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Heading Back and Pinching Affects the Biochemical and Physiological Parameters of Annual Moringa cv. PKM-1 Leaves

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A trial was conducted to assess the physiological and biochemical changes in *M. oleifera* (L.) Millsp.cv. PKM 1 induced by heading back and pinching treatments. Chlorophyll content, nitrate reductase content, soluble protein content and total phenol content were assessed after the new shoot initiated from heading back and pruning treatments before the flower initiation. Height and

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stage at which the apical growth was arrested significantly influenced chlorophyll, nitrate reductase, protein and phenol content in leaves. Heading back at 70 cm combined with pinching 100 days after heading back greatly influenced the physiological and biochemical factors except for soluble protein as it was increased by heading back at 30 cm.

Keywords: Moringa oleifera (L.) Millsp.; pruning, chlorophyll; nitrate reductase; soluble protein; phenols.

1. INTRODUCTION

Moringa (*Moringa oleifera* (L.) Millsp.), an indigenous vegetable of India is widely distributed in most tropical countries. Moringa is rightly termed as a 'miracle tree' of significant socio-economic importance due to several nutritional, pharmacological, and industrial applications. Moringa is adaptable in nature owing to its tuberous roots [1]. This tree as a whole is useful for nutraceuticals, medicinal, water purification, biodiesel production and functional food preparations [2]. For centuries moringa has been recognized for its contribution to traditional medicine. It plays a precise role in the maintenance of the cardiovascular system, blood-glucose level as well as a supplement of anti-oxidants and so on [3]. It is a rich source of alkaloids, flavonoids, phenolic compounds, vitamins, minerals, organic acids and phytosterols. As a reservoir of nutrients and nutraceuticals moringa can reduce malnutrition [4].

Canopy in a tree refers to its physical composition including stem, branches, shoots and leaves. The canopy density is determined by the number and size of the leaves, architecture of stem, branches and shoots. Canopy management of a tree deals with the development and maintenance of its structure concerning the size and shape for maximum productivity and quality [5]. The main objective of canopy management in a tree is to make the best use of the land and microclimate to increase productivity. Tree vigor, light, temperature and humidity play a vital role in the production and quality of fruits. The size, shape and volume of the canopy are affected by climate, planting density, rootstock, method of propagation, training, pruning, the regularity of bearing, soil type, nutrition, irrigation, intercrop, growth regulators used, diseases, pests, environmental pollution, *etc*., [6].

Canopy architecture is a natural expression of the genetic make-up of a tree. Genotypes vary in canopy size and shape. However, the size and shape of the canopy may also be manipulated in several ways [7]. Heading back and pruning can be used, so that canopy structure can be modified to get a balanced structure with increased yield and quality. The removal of plant parts induces various biochemical and physiological changes. Heading back and pinching induced changes were studied in the annual moringa cv. PKM-1.

2. MATERIALS AND METHODS

The trial was conducted at the Department of Vegetable Science, Horticultural College and Research, Periyakulam, during 2018-19. The experiment was laid out in split-plot design with two replications. Seeds of annual moringa cv. PKM-1 were sown in an area of 0.63 acres with a spacing of 3 m x 3m. The main plot was imposed with heading back treatment and the sub-plot was with pinching treatments. The main-plot treatments include heading back at 30 cm (M_1), 50 cm (M_2) and 70 cm (M_3) above the ground level whereas the sub-plot treatments were control (no pinching S_1), pinching at 60 days (S_2), 80 days (S_3) and 100 days (S_4) after heading back.

The chlorophyll content, Nitrate reductase activity, soluble protein and phenol content of leaves were assessed at the vegetative stage after the completion of heading back and pinching treatments. The leaves were collected from five randomly selected trees in each replication and used for analysis. Chlorophyll 'a', 'b' and total chlorophyll content were estimated spectrophotometrically using the procedure described by Yoshida et al. [8]. The chlorophyll content was expressed in mg/g of leaf (on fresh weight basis). The nitrate reductase activity was estimated following the method proposed by Sinha and Nicholas [9]. The enzyme activity was expressed as μg NO_2^{-1} g^{-1} h^{-1} on a wet weight basis. The soluble protein content was estimated ensuring the methodology described by Lowry et al. [10]. The mean value was expressed as mg per gram on a net weight basis. The total phenol content was estimated using the

procedure proposed by Bray and Thorpe [11]. The mean was computed and expressed as mg gram^{-1}. The data obtained were statistically analysed as per the methods of Panse and Sukhatme [12] using agres statistical software.

