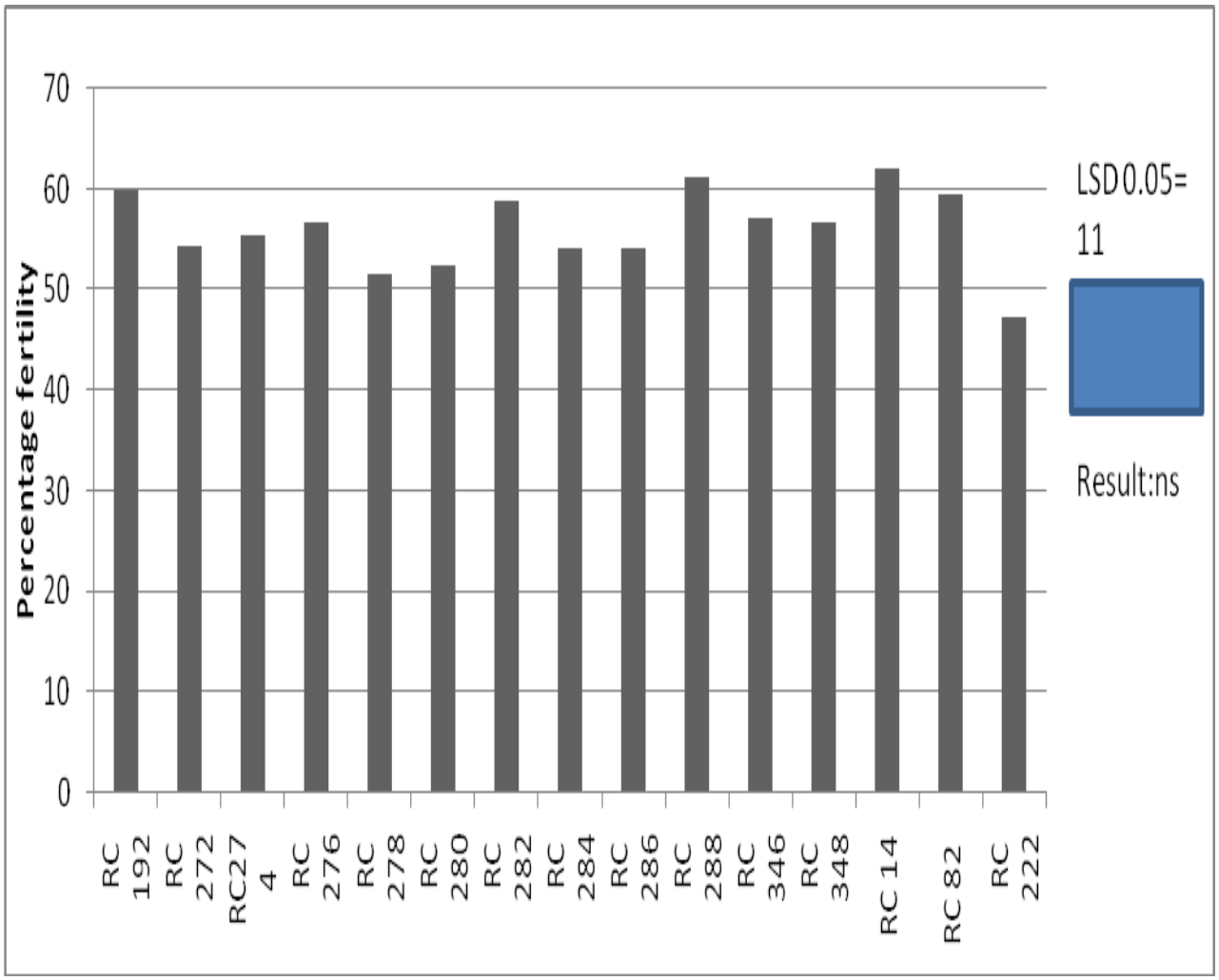

Figure 8a. Percentage fertility of the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 222) across the four crop management Control, Farmers Practice, Rice Crop Manager and Rice Crop Manager+).

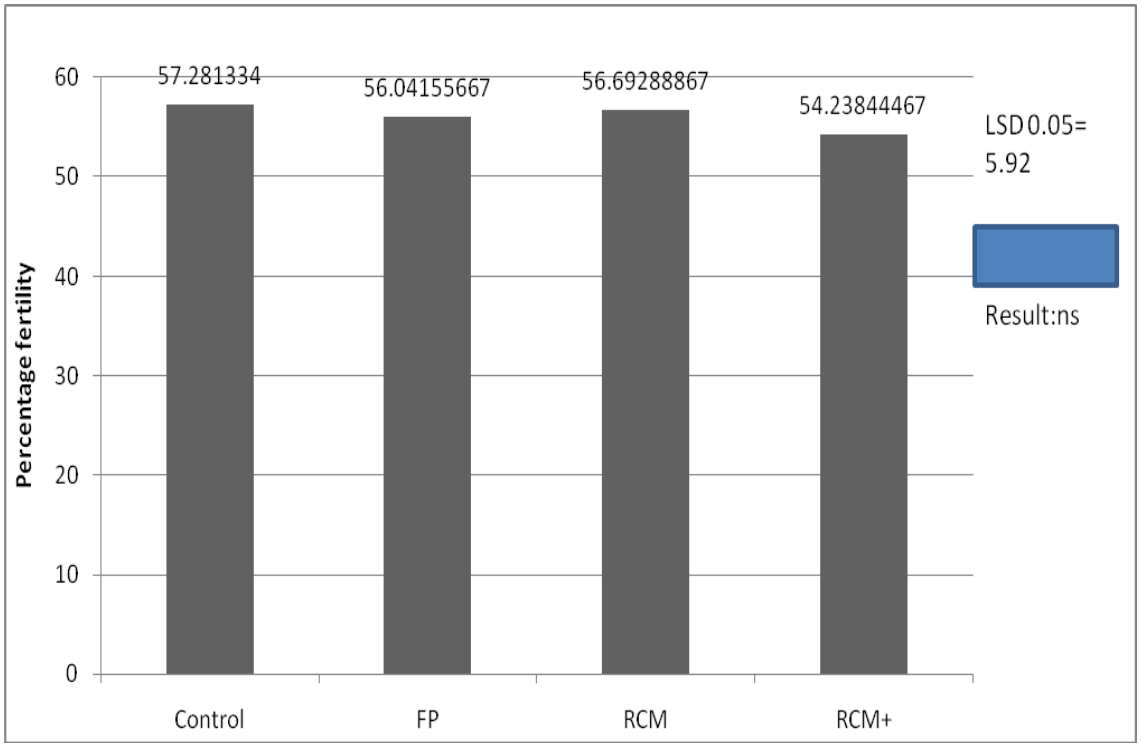

Figure 7a.Percentage fertility of the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 222) across the four crop managements (Control, FP, RCM and RCM+) on percentage fertility. Where: FP=farmers practice; RCM=rice crop manager; RCM+ =rice crop manager plus.

