Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2020; 9(1): 1360-1365
Received: 07-11-2019
Accepted: 09-12-2019

Nidhi Mehta
Forest Ecology and Climate Change Division, Tropical Forest Research Institute, P.O. – RFRC, Mandla Road, Jabalpur, Madhya Pradesh, India

Avinash Jain
Forest Ecology and Climate Change Division, Tropical Forest Research Institute, P.O. – RFRC, Mandla Road, Jabalpur, Madhya Pradesh, India

M Rajkumar
Forest Ecology and Climate Change Division, Tropical Forest Research Institute, P.O. – RFRC, Mandla Road, Jabalpur, Madhya Pradesh, India

Corresponding Author:
Avinash Jain
Forest Ecology and Climate Change Division, Tropical Forest Research Institute, P.O. – RFRC, Mandla Road, Jabalpur, Madhya Pradesh, India

Impact of pruning of *Diospyros melanoxylon* Roxb. (Tendu) bushes on yield and quality of leaves in Maharashtra

Nidhi Mehta, Avinash Jain and M Rajkumar

DOI: https://doi.org/10.22271/phyto.2020.v9.i1w.10646

Abstract
Studies were conducted in SFD controlled pruned tendu bushes dominating forests and CFR controlled non-pruned poles bearing forests in Gondia and Gadchiroli forest divisions of Maharashtra to assess the impact of pruning of tendu bushes on the yield and quality of its leaves. This tree species has attained great economic importance due to its leaves being used as wrappers in the bidi (Indian cigarette) industry and is the good source ofrevenue generation to the states like M.P., Maharashtra, Odisha and U.P. Pruned bushes contributed more than five times healthy leaves (60.33%) than non-pruned poles (11.90%). Gall infested, diseased and defoliated leaves in pruned bushes were recorded less (7.98%, 2.47% and 29.21% respectively), when compared with non-pruned poles (15.37%, 4.97% and 67.76% respectively). The Specific Leaf Area (SLA), which shows the quality of leaves, was found higher (7.46 mm^2/mg) in pruned bushes than non-pruned poles (6.39 mm^2/mg) exhibiting the better quality of leaves collected from the pruned bushes. Leaf gall in tendu was caused by insect *Trioza obsolete*, leaf blight disease by *Pestalotia diospyri* and defoliation by *Hypocala rostrata* insect. Healthy tendu leaves exhibited maximum carbohydrates and phenols content, while maximum proline was found in diseased leaves and maximum ascorbic acid in insect attacked leaves.

Keywords: *Diospyros melanoxylon*, pruning, natural regeneration, CFR, Maharashtra

Introduction
Diospyros melanoxylon Roxb., commonly known as tendu leaf is the most important NTFP of central India which is used to wrap'Bidi'or local Indian cigarette due to its texture, flavour and workability. Its wide scale use is mainly based on its enormous production, agreeable flavour, flexibility, resistance to decay and capacity to retain fire. Tendu leaves are financial lifeline to state forest departments providing seasonal income and employment to 7.5 million forest dwellers in 12 states of the country (Kukreti, 2017) [12]. About 3,50,000 tonnes of tendu leaves worth US $2,000 million are annually collected from the Indian forests, out of which Maharashtra state contributes 10% share providing livelihood to 450,000 tribal families (Bhattacharya, 2008, Broome and Ajit, 2017) [2, 4].

Traditionally, tendu bushes are coppiced near the ground to induce new flush of leaves during February–March of each year, which gives good quality leaves after 40-50 days of the coppicing. Good quality of tendu leaves should be soft, pliable and fairly developed, simultaneously the texture, venation and thickness of midrib and lateral veins should also be taken into account tendu leaves for making *bidis* are collected from pruned bushes, as leaves collected from large trees are stiff and brittle (Desarkar, 1963) [5].

Maharashtra state excels implementation of the Forest Rights Act (2006) by granting villages Community Forest Resource rights (CFR) in 15% of land, however this was only because it had recognised these rights in 66% of the potential land in Gadchiroli district (Kumar *et al.*, 2017) [13]. Over the past few years, pruning of tendu bushes has been a debatable issue keeping in view the lack of scientific background on impact of pruning on quality and productivity of tendu leaves, different pathways of natural regeneration and availability of tendu fruits for wildlife.