3. RESULTS AND DISCUSSION

3.1 Chlorophyll Content

The chlorophyll content is the most important physiological parameter which decides the photosynthetic activity. Chlorophyll 'a', chlorophyll 'b' and total chlorophyll content were highest in heading back at 70 cm (M_3), pinching at 100 days (S_4) after heading back and they were statistically different from other treatments (Table 1.). In the interaction M_3S_4 was significantly different from others except in total chlorophyll it was on par with M_3S_3. The removal of the growing point stimulates the photosynthetic activity of the leaves. This effect has resulted in the enlargement of mesophyll cell size, increase in chlorophyll content and lengthening stomal opening period by increasing leaf water content [13]. Pruning increases chlorophyll content according to the findings of Lal et al. [14] in guava; Hesami et al. [15] in tomato; Sharma and Singh [16] in mango.

Table 1. Effect of heading back and pinching on chlorophyll content of leaves

Chlorophyll 'a' (mg g^{-1})					
Treatments	**S_1**	**S_2**	**S_3**	**S_4**	**Mean**
M1	1.53	1.73	1.72	1.67	1.66
M2	1.44	1.70	1.64	1.70	1.62
M3	1.56	1.67	1.78	1.86	1.72
MEAN	1.53	1.73	1.72	1.75	1.67
				SE(d)	**CD @ 5%**
M – Main plot				0.006	0.027
S – Sub plot				0.010	0.022
M @S				0.016	0.041
S @ M				0.017	0.038
Chlorophyll 'b' (mg g^{-1})					
Treatments	**S_1**	**S_2**	**S_3**	**S_4**	**Mean**
M1	0.55	0.54	0.51	0.47	0.52
M2	0.48	0.50	0.39	0.52	0.47
M3	0.49	0.46	0.57	0.66	0.54
MEAN	0.51	0.50	0.49	0.55	0.51
				SE(d)	**CD @ 5%**
M – Main plot				0.009	0.038
S – Sub plot				0.008	0.018
M @S				0.015	0.044
S @ M				0.013	0.031
Total Chlorophyll (mg g^{-1})					
Treatments	**S_1**	**S_2**	**S_3**	**S_4**	**Mean**
M1	1.96	2.19	2.13	2.02	2.07
M2	1.90	2.07	1.93	2.14	2.01
M3	1.90	1.99	2.27	2.30	2.11
MEAN	1.92	2.08	2.11	2.15	2.07
				SE(d)	**CD @ 5%**
M – Main plot				0.005	0.022
S – Sub plot				0.014	0.033
M @S				0.022	0.053
S @ M				0.025	0.056

Table 2. Effect of heading back and pinching on Nitrate reductase ($NO_2^{-1}g^{-1}h^{-1}$) content of leaves

Treatments	S_1	S_2	S_3	S_4	Mean
M1	6.51	6.15	7.45	9.45	7.39
M2	8.79	8.27	7.36	8.27	8.17
M3	6.51	7.99	9.89	9.59	8.50
MEAN	7.27	7.47	8.23	9.10	8.02
				SE(d)	**CD @ 5%**
M – Main plot				0.026	0.111
S – Sub plot				0.029	0.066
M @S				0.051	0.142
S @ M				0.051	0.115

Table 3. Effect of heading back and pinching on soluble protein (mg 100 g^{-1}) content of leaves

Treatments	S_1	S_2	S_3	S_4	Mean
M1	11.07	12.96	12.13	11.71	11.97
M2	11.28	11.30	12.32	12.39	11.82
M3	10.91	11.69	12.13	12.79	11.88
MEAN	11.09	11.98	12.19	12.30	11.89
				SE(d)	**CD @ 5%**
M – Main plot				0.009	0.039
S – Sub plot				0.022	0.050
M @S				0.035	0.083
S @ M				0.039	0.087

Table 4. Effect of heading back and pinching on Phenol (mg g^{-1}) content of leaves

Treatments	S_1	S_2	S_3	S_4	Mean
M1	0.160	0.260	0.160	0.151	0.183
M2	0.201	0.211	0.279	0.229	0.230
M3	0.239	0.279	0.251	0.211	0.245
MEAN	0.200	0.250	0.230	0.197	0.219
				SE(d)	**CD @ 5%**
M – Main plot				0.006	0.024
S – Sub plot				0.009	0.020
M @S				0.015	0.038
S @ M				0.016	0.035

3.2 Nitrate Reductase

Nitrate reductase plays a significant role in the reduction of nitrate to nitrite and in triggering root architecture remodeling. Nitrate assimilation is greatly influenced by light perception [17]. In the present study, NR-ase was found to be higher in heading back at 70 cm (M_3) and pinching at 100 days (S_4) after heading back also in the combination of pinching at 80 days (S_3) after heading back at 70 cm (Table 2.). Those treatments were significantly different from other treatments. This might be because, well-established lateral branches in headed back and pinched trees promotes increased perception of light by phytochromes. Also, the level of auxin and cytokinin decides the NR-ase activity in crops. Soares et al. [18] reported that increased cytokinin synthesis promoted nitrate reductase activity in soybean. Increased auxin content also promotes nitrate reductase enzyme production according to Anbarasu [19] in annual moringa and Joshi et al. [20].