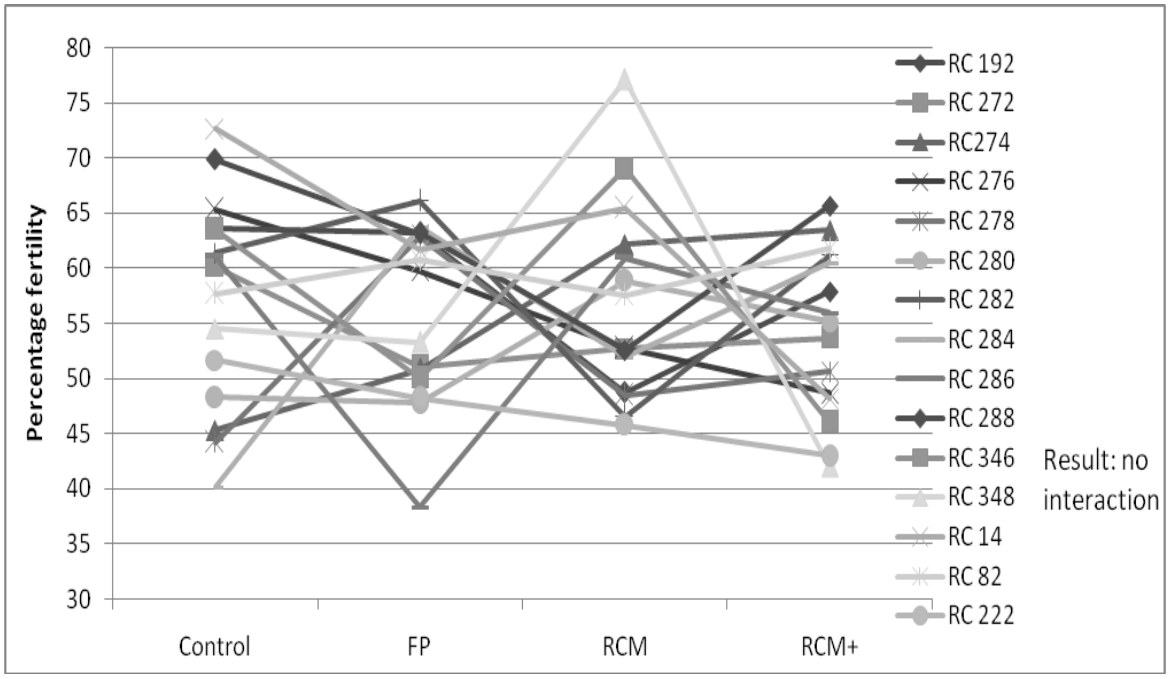

Figure 5c: Interaction of the 12 rainfed rice genotypes including 3 checks (PSB RC 14, PSB RC 82 and PSB RC 22) to four crop managements (Control, FP, RCM and RCM+) on percentage fertility. Where: FP=farmers practice; RCM=rice crop manager; RCM+ =rice crop manager plus.

CONCLUSION

Based from the results of the study, there were significant differences in yield attributed to varietal and genetic differences of materials tested. NSIC Rc284 having obtained the highest yield of 4.2 ton/ha with maturity of 110.67 days and NSIC Rc288 and NSIC Rc276 with yields of 3.89 and 3.88 ton/ha with maturity of 94 and 92 days respectively were the 2nd highest yielder which means that these are the selections specifically adapted at CSU Piat condition.

RECOMMENDATION

The top 3 selections NSIC Rc284, NSIC Rc288, and NSIC Rc276 are specifically adapted at CSU Piat condition which will provide farmers an option of increasing yield and income using the right rainfed variety even in highly variable rainfed ecosystem, thus it is highly recommended to farmers.

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Proceedings of the 3rd International Conference on Agriculture and Forestry, Vol. 2, 2016, pp. 158-166
Copyright © TIIKM
ISSN: 2362-1036 online
DOI: https://doi.org/10.17501/icoaf.2016.2114

PHENOTYPIC AND GENOTYPIC ANALYSIS FOR EARLY MORNING FLOWERING TRAITS AT FLOWERING STAGE IN RICE (*Oryza sativa* L.)

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Abstract

The study focused on phenotypic and genetic factors underlying early morning flowering traits in rice in the hope that rice genetic improvement in the warming future will be made possible. Quantitative trait loci (QTL linked to early morning flowering (EMF) traits was analyzed by selective genotyping of phenotypic extremes among 684 BC_1F_2 lines (derived from the cross PSB Rc82 x WAB56-125) under glasshouse condition was undertaken using single marker analysis (SMA). Four parameters of flower opening time or start time (FOT), peak of flowering (POF), flower mostly closed (FMC), and flower closed (FC) time were recorded. Results of SMA revealed three markers possibly linked to FOT on chromosome 5, 7, and 9, while 6 markers were possibly linked to POF, FMC and FC time on chromosomes 5, 7, 8, 9, and 11. Generally, markers on chromosomes 5, 7 and 9 indicated QTLs controlling EMF during flowering stage in rice. While this needs to be confirmed using a larger population size and other mapping methodology, the results could already be useful for further fine mapping and eventually for marker-assisted selection of heat escape rice cultivars in the future.

Keywords: Early morning flowering, high temperature, QTL analysis, rice

INTRODUCTION

The advent of climate change brought by global warming is a serious threat in rice production, agricultural productivity, farm incomes, and global food security in general. Global warming is estimated to increase temperature by 0.2 ºC per decade thus it poses a serious threat to rice production (Wassman and Dobermann, 2010; Yang *et al.*, 2007). In China, 3 million hectares of rice were damaged and about 5.18 million tons of paddy rice were lost in 2003 along the Yangtze River Valley due to a heat wave of above 38°C lasting for more than 20 days and coinciding with the flowering stage (Lin *et al*. 2004, Xia and Qi 2004, Yang *et al*. 2004). Likewise, severe yield losses were experienced in 2006 and 2007 in South China (Zou *et al*. 2009) and the Kanto and Tokai regions of Japan during the summer of 2007 (Hasegawa *et al*. 2009). Furthermore, simulations by Horie *et al*. (1996) predicted that the yield of current rice varieties in southern Japan would be reduced by up to 40% in future climates. In Tanzania, a projected seasonal temperature in 2050 increases by 2 °C that could reduce average rice yields by 7.6% (Rowhani *et al*., 2011).

Generally, rice in tropical countries is cultivated at its most favorable day/night temperature of 28/22 °C (Redoña *et al.*, 2007). However, further increase of 10-15°C temperature above optimum is considered heat stress (Wahid *et al.*, 2007). Heat stress happens when plants are exposed to high temperature for a period of time sufficient to cause permanent damage to plant growth and development (Ismail and Hall, 2007). The most sensitive growth stage of rice to heat stress is flowering time (Mackill *et al*., 1982; Kuang *et al*. 2002) and rice seed set is very susceptible to high temperature during flowering (Yoshida 1981). Breeding rice for high temperatures has been attempted only recently but progress has been made to date. There are two approaches in developing or breeding rice varieties adapted to high temperatures: first is to breed rice for heat tolerance *per se* (or true heat tolerance); second is to breed rice that would

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avoid high temperature or heat escape (Redoña *et al.*, 2007). A recent study showed that flower opening in the early morning (heat escape) helps prevent sterility of rice caused by heat stress at flowering and this is under genetic control and affected by weather, particularly air temperature (Kobayasi *et al.*, 2010).