The present study has been undertaken with the aim to evaluate the impact of traditional practices of pruning of tendu bushes on yield and quality of its leaves in State Forest Department (SFD) and CFR controlled forests in Gondia and Gadchiroli forest divisions of Maharashtra state.

Materials and Methods

Selection of sites

The studies were conducted at tendudominating Gondia and Gadchiroli forest divisions of Maharashtra during 2016-18 (Fig. 1). Gondia experiences extreme variations in temperature with very hot summers having average maximum temperature of 42 °C, very cold winters having average minimum temperature of 13 °C and annualrainfall of 1418 mm. The average maximum temperature of Gadchiroli is 42.5 °C, average minimum temperature 12.7 °C and annual rainfall is 1493 mm. Both divisions fall under tropical climate and receives fair amount of rainfall during rainy season and slight rains during winters.

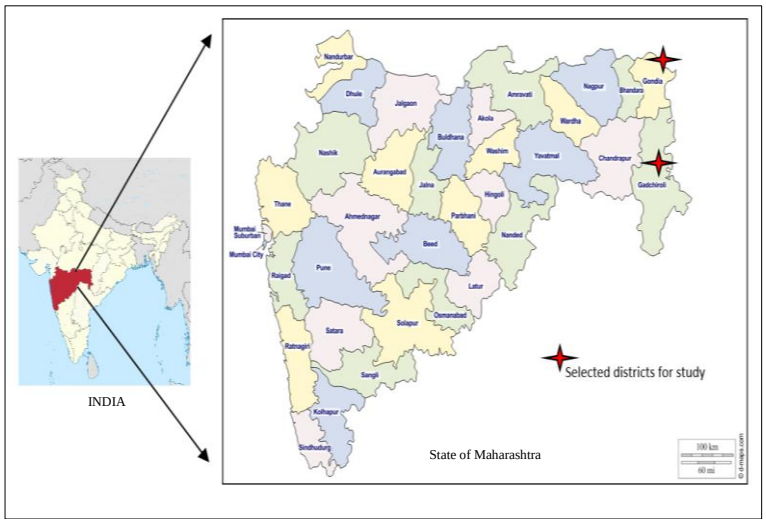


Fig 1: Study Area

Total of seven sites were selected in Gondia and Gadchiroli forest divisions of Maharashtra after thorough survey with the officers of Maharashtra State Forest Department during February 2016. Out of seven, four sites were selected in Gondia and three in Gadchiroli forest division. Sites were selected in both State Forest Department (SFD) and Community Forest Rights (CFR) controlled forests (Table 1).

Table 1: Sites selected in SFD and CFR controlled forests in Maharashtra

S. No.	Forest Division	Sites	SFD/CFR controlled	Latitude (N)	Longitude (E)
1.	Gondia	Koshamtondi	SFD	21º13'03.3"	80º04'38.0"
		Malijunga	CFR	21º13'32.9"	80º07'14.3"
		Pawani		20º53'11.1"	80º24'55.9"
		Mehtakheda-2		20º53'27.5"	80º26'32.5"
2.	Gadchiroli	Maroda	SFD	20º04'40.2"	80º04'07.2"
		East Gurwada		20º06'29.1"	80º03'39.1"
		Savela	CFR	20º03'10.5"	80º07'34.6"

Laying of quadrats and pruning of tendu bushes

During 1st week of March 2016, three quadrats of 0.1ha were laid in each of the selected sites. Hence, a total of 21 quadrats were laid out in the selected seven sites in two forest divisions. Tendu bushes and poles in each quadrat was enumerated and recorded. Pruning of tendu bushes in SFD controlled sites (except East Gurwada site) was regularly done each year while no pruning was done in the CFR controlled sites since 2012, where bushes were converted to poles. Hence, Koshamtondi and Maroda tendu bushes were pruned post collection of their baseline data. Pruning of tendu bushes was done in the first week of March.