3.3 Soluble Protein Content

In the present study heading back at 30 cm (M_1), pinching at 100 days (S_4) after heading back and in the combination of heading back at 30 cm (M_1) with pinching at 60 days (S_2) after heading back showed the highest soluble protein content and those treatments were significantly different from

other treatments (Table 3). Photosynthetic efficiency of a crop can be indexed with RUBP carboxylase activity. RUBP carboxylase activity is measured considering the amount of protein in plants [21,22]. RUBISCO protein is the most abundant protein in leaves. Fifty percent of the leaf protein goes to RUBISCO. The level of nitrogen in plants also determines the availability of soluble protein in leaves. Pinching mainly affects nitro genre distribution resulting from the removal of nitrogen demanding shoot tops. This accumulation of nitrogen increased RUBISCO protein synthesis (Yamashita, 1998). The results are in line up with the findings of Devi [23] in annual moringa cv. PKM 2 and Kalicharan [24] in annual moringa cv. PKM 1.

3.4 Total Phenols

Heading back at 70 cm (M_3), pinching at 60 days (S_2) after heading back and the interaction effect of heading back at 70 cm (M_3) with pinching at 60 days (S_2) on annual moringa cv. PKM-1 showed the highest phenol content in leaves (Table 4.). Interactions such as M_2S_3(heading back at 50 cm with pinching at 80 days), M_3S_2 (heading back at 70 cm with pinching at 60 days)and M_1S_2(heading back at 30 cm with pinching at 60 days)were statistically on par with M_3S_2. Phenolic compounds directly influence the metabolism, growth and development in plants [25]. They act as physiologically active compounds, attractants, feeding deterrents, stress protecting agents and resistance to pathogens [26]. The phenolic content in plants may be influenced by environmental stresses and cultivational techniques. The pruned trees had a higher amount of IAA and lower IAA oxidase which may favour phenol content accumulation [27,28]. The intensity of pruning also decides the amount of phenol accumulation. The wound created by pruning cut activates the defense mechanism of a plant by which phenolic content along with polyphenol oxidase will be increased in trees [29]. A similar finding was also observed by Sanjay et al. [30] in mango.

4. CONCLUSION

Less intensive heading back (M_3) and pruning (S_3 and S_4) positively influenced the growth and development of moringa by promoting physiological parameters such as chlorophyll content and nitrate reductase, whereas intensive heading back at 30 cm above the ground level favours the protein content. Hence heading back at 30 cm and 70 cm followed by pinching at 100 days can be adopted to increase the quality of moringa cv. PKM-1 leaves.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Padayachee B, Baijnath H. An overview of the medicinal importance of *Moringaceae*. J Med Plants Res. 2012;6:5831–5839.
2. Saini RK, Sivanesa I, Keum YS. Phytochemicals of *Moringa oleifera*: A review of their nutritional, therapeutic and industrial significance. Biotech. 2016;6: 203.
3. Meireles D, Gomes J, Lopes L, Hinzmann M, Machado J. A review of properties, nutritional and pharmaceutical applications of *Moringa oleifera:* Integrative approach on conventional and traditional Asian medicine. Advances in Traditional Medicine; 2020.
4. Kunyanga CN, Imungi JK, Vellingiri V. Nutritional evaluationof indigenous foods with potential food-based solution to alleviate hunger and malnutrition in Kenya. J Appl Biosci. 2013;67:5277–5288.
5. Smart RE, Dick JK, Gravett IM, Fisher BM. Canopy management to improve grape yield and wine quality: Principles and practices. South African Journal of Enological Viticulture. 1990;11:3-17.
6. Vandana SPS Solanki, Lamo K. Canopy management: way to develop fruit tree Architecture. Biomolecule Reports; 2017.
7. Singh G. Practical manual on canopy management in fruit crops. Department of Agriculture & Cooperation, Ministry of Agriculture, Govt. of India, New Delhi-110001; 2010.
8. Yoshida S, Forno DA, Cock JH. Laboratory manual for physiological studies of rice. IRRI, Philippines. 1971;36-37.
9. Sinha SK, Nicholas JD. Nitrate Reductase in relation to drought. In: Physiology and Biochemistry of Drought Resistance. (Ed. By Paleg LG, Aspinall D). Academic Press, Sydney. 1981;145-169.
10. Lowry OH, Rose Brough NJ, Farr LA, Randall RJ. Protein measurement with folin phenol reagent. J. Biol. Chem. 1951; 193:265-275.
11. Bray HG, Thorpe WV. Analysis of phenolic compounds of interest in metabolism.