The study aimed to map QTLs for early morning flowering (EMF) in rice and identify markers closely linked to major QTLs. Once fine mapped and cloned, these genes or regions will eventually be used in marker assisted selection to develop EMF varieties and this will accelerate the breeding process in EMF improvement. The detection of SSR markers closest to the QTLs makes easy the study concerning QTL mapping of EMF genes in rice. This study was conducted at International Rice Research Institute from July 2007 to July 2010. It was conducted at the NS02 greenhouse of Plant Breeding, Genetics and Biotechnology Division (PBGBD) and in the Gene Array and Molecular Applications (GAMMA) laboratory of the International Rice Research Institute (IRRI), Laguna, the Philippines (14°30'N, 121°1'E) from November 2007 to July 2010. Early morning flowering evaluation for BC_1F_2 population was done at BG03-b glasshouse.

MATERIALS AND METHODS

Plant Materials and Mapping Population

Two diverse rice varieties – PSB Rc82 (*Oryza sativa*) and WAB56-125 (*Oryza glaberrima*-derived) were used as parents in developing mapping populations in this study. PSB Rc82 is a high yielding rice variety which is susceptible to high temperature stress whereas WAB56-125 is a heat-escape cultivar which manifests some heat tolerance *per se*. Prasad et al. (2006) reported that generally, *Oryza sativa* genotypes will flower between 1000 and 1200 h, whereas *Oryza glaberrima* genotypes completed flowering by 0900 h. Sheehy et al. (2005) proposed that early morning flowering (EMF) trait could be beneficial for reducing yield loss by avoiding or escaping from the damaging effects of high temperature.

The mapping population was developed from a cross between PSB Rc82, a heat-sensitive variety and WAB56-125, a heat-escape donor parent. The F_1 plants derived from this cross (PSB Rc82 x WAB56-125) were subsequently backcrossed to PSB Rc82 (recurrent parent) to generate BC_1F_1. The 235 BC_1F_1 progenies were subjected to heat tolerance screening in internal growth chambers (IGC, Thermoline, Austraia) of IRRI with 6 h of high temperature (38°C) setting each day during flowering time. A temperature setting in the IGC was set to simulate the temperature in the field (Table 1). The same materials were selfed to generate 684 BC_1F_2 progenies that were screened and evaluated for early morning flowering (EMF) trait like flower opening or start time (FOT), peak of flowering (POF), flower mostly closed (FMC), and flower closed (FC) time.

Early Morning Flowering of BC_1F_2 population

Early morning flowering (EMF) traits were evaluated using 685 BC_1F_2 plants and their parents (PSB Rc82 and WAB56-125) under glasshouse condition at IRRI to determine spikelet opening or start time, peak time when 50% of the spikelets are opened, time when most of the spikelets are closed and, lastly, time when all spikelets are closed among the BC_1F_2 plants. To investigate these traits, an intensive data gathering was made by recording every after 30 minutes from 6:00 AM to 1:30 PM the time when the first spikelet opened, the peak time when 50% of the spikelets opened, time when most of the spikelets are closed and, lastly, time when all spikelets are closed. All panicles of each BC_1F_2 individuals were evaluated for these flowering parameters. EMF is a unique trait where the flowers open at cooler and earlier time of the day as an escape mechanism to high temperature-induced sterility during flowering. Kobayashi et al. (2010) reported that flower opening in the early morning helps avoid sterility in rice caused by heat stress at anthesis.

Genotyping of P_1, P_2, and BC_1F_2 Population

Genomic DNA was extracted from 685 BC_1F_2 progenies including the parents using the modified cetyltrimethylammoniumbromide (CTAB) method (Murray and Thompson, 1980). A total of 164 polymorphic SSR markers were identified between parents: PSB Rc82 and WAB56-125. Only 84 SSR markers with distinct banding patterns and having 10-20 centiMorgan (cM) genetic distance evenly distributed across the 12 rice chromosomes were utilized to screen the genotypes of the BC_1F_1

population. Primer sequences were obtained from Gramene database (http://www.gramene.org/). Phenotypic extremes from the best tail (highly fertile) and worst tail (highly sterile) were chosen for selective genotyping, with each tail containing genomic DNA from the two sets of extreme BC_1F_2 progenies. These tails were the top 27 heat tolerant (best tail) and the other 16 heat-sensitive extreme (worst tail) from the whole population. This method saves time, effort, and resources and for these reasons selective genotyping was used in this study. The rationale behind the method is that in a QTL mapping population, some progeny contribute more linkage information than others. The individuals that provide the most linkage information are those genotypes which can clearly be inferred from their extreme phenotypes (Lander and Botstein 1989). PCR and PAGE were carried out rigorously before the stained gels were visualized in the Alphaimager® Gel Documentation device for DNA band scoring. Clear electrophoretic bands generated from each primer were scored as "A" for homozygous sensitive parent, "B" for homozygous tolerant parent and "H" for heterozygote. Since the mapping population used was a backcross-derived population, only two genotypes were observed across the population, homozygous for one parent and heterozygote.

QTL Analysis

The genetic map used was based on the map constructed by the Cornell University developed using the population of doubled-haploid lines (DH) derived from the inter-subspecific cross between IR64 (*indica*) and Azucena (*japonica*) varieties (McCouch *et al*, 1997). The QTLs associated with spikelet fertility, pollen fertility, and Early Morning Flowering traits (flower opening time, peak of flowering, flower mostly closed, and flower closed) were identified using single marker analysis (SMA). SMA is the simplest way for detecting QTLs associated with single markers. Single-marker analysis to detect main effect of QTL was performed by MINITAB 14.0 (Minitab Inc., State College, PA, USA). Significant association of a tested marker with a QTL for heat tolerance was detected by one-way ANOVA. All statistical procedures were performed with MINITAB 14.0 (Minitab Inc., State College, PA, USA).

Marker-Phenotype Association Analysis

SSR primer pairs which generated polymorphic markers between PSB Rc82 and WAB56-125 were used to detect the polymorphic markers associated with the phenotype using the DNA of phenotypic extremes (tails) of BC_1F_2 lines for early morning flowering (EMF) traits. The SSR primer pairs producing polymorphism between parents – PSB Rc82 and WAB56-125 were surveyed on selected (the 16 heat-sensitive and 27 heat-tolerant BC_1F_2 plants) BC_1F_2 progenies to evaluate the segregation of the markers.