Assessment of yield and quality of tendu leaves

Harvesting of mature leaves from tendu bushes and poles was done in three phases in the first week of May, third week of May and second week of June. The number of harvested leaves was recorded to assess their yield and quality from bushes and poles during each pruning. Collected leaves were assessed for their physical and biochemical characteristics. Number of healthy, gall infested, diseased and defoliated leaves were recorded separately for each individual bush or pole. Specific Leaf Area (SLA) of twenty leaves from each pole and bush was calculated. Biochemical changes in healthy, defoliated, diseased and gall infected leaves was assessed by estimation of their total carbohydrates (Hedge and Hofreiter, 1962) [8], proline (Bates *et al.*, 1973) [1], phenols (Folin–Ciocalteu method by Malik and Singh, 1980) [17] and ascorbic acid (Roe and Bruemmer, 1974) [20] content.
The data were statistically analysed using SX software.

Results and Discussion

A total of 34377 numbers of pruned tendu shoots and 1870 number of non-pruned poles were recorded cumulatively in all the laid twenty-one quadrats, each of 0.1 ha size covering 2.1 ha area in both the forest divisions considered under study. Number of pruned tendu shoots was found to be 18 times more as compared to non-pruned tendu poles in the selected sites. The maximum number of tendu shoots were found in SFD controlled Koshamtondi (7752) and Gurvada (7720) sites, while least number of shoots was recorded in CFR controlled Mehtakheda-2 (295) forest. Maximum number of poles were recorded in Savela (940), followed by Malijunga (430) and East Gurwada (350) forests. No non-pruned tendu pole was found in Koshamtondi and Maroda forest sites. The number of shoots and poles per quadrat ranged from 98.33 to 2584 and 16.67 to 313.33 respectively in the selected seven sites (Table 2).

Table 2: Tendu shoots and poles in the selected sites in Gondia and Gadchiroli divisions of Maharashtra

S. No.	Sites	Tendu Shoots		Tendu Poles	
		Total	Mean±SD*	Total	Mean±SD*
1.	Malijunga	2160	720.00 ± 362.90	430	143.33±128.97
2.	Koshamtondi	7752	2584.00±800.12	-	-
3.	Pawani	2670	890.00±439.66	50	16.67±28.87
4.	Mehtakheda-2	295	98.33±95.70	100	33.33±25.15
5.	Maroda	6080	2026.67±915.11	-	-
6.	East Gurwada	7720	2573.33±2534.59	350	116.67±134.29
7.	Savela	7700	2566.67±2209.44	940	313.33±306.16
Total		34377		1870	

*SD=Standard Deviation

Average number of leaves/bush was calculated by multiplying number of leaves per shoot by number of shoots per bush. Maximum number of leaves per bush were reported in pruned bushes of Pawani (29.11), followed by Malijunga (28.84) while minimum number of leaves per bush were observed in Maroda (10.56). The average number of leaves per pole ranged from 117.64 (Savela) to 47 (Pawani) (Table 3).

Average healthy leaves in pruned bushes were found to be approximately five times (52.45%) than non-pruned poles (11.34%). Among the pruned bushes, healthy leaves ranged from 33.15% in Pawani to 85.29% in Maroda, while in non-pruned poles they ranged from 4.68% in Pawani to 15.53% in Malijunga. Assessment of yield of leaves in poles and bushes revealed that although non-pruned poles were reported to produce a higher number of leaves as compared to pruned bushes, but percent of healthy leaves showed opposite trend. Therefore, pruning of tendu bushes enhanced quality by producing increased number of healthy leaves. The results are in agreement with the studies of Orwa *et al.* (2009) [18] who concluded that tendu bushes up to 15 cm in girth pruned near the ground encouraged sprouting of coppice shoots providing best quality leaves after 40-50 days of pruning operation. Also, soft and least pubescence *bidi* leaves harvested from tendu bushes over low-quality leaves from poles.