Methods of Biochemical Analysis. 1954;52: 1-27.

12. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. Published by Indian Council of Agricultural Research. New Delhi. 2000;1967;166-175.
13. Mika A. Physiological responses of fruit trees to pruning. Horticultural reviews. 1986;8(9):337-378.
14. Lal S, Tiwari JP, Mishra KK. Effect of plant spacing and pruning intensity on fruit yield and quality of guava. Progressive Horticulture. 32(1):20-25.
15. Hesami A, Sarikhani S, Hosseini SS. Effect of Shoot Pruning and Flower Thinning on Quality and Quantity of Semi-Determinate Tomato (*Lycopersicon esculentum* Mill.). Not Sci Biol. 2012;4(1): 108-111.
16. Sharma RR, Singh R. Effect of pruning intensity on light penetration and leaf physiology in Amrapali mango trees under high-density planting. Tropical Science. 2006;46(1):16-19.
17. Mohr H, Neininger A, Seith B. Control of nitrate reductase and nitrite reductase gene expression by light, nitrate and a plastidic factor. Botanica Acta. 1992; 105(2).
18. Soares LH, Neto DD, Fagan EB, Teixeira WF, Pereira IS. Physiological, phenometric and productive changes in soybean crop due to the use of kinetin. Pesq. Agropec. Trop. 2012;47(1):80-86.
19. Anbarasu R. Induction of off-season production in annual moringa cv. PKM 1. M.Sc., (Hort.) thesis submitted to Horticultural College and Research Institute, Tamil Nadu Agricultural University, Periyakulam; 2009.
20. Joshi G, Shukla A, Shukla A. Synergistic response of auxin and ethylene on physiology of *Jatropha curcas* L. Braz. J. Plant Physiol. 2011;23(1):67-77.
21. Puri S, Verma RC. Mass propagation of Dalbergia sisoo by cuttings- Factors affecting the rooting of cuttings. Intl. Tree Crops J. 1995;8:151-161.
22. Senthil A. Influence of PGRs, chemicals and *Azospirillum* on rooting in rice seedlings (*Oryza sativa* L.) and effect on growth and yield. M.Sc. (Ag.) thesis submitted to TNAU, Coimbatore; 1998.
23. Devi C. Studies on influence of plant density and pinching on growth, yield and quality of annual moringa (*Moringa pterygosperma* Gaertn.) cv. PKM2. M.Sc. thesis submitted to Horticultural College and Research Institute, Tamil Nadu Agricultural University, Periyakulam; 2003.
24. Kalicharan E. Studies on off season production in moringa (*Moringa oleifera* Lam.) PKM1. M.Sc. (Hort.) thesis submitted to Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore; 2012.
25. Kozlowski TT, Pallardy SG. Physiology of woody plants. 2nd ed. Academic Press, San Diego, CA. 1997;411.
26. Treutter D. Significance of flavonoids in plant resistance and enhancement of their biosynthesis. Plant Biol. 2005;7:581-591.
27. Murti GSR, Upreti KK. Endogenous hormones and phenols in rootstock seedling of mango cultivars and their relationship with seedling vigour. European Journal of Horticultural Science. 2003;68: 2-7.
28. Singh SK, Singh SK, Sharma RR. Endogenous phytohormones after pruning in three mango cultivars planted under high density. Indian Journal of Plant Physiology. 2009;14:392-396.
29. Bagchi TB, Sukul P, Ghosh B. Biochemical changes during off-season flowering in guava (*Psidium gujava* L.) induced by bending and pruning. Journal of Tropical Agriculture. 2008;46(1-2):64-66.
30. Sanjay KS, Sanjay KS, Ram RS. Effects of pruning intensity on the biochemical status of shoot buds in three mango (*Mangifera indica* L.) cultivars planted at high density. Journal of Horticultural Science & Biotechnology. 2010l85(6):483-490.

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