Proceeding of the 2nd International Conference on Agriculture and Forestry, Vol. 1, 2015, pp. 43-48

ISSN: 2362 – 1036 online
DOI: 10.17501/icoaf2015-1106

STUDIES ON PHENOLOGICAL BEHAVIOR OF TWO *CASSIA* SPECIES IN GIRNAR RESERVE FOREST, GUJARAT, INDIA

R.N.Nakar[1] and B.A.Jadeja[2]

[1]*Sheth PT Arts & Science College (Under Gujarat University)*

[2]*M.D.Science College (Under Saurashtra University)*

Abstract

Phenological cycle of two tree species *viz. Cassia siamea* Lam and *Cassia fistula* L. was studied in Girnar Reserve Forest, Gujarat, India from August-2008 to August-2011. Both species varied with different phenological behavior in all four phenological events studied such as new foliage, leaf fall, flowering and fruiting by showing significant variation (P value <0.05) in number of days. For *Cassia fistula* L., mean new foliage, leaf fall, flowering and fruiting days were 43, 52, 103 and 107 approximately but they were, 40, 162, 160 and 135 respectively for *Cassia siamea* Lam. Among different morpho-phenological characters studied, positive significant association was recorded between diameter of stem and branches per tree (0.84**), flowers per branch and inflorescence per branch (0.91**) for *Cassia fistula* L. However, in *Cassia siamea* Lam, positive correlations were recorded between inflorescence per branch and flowers per branch (0.93**). Interestingly, there were negative correlations found between leaves per branch and inflorescence per branch (-0.55*), also between leaves per branch and flowers per branch (-0.54*) for same species. Climatic factors affected phenology of both species by showing direct association. In *Cassia fistula* L., wind speed showed positive association with inflorescence per branch (0.59*), and with flowers per branch (0.56*) whereas, rain pertained positive correlation with fruits per branch (0.64*). In case of *Cassia siamea* Lam, positive correlation was observed between wind speed and fruits per branch (0.49*) as well as between rain and fruits per branch (0.74*). This kind of work can be highly useful in understanding adaptation mechanisms of plant species; can also be of immense use for different branches such as physiology, ecology and forestry.

Keywords: Phenology, Morpho-phenological characters, Girnar Reserve Forest, Climate

Introduction

Phenology is time of recurring phenomena in relation with climate. Phenological events such as new foliage, leaf fall, flowering and fruiting are influenced by abiotic factors like rain, temperature and wind speed. Phenological studies have importance in conservation of forest genetic tree recourses, furthermore; they can be utilized for making strategies for management system of forest in reforestation and in climate change studies. According to Molau (1993), timing of flowering is much cruisal to reproductive success of all plants however in phenological analysis fruiting plays very important role too, especially in study against climate change (Cortes Flores *et al* 2013). New foliage and leaf fall are useful characters, and were studied for phenology (Kikim and Yadava, 2001) in addition to reproductive characters.

General aspects studied for phenology for different species are very inspiring (Borchert, 1983; Daubenmire, 1972; Jyotinath, 2008), but there are few examples of published material for phenological studies for Girnar Reserve Forest, Gujarat, India (Nakar and Jadeja, 2009; Jadeja and Nakar, 2010; Nakar and Jadeja, 2014; Nakar and Jadeja, 2015). Present study aim (i) to analyze phenological behavior of two two tree species of Cassia

Corresponding Author. Email: rupeshnakar@gmail.com

viz. Cassia siamea Lam. and *Cassia fistula* L. (ii) to correlate data of climatic factors such as rain, temperature and wind speed with that of morpho-phenological data.

Material and methods

Study area and climate

Girnar Reserve Forest, is National Sanctuary in West Saurashtra region of Gujarat State of India. It has spead of 186 km, surrounded by Junagadh and Bhesan Talukas at both sides. It lies within $70^0$28-$70^0$27′N longitude and $21^0$30-$21^0$26 E latitude. Forest is mainly surrounded by Teak, which is in mixture of other species. There are different areas such as Bordevi forest, Jatashankar forest, Jinababa madhi forest, forest area near Prerarana dham, area near Gayatri Mandir etc. Climate of the Girnar Reserve Forest can be devided into mainly three sub seasons: summer (April to mid June), monsoon (mid June to September) and winter (November to February). Of the total rain fall, almost 95% occurs during rainy season.