Harvested tendu leaves from all the seven sites were categorized into healthy, diseased, gall infested and defoliated. Healthy leaves are free of gall, disease and defoliation and are characterized by Specific Leaf Area (SLA) dividing the leaf area with mass, which means higher SLA is exhibited by thin leaves with large area (Kerketta *et al.*, 2018) [11]. Healthy leaves in pruned bushes ranged from 26.92% - 85.29% and the maximum was reported from Maroda (Fig. 2).Thereby, healthy leaves/bush were calculated and it was revealed that village Savela was found to have maximum (13.03) healthy leaves/bush, while Mehtakheda-2 reported the least (7.34) (Table 3). A severe drop was observed in percent healthy leaves in tendu poles, where only 15.53% of maximum was recorded in Malijunga poles. Moreover, 2.20-15.85 number of healthy leaves/pole was reported in tendu poles (Table 3). More than 95% of the total leaves of Pawani were found to be unhealthy, followed by 92% leaves of East Gurwada.

Table 3: Status of harvested and healthy tendu leaves

S. No.	Site	Pruned Bushes					Non-Pruned Poles		
		Av. No. of shoots/ bush	Av. No. of leaves/ shoot	Av. No. of leaves/ bush	Healthy leaves (%)	No. of healthy leaves/bush	No. of leaves/ pole	Healthy leaves (%)	No. of healthy leaves/ pole
		(A)	(B)	(C=A*B)	(D)	(E=C*D/100)	(F)	(G)	(H=F*G/100)
1	Malijunga	2.80	10.30	28.84	37.40	10.79	57.07	15.53	8.86
2	Koshmatondi	2.50	6.10	15.25	70.19	10.70	-	-	-
3	Pawani	4.10	7.10	29.11	33.15	9.65	47.00	4.68	2.20
4	Mehtakheda-2	2.90	9.40	27.26	26.92	7.34	103.31	15.34	15.85
5	Maroda	1.60	6.60	10.56	85.29	9.01	-	-	-
6	Gurwada	2.40	8.00	19.20	61.25	11.76	84.17	7.87	6.62
7	Savela	2.30	10.70	24.61	52.96	13.03	117.64	13.28	15.62
Average		2.66	8.31	22.12	52.45	10.33	81.84	11.34	9.83

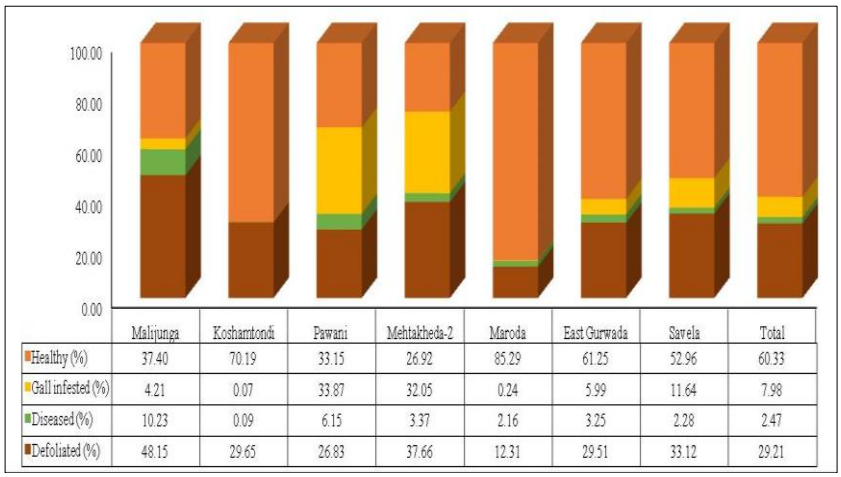
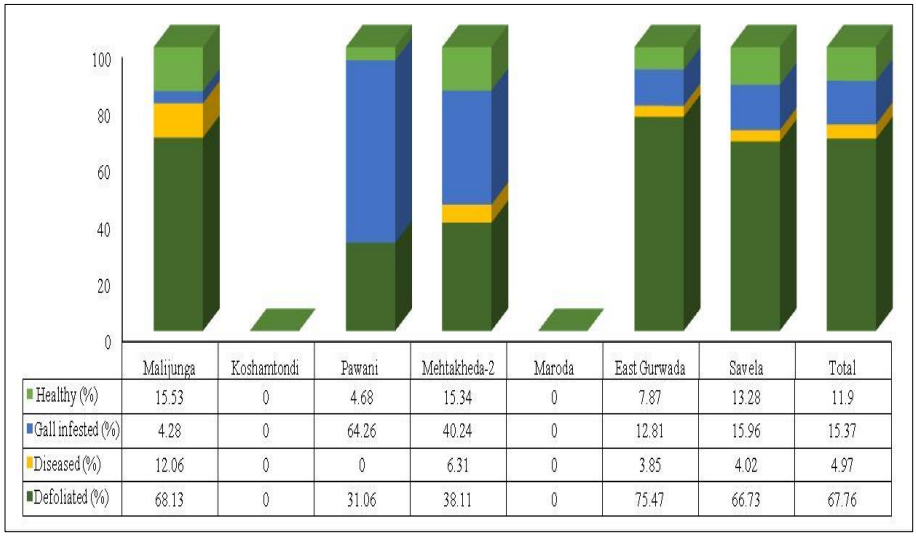