RESULTS AND DISCUSSION

Early Morning Flowering (EMF) of the BC_1F_2 population

Rice flowering time usually occurs within 1000H-1200H (Nishiyama and Blanco 1980). Flower opening of rice in early morning is a useful response to avoid heat-induced sterility at anthesis, considering that sensitivity of rice flowers to high temperatures decreases within the 1 h period after flower opening (Satake and Yoshida 1978). Prasad et al. (2006) claimed that rice genotypes can either escape or avoid heat stress at flowering by heading during the cooler periods of the season or by flowering during cooler hours of early morning.

Early morning flowering (EMF) of PSB-Rc82, WAB56-125 and their BC_1F_2 plants were evaluated under glasshouse conditions at IRRI from April 4, 2010 to June 11, 2010.

This was done in the glasshouse to avoid the effect of other environmental factors. Relative time when flowers start to open (FOT), peak flowering time (PFT), time when most of the flowers are closed (FMCT), and time when all of the flowers are closed (FCT) were observed and recorded. Results revealed that WAB56-125 started opening spikelets earlier than PSB-Rc82. Closing of spikelets was also earlier in WAB56-125 than PSB-Rc82 at 0930H and 0945H, respectively. This could be a potential escape mechanism for WAB56-125 in order to avoid the high temperature during the day. On the other hand, variations in FOT, PFT, FMCT, and FCT were observed among the 684 BC_1F_2 plants. Among the BC_1F_2 plants evaluated based on these parameters,

the most stable and the earliest flowering plants were BC_1F_2-227-3, BC_1F_2-229-4 and BC_1F_2-195-1. These materials are promising source for the EMF trait which exhibit escape mechanism under high temperature stress condition during the day. EMF is a unique trait where the flowers open under cooler and earlier time of the day as an escape mechanism to high temperature-induced sterility during flowering. Kobayashi et al. (2010) reported that flower opening in the early morning helps avoid sterility in rice caused by heat stress at anthesis.

Start of Flowering

The normal distribution of time for flowers to start opening of 684 BC_1F_2 progenies derived from the 235 BC_1F_1 plants compared to their parents is shown in Figure 1. Majority of the BC_1F_2 plants started opening spikelets at 480 min (0800H). WAB56-125 opened its spikelets at 431.67 min (0811H), than PSB-Rc82 at 495 minutes (0915H). Likewise, WAB56-125 had earlier spikelet opening compared with most of the 684 BC_1F_2 plants. This could be attributed to the genetic make-up of WAB56-125 having been derived from a cross between *Oryza sativa* L. and *Oryza glaberrima* Steud. Generally, *glaberrima* Steud and its hybrids derived from interspecific crosses to *O. sativa* open flowers earlier than those of *sativa* L. (Nishiyama and Blanco 1980; Jagadish et al. 2008; Nishiyama and Satake 1981). A recent study showed that start of flower opening time in the early morning is an escape mechanism to avoid spikelet sterility caused by heat stress at flowering in rice (Kobayashi et al. 2010).

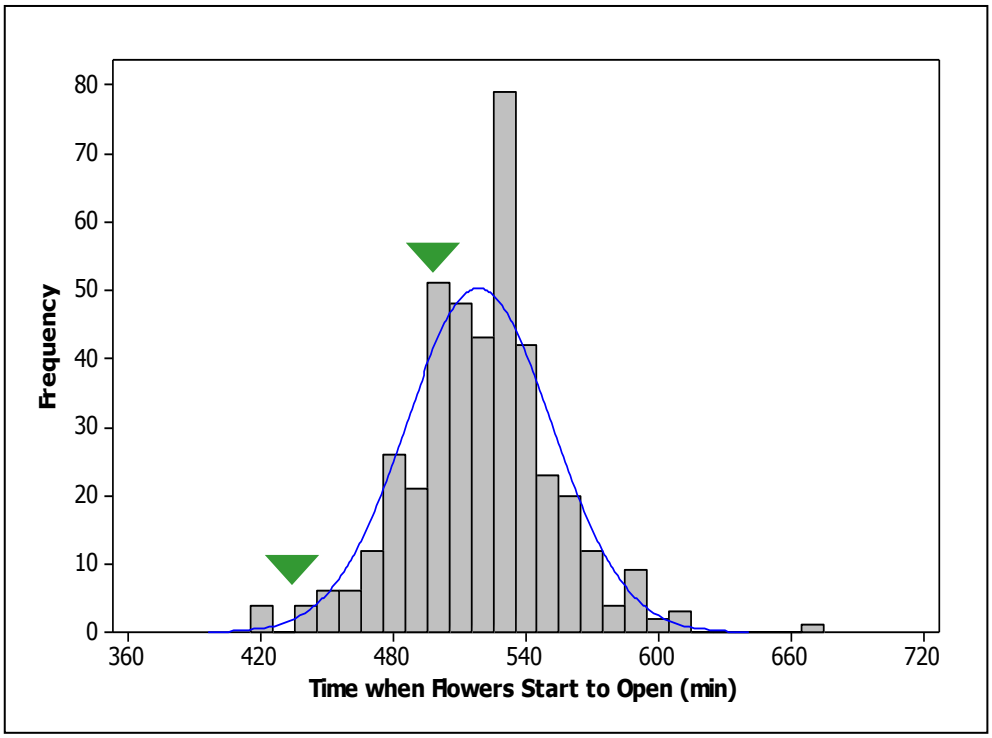

Figure 1. Frequency distribution of the start of flower opening in 684 BC_1F_2 progenies and their parents PSB-Rc82 and WAB56-125.

Peak of Flowering

Peak flowering in this study was considered when 50% of the spikelets were opened (Thanh et al. 2010). Figure 2 illustrates the normal distribution of peak flowering among 684 BC_1F_2 plants and their parents. Since it fit the normal distribution, this indicates that

the time of peak flowering is controlled by multiple genes. The relative values of peak flowering among the 684 BC_1F_2 plants ranged from 465 min (0745H) to 690 min (1130H), with an average of 561.77 min (0922H). WAB56-125 had its peak flowering at 477.5 min (0757H) which was earlier than PSB-Rc82 that peaked at 547.50 min (0907H). In addition, WAB56-125 was relatively earlier to reach the peak of flowering than the majority of the BC_1F_2 population.

Peak of flowering is a very important parameter for the early morning flowering trait since this is the time when most (≈50%) of the spikelets are opened during the day, the peak of pollination is where subsequent events before fertilization occur, and the most sensitive stage in rice to heat stress (Mackill *et al*. 1982; Kuang *et al*. 2002; Yoshida 1981). High temperature that coincides with flowering would result to sterility due to poor anther dehiscence and decreased pollen growth, hence reduced numbers of pollen grains germinating on the stigma (Matsui et al. 2000, 2001; Prasad et al. 2006). Advancing the peak of flowering at early hours in the morning would mean escaping high temperatures during later hours of the day (Prasad et al. 2006). Avoidance of high temperature stress even for 1 hour during flowering is sufficient to reduce spikelet sterility (Jagadish et al. 2007).