Plant phenoloy

Phenological characters for *Cassia siamea* Lam. and *Cassia fistula* L. such as new foliage, leaf fall, flowering and fruiting were studied using method of Opler *et al*. (1980) for three years from Aug-2008 to Aug-2011. Month wise numbers of days for each species were calculated for all four phenological events, which later on converted into mean approximate number of days.

Morpho-phenological characters

Morphophenological characters such as diameter of stem, branches per tree, leaves per branch, inflorescence per branch, flowers per branch and fruits per branch were observed at 2 month regular interval. For that, a branch was selected on 5 tagged trees, and then individual traits were recorded monthwise.

Stastical analysis

Simple parameters like average, minimum, maximum were calculated using MS-Excel 2010 whereas, for studying variation one way ANOVA was performed using software SPSS. Linear correlation was studied using PAST software, between climatic and phenological traits to find association between them.

Results and discussion

During three years study, highest temperature was 44.5°C in May 2009, and lowest was 18.35°C, recorded in December 2010. Mean values for rainfall during 2008–09, 2009–10 and 2010–11 were 103.05, 69.18 and 102.85 mm respectively, while wind speed showed average values of 6.39, 6.34 and 4.60 km h^{-1} for same respective years. There was significant negative correlation between minimum temperature and wind speed.

Phenology of two *Cassia* species showed significant variation in their phenological behavior (P value<0.5). Mean number of new foliage showed values of 36, 45 and 48 days for respective years 2008-09, 2009-10 and 2010-11 for *Cassia fistula* L. however, they were, 27,43 and 49 days for *Cassia siamea* Lam. In leaf fall event, mean leaf fall were 58,50 and 49 days for *C. fistula* L. whearas they were, relatively higher in *Cassia siamea* Lam. with values of 174, 154 and 159 days. For reproductive phenological events, mean number of flowering days were, 107 and 148 in 2008-09 for *C.fistula* L. and *C.siamea* L., while in 2009-10, they were 101 and 161 days for both species. During last year 2010-11, *C.fistula* L and *C.Siamea* Lam. exhibited 100 and 170 days for flowering. On the other hand for fruiting, *C.siamea* Lam showed more fruiting days compared to *C.fistula* with respective values of 135 for 2008-09, 121 for 2009-10 and 148 for 2010-11 Lam compared to values of 96 for year 2008-09, and same value 113 days for both next years for *C.siamea* Lam. Mean values for three years study indicated that, among all phenological events, fruiting event dominated with mean of 107 days followed by 102 days for *C.fistula* L. Interestingly, in *C.siamea* Lam. there was highest leaf fall period with value of 162 days followed by 159 days for flowering.

Variation was significant for all morpho-phenological traits studied. *C.siamea* Lam. showed range of 41.20 to 41.28 cm for diameter of stem, 4 to 4.2 for branches per tree, 41.2 to 1056 for leaves per branch, 11 to 882 for inflorescence per branch, 14 to 642 for flowers per branch, and 0 to 158 for fruits per branch. In case of *C. fistula* L., they were, 33.24 to 33.28 cm or diameter of stem, 3.9 to 3.93 for branches per tree, 33.25 to 1328 for leaves per branch, 5 to 903 for inflorescence per branch, 13 to 1268 for flowers per branch and 0 to 580 for fruits per branch. In *C.fistula* L., positive significant correlation was recorded between BPT and DOS (0.841**), between FLPB and IPB (0.92**),between IPB and wind speed (0.59*), between FLPB and wind speed (0.56*), as well as between FRPB and rain (0.64*). But on the other hand, for *C.siamea* Lam., positive significant association was recorded between IPB and FLPB (0.93*), FRPB and wind speed (0.49*), rain and FRPB (0.74*). Additionally, there was negative significant correlation found between LPB and IPB (-0.55*), and between LPB and FLPB (0.54*). Analysis of Variance for three years study showed that variation between species was significant furthermore, there was also found significant interaction between phenological parameters studied and years.