Fig 2: Quality of leaves harvested from pruned bushes of selected sites of Maharashtra



	Malijunga	Koshamtondi	Pawani	Mehtakheda-2	Maroda	East Gurwada	Savela	Total
Healthy (%)	15.53	0	4.68	15.34	0	7.87	13.28	11.9
Gall infested (%)	4.28	0	64.26	40.24	0	12.81	15.96	15.37
Diseased (%)	12.06	0	0	6.31	0	3.85	4.02	4.97
Defoliated (%)	68.13	0	31.06	38.11	0	75.47	66.73	67.76

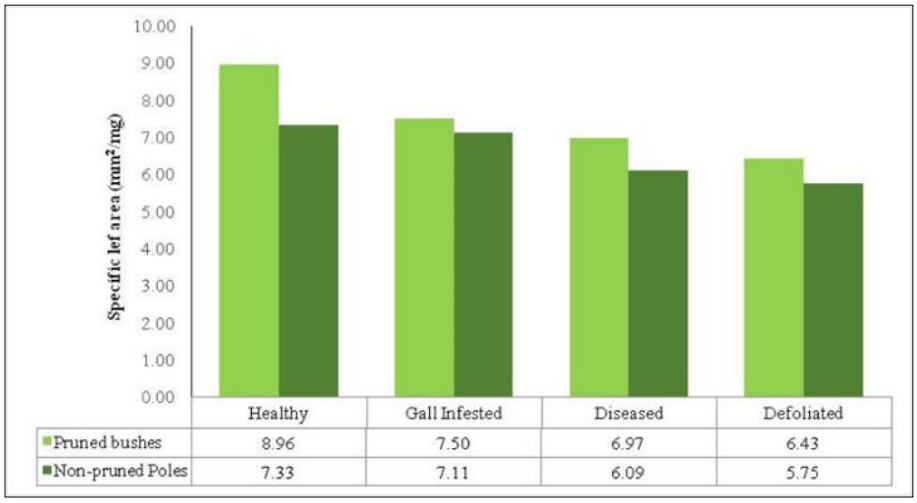
Fig 3: Quality of leaves harvested from poles of selected sites of Maharashtra

Pruned bushes contributed 60.33% healthy leaves in the selected sites against 11.90% in non-pruned poles. The average number of healthy leaves/pruned bush was found to be more (10.33) as compared to average number of healthy leaves/ non-pruned pole (9.83) (Table 3).Diseased and defoliated tendu leaves in pruned bushes were found to be much less (2.47% and 29.21% respectively), than non-pruned poles (4.97% and 67.76% respectively).Similarly, gall infested leaves in non-pruned poles (15.37%) were recorded higher than pruned bushes (7.98%) (Fig 2 and 3).

Assessing the quality of leaves obtained under different categories, it was deduced that the reduction in SLA was found to be maximum due to defoliation, followed by attack of disease andgall infestation when compared to healthy leaves. Insect *Trioza obsolete* was found to be responsible for gall infestation and *Pestalotia diospyri* for leaf blight disease in tendu leaves. Whereas, prominent tendu defoliator *Hypocala rostrata* decreased the quality of tendu leaves through defoliation (Kumar *et al*., 1989) [14].