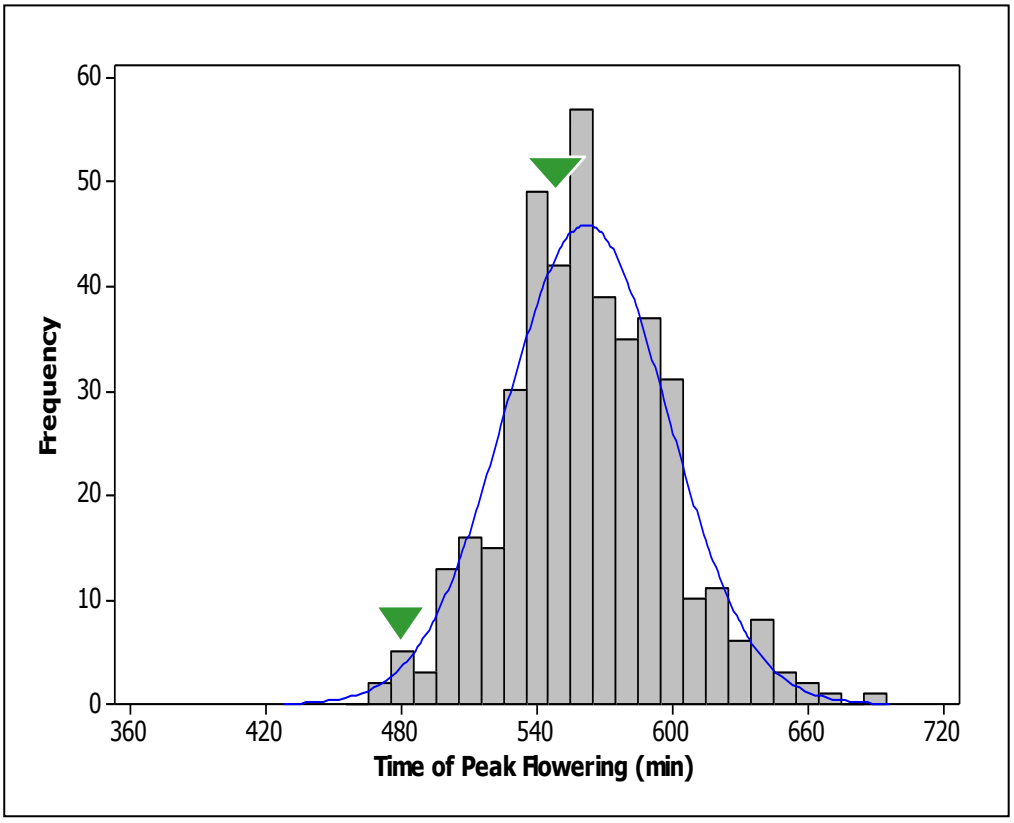

Figure 2. Frequency distribution of the peak of flowering in 684 BC_1F_2 plants and their parents PSB-Rc82 and WAB56-125.

Most of the Flowers are Closed

Figure 3 shows the normal distribution of the time when flowers (spikelets) were mostly closed in 684 BC_1F_2 plants and their parents. For the 684 BC_1F_2 plants, the closing of flowers ranged from 510 min (0830H) to 750 min (1230H) with a mean of 630 min (1030H). WAB56-125 had most of its spikelets closed at 536.67 min (0857H) which was earlier than that of PSB-Rc82 at 585 min (0945H). In addition, WAB56-125 had most of its spikelets closed relatively earlier than the majority of the BC_1F_2 plants.

When most of the spikelets are closed it is considered to be safe from the negative effect of high temperature stress. This is a morphological mechanism of the rice spikelet to protect its pollination and fertilization processes, although no studies have been conducted yet to determine the closing time of spikelets in association with spikelet sterility. Sterility does not occur when spikelets close 1 h before high temperature treatment, suggesting that spikelets have considerably high tolerance after completion of fertilization as claimed by Satake and Yoshida (1978).

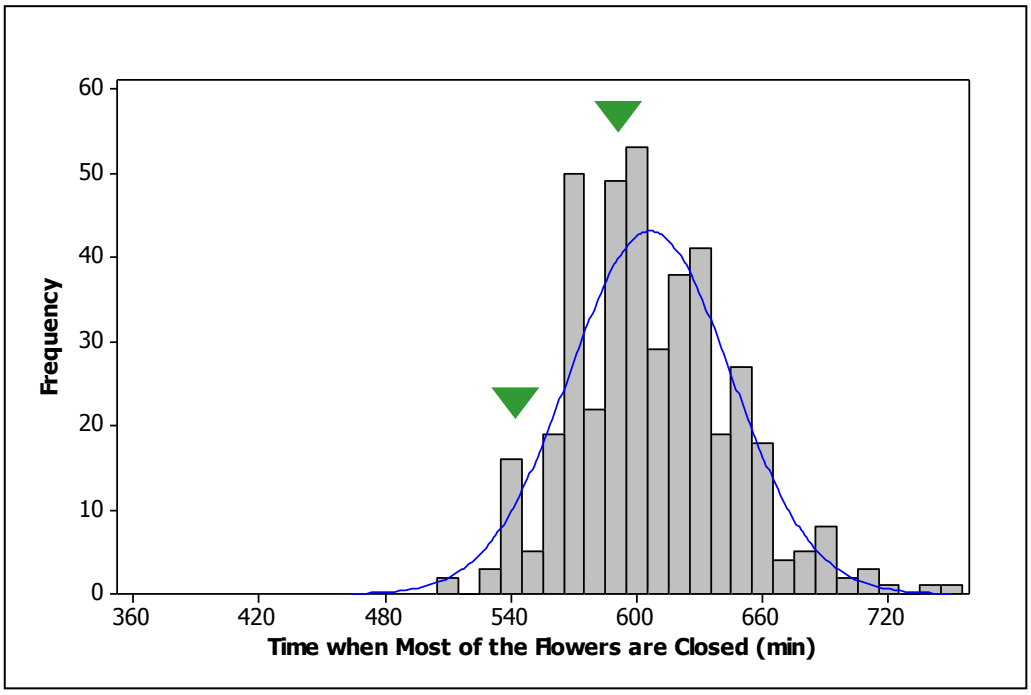

Figure 3. Frequency distribution of the time when most of the flowers are closed in 684 BC_1F_2 plants and their parents PSB-Rc82 and WAB56-125.

Flower Closing Time

Closing of spikelets at cooler temperature (before 0930H or ≤570 min) in the morning means full protection against high temperature-induced sterility in rice, and could be a good index for selecting heat escape materials (Howell 2010, Personal Communication). Figure 4 shows the normal distribution of flower closing time among 684 BC_1F_2 plants and their parents, indicating that flower closing time is controlled by several genes and is fit for QTL analysis. Flower closing time among the 684 BC_1F_2 plants ranged from 540 min (0900H) to 780 min (1300H) with a mean of 638.78 min (1039H). It can be inferred that majority of the BC_1F_2 plants closed spikelets from 1000H to 1100H, with the highest number of plants (≈50) that have spikelets closing at 1000H. WAB56-125 closed earlier at 566.67 min (0927H) than PSB-Rc82 with 600 min (1000H). Consistently, WAB56-125 closed its spikelets relatively earlier than most of the BC_1F_2 plants.