In recently published study, there was positive interaction between year and phenology for selected taxa of herbs, shrubs undershrubs (Nakar and Jadeja, 2015). In addition, it was also pertained that there was strong correlation between climatic factors and phenological patterns of Girnar Reserve Forest which is in line of current work. Both *Cassia* species showed leaf fall from December to February which is peak season for most of the species for this study area, hence support earlier studies (Jadeja and Nakar,2010; Nakar and Jadeja, 2013, 2014) In one interesting study, 64% woody species found to be in fruiting during pre-monsoon period in Northern Western Ghats, India (Tadwalkar, 2012). According to Singh and Khushwaha (2006), there is wide range of time lag around 1 to 8 months for vegetative phase and reproductive phase for deciduous species. Even here from vegetative to reproductive stage approximately 8 to 9 months were taken to complete whole process. They further stated that in most of the species flowering was recorded during summer season, which is good evidence for current study. Earlier study on two Bombacean members at same site indicated very high variation for leaves per branch compared to other morpho-phenological traits, even in current one there was high range of leaves per branch for both species. Additionally, there was positive significant correlation between diameter of stem and branches per tree for bombacaceae member (Nakar and Jadeja, 2014) similarly here, strong positive significant correlation was recorded between both these traits for two species of Caesalpiniaceae family.

Conclusion

It is concluded that, phenology of two *Cassia* species showed significant variation in all traits studied *viz.* new foliage, leaf fall, flowering and fruiting. Positive association of climatic factors such as wind speed and rain advocated that, these factors affect phenological behavior of species directly, hence it is the plant adaptation in response to climate of the area. Interestingly, rain showed positive significant association for both species, which emitted that, if there was increased rain then, fruiting duration was elongated for both species of *Cassia*. Current work can be highly useful to workers of different fields but, still more work is required to put some concrete output.

Acknowledgement

Authors are thankful to Dr. H.L.Dhaduk (Anand Agricultural University), Dr. Chetanaben Mandavia and Dr. V.P.Chovatiya (Junagadh Agricultural Univresity), Dr. P.S. Nagar (M.S.University, Baroda). They also show gratitude to Forest Department of Junagadh and Gujarat for providing me necessary permission to work in Girnar Reserve Forest, Gujarat, India.

References

Borchert, R., G. Rivera & W. Hagnauer (2002). Modification of vegetative phenology in a tropical semi deciduous forest by abnormal drought and rain. Biotropica, 34, 27-39.

Cortés-Flores, J., Andresen, E., Cornejo-Tenorio, G. & Ibarra-Manríquez, G. (2013) Fruiting phenology of seed dispersal syndromes in a Mexican Neotropical temperate forest. For. Ecol. Manage, 289, 445–454.

Daubenmire R. (1972). Phenology and other characteristics of tropical semi-deciduous forest in North-Western Costa Rica. Journal of Ecology, 60, 147–170.

Jadeja, B.A. & Nakar, R.N. (2010). Phenology of some tree species from Girnar Reserve Forest, Gujarat. Plant Archives, 2, 825-828

Jyoti nath, A., Das, G. & Das, A.K. (2008) Vegetative phenology of three bamboo species in sub tropical humid climate of Assam. Tropical Ecology, 49 (1), 85-89

Kikim, A. & Yadava, P. S.(2001) Phenology of tree species in subtropical forests of Manipur in northeastern India. Tropical Ecology.42(2), 269–276.

Molau, U., Nordenhall, U. & Ericsen, B. (2005) One set of flowering and climate variability in an Alpine landscape: a 10 years study from a Swedish Lapland. American Journal of Botany, 92(3), 422–431.

Opler, P. A., G. W. Frankie & H. G. Baker (1980). Comparative phenological studies of treelet and shrubs species in tropical wet and dry forests in the lowlands of Costa Rica. Journal of Ecology, 68, 167- 188.

Tadwalkar, M.,Joglekar, A.M.,Mhaskar, M.,Khande, R.B., Chavan, B.,Watve, A.V.,Ganeshahiah, A.N. & Patwardhan, A. (2012) Dispersal modes of woody species from Northern Western Ghats, India. Tropical Ecology, 53(1), 53-67.

Nakar, R.N. & Jadeja, B.A. (2009). Morphology, ethno-botany and phenology of Prosopis from Girnar Reserve Forest, Gujarat. In Proceedings of the National Symposium on Prosopis: ecological, economic significance and management challenges. Gujarat Institute of Desert Ecology, Bhuj, pp. 51-53.

Nakar, R.N. & Jadeja, B.A. (2013). Studies on phenology of some shrubs from Girnar Reserve Forest, Gujarat, India. In National Conference of Medicinal and Aromatic Plants for Rural Development and Prosperity, Anand Agricultural University, Anand, p. 18.