Table 4: Specific leaf area of tendu leaves in pruned bushes and non-pruned poles in Maharashtra

S. No.	Site	Pruned bushes				Non-pruned Poles			
		Healthy	Gall Infested	Diseased	Defoliated	Healthy	Gall Infested	Diseased	Defoliated
1	Malijunga	8.75±0.57	6.96±0.14	7.00±0.07	6.40±0.57	7.69±0.16	7.72±0.67	6.48±0.05	5.89±1.03
2	Koshamtondi	7.88±0.60	7.06±0.67	6.29±0.25	6.23±0.57	-	-	-	-
3	Pawani	10.50±0.71	7.31±1.13	7.10±0.14	6.75±0.35	7.28±0.55	7.39±0.41	5.69±0.31	5.15±0.21
4	Mehtakheda-2	8.58±1.41	6.90±0.14	6.97±0.14	5.90±0.14	6.60±0.18	7.20±0.28	5.22±0.18	4.90±0.21
5	Maroda	9.21±0.61	7.45±0.55	6.97±0.15	5.83±0.35	-	-	-	-
6	East Gurwada	9.19±0.78	9.14±0.25	7.49±1.56	6.76±0.68	7.40±0.62	6.93±0.70	6.73±0.10	5.81±0.14
7	Savela	8.86±0.50	7.17±0.56	6.93±0.98	7.03±0.78	7.40±0.93	6.69±0.35	6.01±0.23	6.54±0.43
	Average	7.46±1.24				6.39±0.90			



	Healthy	Gall Infested	Diseased	Defoliated
Pruned bushes	8.96	7.50	6.97	6.43
Non-pruned Poles	7.33	7.11	6.09	5.75

Fig 4: Specific leaf area of the harvested tendu leaves

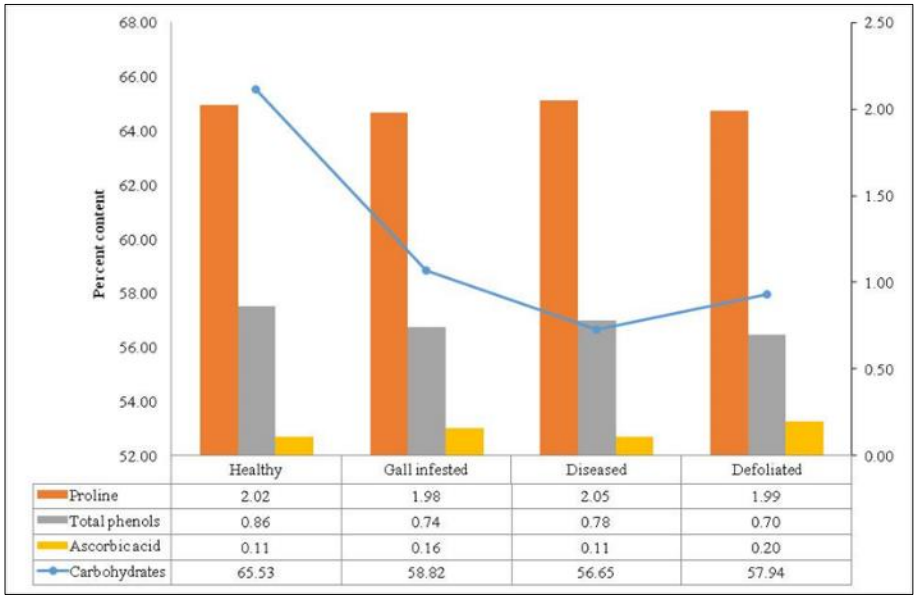


Fig 5: Estimated biochemicals in the harvested tendu leaves

The SLA of leaves collected from pruned bushes was found higher (7.46 mm^2/mg) than the leaves collected from non-pruned poles (6.39 mm^2/mg) (Table 4). Healthy tendu leaves reported higher SLA in both pruned bushes and non-pruned poles, followed by gall infested, diseased and defoliated leaves (Fig 4). SLA of the healthy leaves of pruned bushes varied from 7.88 mm^2/mg (Koshamtondi) to 10.50 mm^2/mg (Pawani), while that of non-pruned poles ranged from 6.60 mm^2/mg (Mehtakheda-2) to 7.69 mm^2/mg (Malijunga) (Table 4).

This trend of higher SLA of leaves from pruned bushes as compared to non-pruned poles suggests production of better quality than former one. The results corroborates other studies suggesting pruning in *Diospyros melanoxylon* for increasing qualitative and quantitative production of *bidi* leaves, besides providing ease during collection of the harvest (Desarkar, 1963, Luna, 2006) [5, 15].