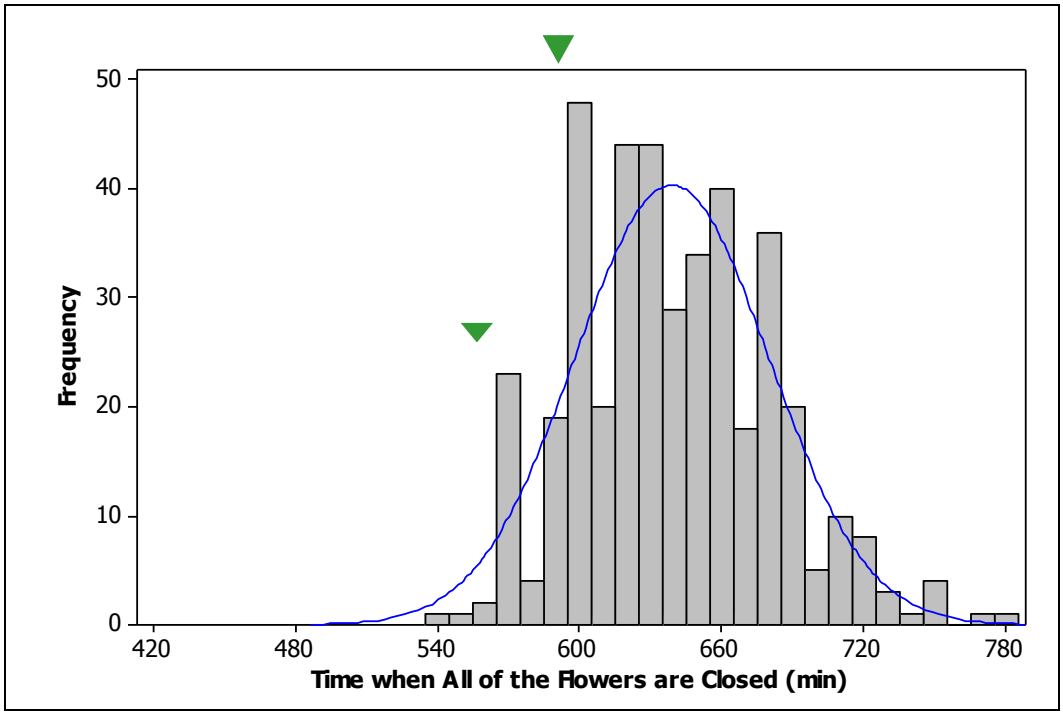

Figure 4. Frequency distribution of the time when all of the flowers are closed in 684 BC_1F_2 plants and their parents PSB-Rc82 and WAB56-125.

Polymorphism Between the Parental Varieties

A total of 217 SSR primer pairs were used to evaluate polymorphisms of the two parents (PSB-Rc82 and WAB56-125) used in this study. Among the 217 SSR markers surveyed, 164 (75.6%) showed polymorphism between the two parents used. From these 164 polymorphic SSR markers, only 85 SSR markers were utilized in selective genotyping of the 11 extreme heat-tolerant, 11 extreme heat-sensitive BC_1F_1 plants, and their parents. The selection of the 85 polymorphic SSR markers were based on the primers' distinct DNA banding patterns, and the genetic distance between markers that was set at between 10-20 cM along each chromosome. Information on each SSR primer, such as expected PCR product size, annealing temperature, and map position were obtained from Cornell University in the Gramene database (Gramene 2009).

High level of polymorphism in this study is attributed to the high genotypic variation between parents used which are *Indica (*PSB-Rc82) and *Oryza glaberrima*-derived (WAB56-125) rice genotypes. Generally, sufficient polymorphisms rely or exist with parents that are distantly related or genetically diverse (Anderson et al. 1993; Collard et al. 2003; Joshi and Nguyen 1993; Yu and Nguyen 1994).

QTL Analysis for the Early Morning Flowering (EMF) Traits

QTL analysis using selective genotyping revealed significant differences in the start of flower opening time among the 16 heat-sensitive and 27 heat-tolerant BC1F2 plants. The single marker analysis had shown the association of SSR markers RM233B ($p = 0.010$) on chromosome 5, RM321 ($p = 0.003$) on chromosome 9, and RM481 ($p = 0.019$) on chromosome 7 showed significant P value among the BC1F2 plants. These microsatellite markers can be possibly linked or associated to the start of flower opening time for the EMF trait in rice. Similarly, Thanh et al. (2010) using backcross population, identified QTL for starting time when the first spikelet opened (SOTb) on chromosome 5, with markers flanking RM249-RM440.

For the time of peak flowering, SSR markers RM556 ($p = 0.031$) on chromosome 8, RM574 ($p = 0.041$) and RM233B ($p = 0.002$) on chromosome 5, RM481 ($p = 0.026$) on chromosome 7, RM4 ($p = 0.034$) on chromosome 11, and RM321 ($p = 0.006$) on

chromosome 9 had significant P values among BC1F2 plants. These could be possibly linked to peak flowering time. Same markers were identified to be possibly linked to time when most of the flowers are closed and time when all of the flowers are closed. These results indicate that chromosomes 5, 7, 8, 9, and 11 were most likely the possible QTL locations for peak flowering time, time when most of the flowers are closed and time when all of the flowers are closed. Thanh et al. (2010) reported that related QTL was detected for peak flowering time on chromosome 5 in the region of RM249. In this study, the QTL region for SOTb and peak flowering time on chromosome 5 overlapped which could indicate the most likely location of flower opening time QTL in rice. This information could be used in determining the genetic basis of flower opening time in relation to early morning flowering.

Flower opening time varies among rice genotypes in response to high temperature. Kobayashi et al. (2010) showed that flower opening in the early morning can reduce sterility in rice, but it can be affected by weather such as air temperature (Nishiyama and Satake 1981; Imaki et al. 1983; Hoshikawa 1989; Jagadish et al. 2007, 2008; Nakagawa and Nagata, 2007). Similarly, Jagadish et al. (2007 and 2008) found that the flowers of rice varieties open earlier at high temperatures to avoid high midday temperatures.

For the time when most of the flowers are closed, SSR markers RM556 (p = 0.043) on chromosome 8, RM574 (p = 0.033) and RM233B (p = 0.001) on chromosome 5, RM481 (p = 0.036) on chromosome 7, RM4 (p = 0.030) on chromosome 11, and RM321 (p = 0.005) on chromosome 9, produced significant P values among BC1F2 plants through single marker analysis. These markers are possibly linked to QTL for time when most of the flowers are closed.

Single marker analysis (SMA) results revealed QTLs for time when all of the flowers are closed were possibly linked with SSR markers RM556 (p = 0.044) on chromosome 8, RM574 (p = 0.043) and RM233B (p = 0.001) on chromosome 5, RM481 (p = 0.027) on chromosome 7, RM4 (p = 0.034) on chromosome 11, and RM321 (p = 0.003) on chromosome 9.