Nakar,R.N. & Jadeja, B.A. (2014). Phenological studies on two bombacacean members from Girnar Reserve Forest, Gujarat, India. Indian Forester,140, 59-64

Nakar, R.N. & Jadeja, B.A. (2015). Flowering and fruiting phenology of some herbs, shrubs and undershrubs from Girnar Reserve Forest, Gujrat, India. Current Science, 108(1), 111-118.

Table 1. Phenological diversity in mean number of days from Girnar Reserve Forest

Year	New foliage		Leaf fall		Flowering		Fruiting	
	CS	CF	CS	CF	CS	CF	CS	CF
2008-09	36	27	58	174	107	148	96	135
2009-10	45	43	50	154	101	161	113	121
2010-11	48	49	49	159	100	170	113	148
Mean ± SD	43±6	40±11	52±5	162±10	103±4	160±11	107±9	135±14

Where, CS and CF are Cassia siamea Lam, and Cassia fistula L. respectively.

Table 2. Analysis of Variance (MS Values) for different phenological traits

EFFECT	DF	NF days	LF days	FL days	FR days	DOS	BPT	LPB	IPB	FLB	FRPB
Block	1	18.75	12.00	192.00	48.00	0.00	0.00	50897.79	30653.52	7252.08	520.08
Species	1	60.75	29601.33**	6816.33**	2028.00**	190.68**	0.05**	324647.33	46066.02*	330.75	2914.08
Year	2	254.33*	204.33	375.08	495.75*	0.00*	0.00*	180567.00	14138.40	592.02	18832.94*
Species x Year	2	109.00	30.33	300.08	452.25*	0.00*	0.00	82706.63	21545.90	597.56	11271.27
Residual	5	22.15	152.80	214.20	46.40	0.00	0.00	71898.08	6841.72	597.83	2397.63
Total	11	83.36	2804.24	857.24	382.18	17.34	0.01	114689.34	16572.43	1177.38	6875.52
CV		11.74	11.41	10.82	5.85	1.74	0.53	34.66	68.47	43.53	62.17
LSD (0.01) for sp.		10.95	28.77	34.07	15.85	0.015	0.049	624.21	192.48	56.92	113.97

Here, * and ** indicate significance level at 0.5 and 0.1 (P value <0.5, 0.1) respectively. CV, DF and LSD show Coefficient of variation, Degree of freedom and Least significance difference. DOS, BPT,LPB,IPB,FLB,FRPB are Diameter of stem, Branches per tree, Leaves per branch, Inflorescence per branch, Flowers per branch and Fruits per branch respectively.

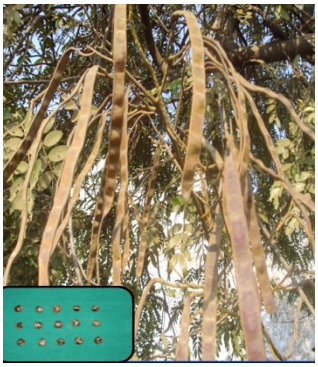
Table 3. Linear correlation between different phenological traits

No.	Correlation bet.	Cassia siamea Lam.		Cassia fistula L.	
		R Value	Result	R Value	Result
1.	BPT-DOS	0.84**	P < 0.01	0.22*	P < 0.05
2.	FLPB-IPB	0.94**	P < 0.01	0.93**	P < 0.01
3.	IPB-Wind sp.	0.59*	P < 0.05	-	NS
4.	FLPB-Wind sp.	0.56*	P < 0.05	-	NS
5.	FRPB-Wind sp.	-	NS	0.49*	P < 0.05
6.	FRPB-Rain	0.64*	P < 0.05	0.74*	P < 0.05
7.	IPB-LPB	-	NS	-0.55*	P < 0.05
8.	IPB-FLPB	-	NS	-0.54*	P < 0.05

NS exhibits Non-significant results, BPT-Branches per tree, DOS- Diameter of Stem, FLPB-Flowers per branch, IPB- Inflorescence per branch, FRPB-Fruits per branch, LPB-Leaves per branch respectively.

Figure 1. Photographs of selected tree species for phenological study

[A] Cassia siamea Lam. in flowering



[C] Cassia siamea Lam. fruiting/ seeds

[B]. Cassia fistula L. in flowering

[D]. Cassia fistula L. in fruiting/ seeds