Biochemical characteristics of the harvested tendu leaves was studied by estimating total carbohydrates, proline, phenols and ascorbic acid contents in healthy, defoliated, diseased and gall infected leaves. The average total carbohydrates content among the leaves of all groups *viz.* healthy, defoliated, diseased and gall infested was calculated to be 59.73%. Maximum carbohydrates content was reported in healthy leaves (65.53%), followed by gall infested (58.82%) and defoliated leaves (57.94%), while diseased leaves had minimum carbohydrates content (56.65%). Various authors have reported foliar diseases to readily utilise carbohydrates, reduce photosynthesis and protein synthesis, increase transpiration and respiration rates and cause cell necrosis (Husain and Kelman, 1959, Sempio, 1959, Subramanian and Saraswathi, 1959, Bollard and Matthews, 1966) [9, 21, 22, 3]. Mainer and Leath (1978) [16] also reported reduction in carbohydrate of grasses at higher levels of foliar infection and suggested that foliar infections not only lower energy content of the forage but also evidently hinders forage yield thereby increasing the dry matter.

The maximum proline (2.05%) was found in diseased leaves, followed by healthy leaves (2.02%) and minimum in gall infested leaves (1.97%). Plants accumulate an array of metabolites, particularly amino acids like proline when exposed to stressful conditions. Besides acting as an excellent osmolyte, proline plays three major roles during stress like a metal chelator, an antioxidative defence molecule and a signalling molecule. Hayat *et al.* (2012) [7] suggested in their study that a stressful environment results in an over production of proline in plants, which in turn imparts stress tolerance by maintaining cell turgor or osmotic balance.

Total phenols content was reported maximum in healthy leaves and minimum in defoliated leaves. The foliar phenols exhibit resistance against insect attack, although contradictory opinions exist regarding role of phenols in the dynamics of insect-plant interactions (Porter and Hemingway, 1989, Roychoudhury *et al.*, 1995) [19, 24]. The present study clearly suggests the allomonic effects of foliar phenols against defoliator *Hypocala rostrata* and *Trioza obsolete* responsible for gall infestation in tendu. A similar notion has also been envisaged for some other plant-host interactions (Reese, 1979, Jain *et al.*, 2000) [22, 10]. Similarly, abundance of ascorbic acid in plants influences their susceptibility to insect attack, because it is an essential dietary nutrient as an antioxidant in the insect midgut (Goggin *et al*., 2010) [6]. The present work demonstrates higher concentration of ascorbic acid in defoliated, followed by gall infested tendu leaves supporting the role of this chemical in providing susceptibility to insect feeding. The present study suggests pruning of tendu bushes to enhance production of healthy, insect attack and disease-free leaves for making *bidis* in Maharashtra and other tendu bearing states of India.

Conclusion

Tendu leaves are good source of revenue generation to the state forest departments due to their role in wrapping *bidi* or Indian cigarette and play significant role in the livelihood of tribals of central India. The study area showed greater occurrence of tendu bushes than poles. SFD controlled forests showed abundance of pruned bushes as opposed to CFR sites, where non-pruned poles were found. It is concluded from the study that traditional practices of pruning of tendu bushes contribute considerably better quality and quantity of leaves, which should continue in tendu production areas.

Acknowledgement

The authors are grateful to Maharashtra State Forest Department for providing financial assistance to carry out the study. We are thankful to Director and Group Coordinator

(Research) of Tropical Forest Research Institute (TFRI), Jabalpur for their valuable guidance and continuous support. Thanks are also due to the scientists and technical staff of Forest Ecology and Climate Change Division of TFRI Jabalpur for regular collection of data from the field and analysis of samples in laboratories.