In general, SSR markers RM556 on chromosome 8, RM574 and RM233B on chromosome 5, RM481 on chromosome 7, RM321 on chromosome 9, and RM4 on chromosome 11 were the most possibly linked to QTL for peak flowering time, time when most of the flowers are closed, and time when all of the flowers are closed. Therefore, the most likely sites of early morning flowering QTL are on chromosomes 5, 7, 8, 9 and 11.

CONCLUSION

The study aimed to identify quantitative trait loci (QTL) for early morning flowering (EMF) trait BC_1F_2 rice population and identify markers for marker-assisted selection. Genetic factors underlying EMF trait in rice were analyzed by selective genotyping of phenotypic extremes among 684 BC_1F_2 plants (derived from the 235 BC_1F_1 plants that was further derived from the cross PSB Rc82//PSB Rc82/WAB56-125) evaluated under glasshouse conditions were undertaken using single marker analysis (SMA). Four parameters were determined such as flower opening time or start time (FOT), peak of flowering (POF), flower mostly closed (FMC), and flower closed (FC) time using 684 BC_1F_2 plants.

Results revealed that SSR markers RM321 (p=0.003) on chromosome 9, RM233B (p=0.010) on chromosome 5, and RM481 (p=0.019) on chromosome 7 were possibly linked to QTL for FOT. While SSR markers RM556 on chromosome 8, RM574 and RM233B on chromosome 5, RM481 on chromosome 7, RM321 on chromosome 9, and RM4 on chromosome 11 were most possibly linked to QTL for POF, FMC, and FC. Results further indicate the most likely genomic regions of EMF QTL to be distributed on chromosomes 5, 7, 8, 9 and 11.

RECOMMENDATION

While this needs to be confirmed using a larger population size and other QTL mapping method/s, the results could already be useful for further fine mapping and eventually for marker-aided selection of EMF/heat escape rice varieties adapted to future warming climates.

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Proceedings of the 3rd International Conference on Agriculture and Forestry, Vol. 2, 2016, pp. 167-170
Copyright © TIIKM
ISSN: 2362-1036 online
DOI: https://doi.org/10.17501/icoaf.2016.2115

INTRASPECIFIC CLASSIFICATION OF CANTALOUPE (*Cucumis melo* L. var.*recticularis Naudin.*) AND THAI MELON (*Cucimis melo* L. var.*conomon*) IN MOLECULAR VARIATION

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Abstract

Genetic variation of 14 melon varieties (2 Thai melon and 12 cantaloupes) was studied molecular maker techniques. Three primers; from 13 primer sets showed polymorphism of the melon varieties. The results from these primers form only two cluster groups (Thai melon group and Cantaloupe group)with the R^2= 0.87. These results will further help support the efficiency of parent lines selection in cantaloupe and Thai melon breeding program.

Keywords: Cantaloupe, Melon, RAPD, ISSR

INTRODUCTION

Cantaloupe (*Cucumis melo* L.) belong to the genus Cucumis in the family Cucurbitaceae. Within the genus Cucumis, it belongs to the subgenusmelo, having 2n=24 chromosomes. It's origin was thought to be in Africa, but recent data suggest that melon and cucumber may be of Asian origin (Sebastian P. et al, 2010). Melons are classified into 16 groups, 5 of which (conomon, makuwa, chinensis, momordica, and acidilus) can be assigned to the subspagrestis and 11 (cantalupensis, reticulatus, adana, chandalak, ameri, inodorus, flexuosus, chate, tibish, dudaim, and chito) to the subsp.melo. (Pitrat M. et al, 2000) Cantaloupe is an important horticultural crop across wide areas of the world, with 26 million tons produced worldwide in 2009 (FAO, 2011). Cucumis is an attractive model for studying valuable biological characters, such as fruit ripening (Pech J.C. et al, 2008) Great morphological variation exists in fruit characteristics such as size, shape, color and texture, taste and composition, *C. melo* is considered the most diverse species of the genus Cucumis. Sensitive DNA fingerprinting techniques have been used to resolve taxonomicrelationships, providing an objective and quantitative measure for genetic diversity between taxa, e.g. among genera and species (Schierwater B., 1995 ; Campos L. et al, 1994 and Millan T. et al, 1996). The sensitivity of the new methodologies also allows genotyping of varieties or cultivars within the species (Fang D.Q. et al, 1997 and Lee S.J. et al, 1996). Molecular markers have been shown to be useful to assess genetic diversity in a number of plant species (Bretting P.K. and Widerlechner M.P., 1995 and StaubJ.E. et al, 2000). Molecular characterization of cantaloupe has been performed using techniques including cleaved amplified polymorphic sequences. (Zheng J. et al, 1999) Random amplified polymorphic DNA (RAPD) profiles are obtained using decamer-primers of arbitrary sequence (William J.G.K. et al, 1993) Inter-simple-sequence-repeat (ISSR) PCR involves longer (16-18 nucleotides) primers encoding microsatellite elements that amplify DNA segments between microsatellite repeats (Gupta M. et al, 1994 and Zietkiewicz E. et al, 1994)

The aim of this study was to determine the genetic diversity of melon varieties of cantaloupe and Thai Melon genotypes collected from different provinces of Nakhonratchasima in Thailand, using reference genotypes. ISSR and RAPD analysis were done and molecular data were subjected to cluster analysis.

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MATERIAL AND METHODS

This study was carried out in the School of Crop Production Technology, Institute of Agricultural Technology, Suranaree University of Technology, Nakhon Ratchasima, Thailand.

Plant materials

A total of 14 cultivars of *Cucumis melo* L. were used. Twocultivars of Thai melon and 12 cultivars cantaloupe.(Thai melon01, Thai melon03, Madhurima, Nun 2002, Green Jam 1361, ML201, ML196, ML052, Sun Lady 227, Golden Sun TA088, Sweetie 1823, Honey Sweet 1846, Pot Orange T1957 and Sophy 1899) were showed. Seedlings of each cultivar were grown in a greenhouse andgenomic DNA was extracted from freeze-dried fresh leaves of 15 day old seedlings. DNA was extracted using the method described by Gusmini G. et al, 2004.

RAPD and ISSR analyses

DNA fingerprinting were performed using eight ISSR primer and five RAPD primer (Table 1). PCR reaction mixture contained: 0.4 mM DNA template, 0.2 mMdNTP, 2 mM $MgCl_2$, 10µM Primer, 5X PCR buffer (Applichem: Germany), 1.0 mL Taq DNA (Vivantis: Malaysia) in a total volume of 50 mL. The amplification program was as follows: Step 1: 5 min at 94°C. Step 2: 30 sec at 94°C, Step 3: 30 sec at 37-47.9°C, Step 4: 45 sec 72°C,Step 2-4 for 40 cycles and a final extension of 2 min at 72°C. DNA fingerprinting by the reaction products were subjectedto electrophoresis on 3% agarose gels in 1xTAE buffer, stained with ethidium bromide and visualised under UV light.

Band scoring and cluster analysis

ISSR and RAPD DNA polymorphic fragments were scored as present (1) or absent (0) and the binary matrix obtained was used to calculate the Dice similarity coefficient among the genotypes utilized. The UPGMA cluster analysis, analyses were made using the NTSYS-pc vs. 2.20 software. The correlation coefficient was also calculated.

Table 1 Primer and Annealing Temperature used.

Primer name	Sequence (3'---->5')	Annealing Temp. (°C)	Reference
ISSR_$(AC)_8$YC	ACACACACACACACYC	47.9	Stepanskyet al, 1999
ISSR_$(GA)_8$YG	GAGAGAGAGAGAGAGAYG	47.9	
ISSR_$(ATG)_6$	ATGATGATGATGATG	46.9	
ISSR_$(TG)_8$G	TGTGTGTGTGTGTGTGG	48.0	
ISSR_$(AC)_8$T	ACACACACACACACACT	57.2	
ISSR_$(CA)_8$CG	CACACACACACACACACG	54.8	
ISSR_$(CA)_8$GT	CACACACACACACACAGT	57.2	
ISSR_$(GA)_8$TC	GAGAGAGAGAGAGAGATC	57.2	
RAPD_C43	GGCGGCACAGGA	37.0	Matsui et al, 2002
RAPD_C48	GGAGGATGGCCC	37.0	
RAPD_A20	TTGCCGGGACCA	37.0	Tanaka et al, 2007
RAPD_A41	TGGTACGGTATA	37.0	
RAPD_OPL07	AGGCGGGAAC	37.0	UBC primer set

RESULTS

Genetic distance-based phylogeny: Out of 8 ISSR and 5 RAPD primers,amplification was successful with 2 ISSR and 1 RAPD primers.The results from were use ISSR_$(GA)_8$YG, ISSR_$(ATG)_6$ and RAPD_OPL07 used in clustering. In Table 2. The polymorphism rate was 93% which was higherthan report in other literature[86%, Danin P.et al 2001 and 66.7%, Lopez S. et al, 2002]. The obtained data were analyzed by the president dendrogram. Genetic similarity values were calculated from the Dice similarity index for all 14cultivars. These values were used to compute the NTSYSpc program. Our results show that the ISSR and RAPD method is highly informative in melon, although the combination between molecular data and agronomic traits could help in detecting the differences among these genotypes that belong to the same variety type. The

analyzed genotypes are well visible on agarose gel. In the dendrogram 14cultivars were grouped into two main clusters, The analysis classified the melon at R^2= 0.87. Interprertationof the correlation coefficient was as follows: r ≥ 0.9, very good; 0.8 ≤ r < 0.9, good; 0.7 ≤ r <0.8, poor; r < 0.7, very poor. The first cluster (cluster I) contained 2 cultivars (Thai melon01 and Thai melon03). The second cluster (cluster II) contained 12 cultivars (Madhurima, Nun 2002, Green Jam 1361, ML201, ML196, ML052, Sun Lady 227, Golden Sun TA088, Sweetie 1823, Honey Sweet 1846, Pot Orange T1957 and Sophy 1899). (Fig. 1) confirming the usefulness of these markers in better understanding the genetic relationships among Thailand's melon populations.

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Table 2 Marker bands used to assess the genetic diversity of Cantaloupes and Thai melon.

Primer name	Sequence (5'---->3')	Total bands	Polymorphic	Percentage
ISSR_$(GA)_8$YG	GAGAGAGAGAGAGAGAYG	18	16	89
ISSR_$(ATG)_6$	ATGATGATGATGATGATG	10	10	100
RAPD_OPL07	AGGCGGGAAC	20	18	90
Total		**48**	**44**	**93**

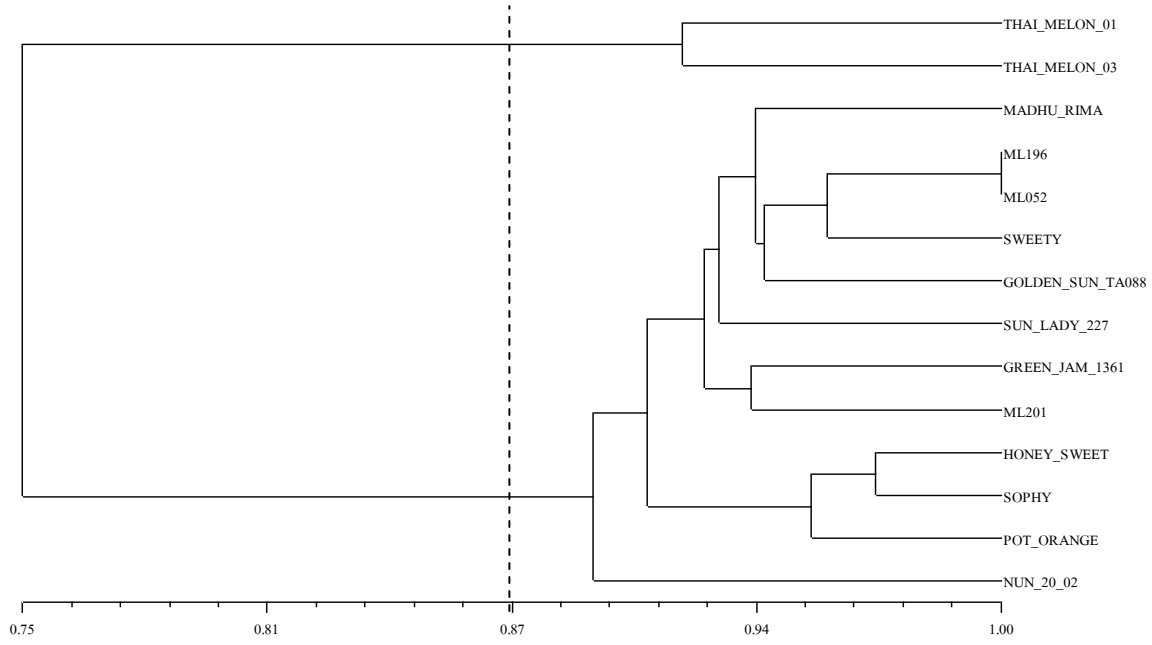

Figure 1 In the dendrogram 14cultivars were grouped into two main clusters from ISSR_$(ATG)_6$, ISSR_$(GA)_8$YG and RAPD_OPL07 by the NTSYSpc program

CONCLUSION

This study confirmed the efficacy of the approach used for distinguishing closely related melon landraces Itcan contribute to preserving genetic variability in germplasm conservation and breeding programs. An in depth study on the agronomic traits will be of great importance to clearly define the genetic similarities.

ACKNOWLEDGEMENTS

This research was supported by the National Research Council of Thailand (NRCT) and Suranaree University of Technology, Nakhon Ratchasima, Thailand.

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