References

1. Bates LS, Waldren RP, Teare ID. Rapid determination of free proline for water stress studies. Plant Soil. 1973; 39:205-207.
2. Bhattacharya P. Tendu Leaves (*Diospyrous melanoxylon*). NTFP enterprise and forest governance. Centre for People's Forestry, 2008.
3. Bollard EG, Matthews REF. The physiology of parasitic disease. Plant physiology a treatise. Vol. 4B, Steward, FC, Ed. Academic Press, New York, 1966, 417-550.
4. Broome NP, Ajit S. Citizens Report on promise and performance: Ten Years of the Forest Rights Act in Maharashtra. CFR learning and advocacy group Maharashtra, 2017, 44.
5. Desarkar BK. A note on *bidi* leaf (*Diospyros melanoxylon*). Indian Forester. 1963; 89:39-45.
6. Goggin L, Avila C, Lorence A. Vitamin C content in plants is modified by insects and influences susceptibility to herbivory. Bio Essays. 2010; 32(9):777-790.
7. Hayat S, Hayat Q, Alyemeni MN, Wani AS, Pichtel J, Ahmad A. Role of proline under changing environments: a review. Plant signalling and behaviour. 2012; 7(11):1456-1466.
8. Hedge JE, Hofreiter BT. Carbohydrate chemistry 17. Whistler R, Be Miller JN, Eds., Academic Press, New York, 1962.
9. Husain A, Kelman A. Tissue is disintegrated. Plant pathology, and advanced treatise. Horsfall JG, Dimond AE Ed., Academic Press, New York, 1959, I:143-188.
10. Jain A, Roychoudhury N, Bhargava A. Role of foliar protein and polyphenol and their relationship to clonal resistance in teak against the leaf skeletonizer, *Paliga machoeralis* Walker (Lepidoptera: Pyralidae). Journal of Tropical Forest Science. 2000; 12(2):221-226.
11. Kerketta JK, Singh S, Kumar B. Effect of silvicultural treatments on quantity and quality assessment of Tendu (*Diospyros melanoxylon* Roxb.) leaves. Journal of Pharmacognosy and Phytochemistry. 2018; SP1:1317-1322.
12. Kukreti JI. Not a minor lapse. Down To Earth, 2017.
13. Kumar K, Singh NM, Rao YG. Promise and performance of the Forest Rights Act - A ten-year review. Economic and Political Weekly. 2017; 52:25-26.
14. Kumar S, Lalji P, Khan HR. Bionomics and control of tendu defoliator *Hypocala rostrata* L. (Lepidoptera: Noctuidae). Indian Forester. 1989; 115(1):258-263.
15. Luna RK. Tending operations. Plantation in Forestry. International Book Distributors, Dehradun, 2006, 266.
16. Mainer A, Leath KT. Foliar diseases alter carbohydrate and protein levels in leaves of alfalfa and orchard grass. Phytopathology. 1978; 68:1252-1255.
17. Malik EP, Singh MB. Plant Enzymology and Hittoenzymology. Edn 1, Kalyani Publishers: New Delhi, 1980, 286.
18. Orwa C, Mutua A, Kindt R, Jamnadass R, Anthony S. *Diospyrous melanoxylon*. Agroforestree Database: A tree reference and selection guide version 4.0, 2009.
19. Porter LJ, Hemingway RW. Significance of the Condensed Tannins. Natural Products of Woody Plants. Rowe JW, Ed. Springer Series in Wood Science. Springer, Berlin, Heidelberg, 1989.
20. Roe B, Bruemmer JH. Estimation of ascorbic acid in orange juice by a chronometric method. Proceedings of the Florida State Horticultural Society. 1974; 87:210-213.
21. Sempio C. The host is starved. Plant pathology, and advanced treatise. Horsfall JG, Dimond AE Ed. Academic Press, New York, 1959; I:277-312.
22. Subramanian D, Saraswathi D. Water is deficient. Plant pathology, and advanced treatise. Horsfall JG, Dimond AE, Ed. Academic Press, New York, 1959; I:313-348.
23. Reese JC. Interactions of allelochemicals with nutrients in herbivore food. Herbivores: Their Interactions with Secondary Plant Metabolites. Rosenthal GA, Janzen DH, Eds. Academic Press, New York, 1979, 309-330.
24. Roychoudhury N, Jain A, Joshi KC. Alteration of growth and development in leaf skeletonizer, *Eutectona machaeralis* Walker, due to variations in teak leaves of different maturity. Indian Journal of Experimental Biology. 1995; 33(3):227-229.