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Effect of different planting density on leaf yield and quality of moringa (*Moringa oliefera* Lam.)

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ABSTRACT : The present study effect of different planting density on leaf yield and quality in leaf production of moringa (*Moringa oleifera* Lam.) was carried out during (Feb. - Dec.) 2015-16 in the vegetable field unit, Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar. The treatment consisted of five different planting density *viz.*, T_1 (45 x 45 cm), T_2 (60 x 60 cm), T_3 (75 x 75 cm), T_4 (90 x 90 cm) and T_5 (120 x 120 cm). Observations on growth and yield characters were recorded at 35 days interval and totally eight harvest were made during the study period. The treatment T_5 (120 x120 cm) recorded highest value for leaf weight, herbage yield per plant and chlorophyll content.

KEY WORDS : Leaf weight, Chlorophyll, Leaf yield/plot, Leaf yield/ha

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The genus *Moringa* consists of 13 species but the most popular and cultivated type is *Moringa oleifera*, which is spread over in tropical and sub-tropical regions and adapt well in the different soils and adjust well even in marginal conditions. Incredible ability of moringa to survive harsh weather and even drought has made this crop a wider adaptability in varying situations. Besides India, it is grown in Africa, Sri Lanka, Mexico, Malaysia and Philippines (Dillard and German, 2000). The leaves are the most nutritious part of the plant, being a significant source of B vitamins, vitamin C, provitamin A as beta-carotene, vitamin K, manganese, and protein, among other essential nutrients (Rajkumar *et al.*, 1973).

RESEARCH METHODS

The present investigation on the effect of different planting density on leaf yield and quality in leaf production of moringa (*Moringa oleifera* Lam.) was carried out at the vegetable unit of the Department of Horticulture, Faculty of Agriculture, Annamalai University during 2015-16. The treatment consisted of five different planting density *viz.*, T_1 (45 x 45cm), T_2 (60 x 60cm), T_3 (75 x 75cm), T_4 (90x 90cm) and T_5 (120 x120cm). The experiment was laid out in Randomized Block Design with five treatments and four replications. Observations on growth parameters were recorded on 35 days intervals starting from 70 days after sowing and totally seven harvest were made during the study period. Observations were recorded on leaf weight, herbage yield per plant and chlorophyll content. Ten well matured compound leaves were snapped from the branches of tagged plants from each treatment and weighed in an electronic weighing balance. The leaf weight was expressed in gram. Regarding the herbage yield per plant, the green leaves were harvested at every 35 days interval by giving a cut at a distance of 60 cm above ground. At each harvest, the weight of herbage was observed using a weighing balance. The average herbage yield plant^{-1} was worked out and expressed in gram.

The total chlorophyll content was determined by following the procedure of Arnon (1949) and expressed

in mg per gram of fresh leaf sample.

$$\text{Total chlorophyll (mg g}^{-1}) = \frac{20.2 \times A_{645} + 8.02 \times A_{663} \times V}{1000 \times W}$$

where,

A = Absorbance at specific wave lengths (645 and 663 nm)

V = Final volume of chlorophyll extracted in 80 per cent acetone

W = Fresh weight of leaf sample extracted.

The statistical analysis of data were done by adopting the standard statistical procedures given by Panse and Sukhatme (1985). Te critical difference was worked out for 5 per cent level of significance. The IRRISTAT software was used for the statistical analysis of data.

RESEARCH FINDINGS AND DISCUSSION

The data recorded on leaf weight at eight stages of evaluation (35, 70, 105, 140, 175, 210, 245, 280) days after planting are furnished in the Table 1 which showed significant variation for the trait among different accessions. The treatment T_5 (120 x 120cm) recorded the highest leaf weight of 46.30, 53.45, 56.90, 57.85, 59.35, 61.80, 63.85 and 67.30 (g) at 35, 70, 105, 140, 175, 210, 245 and 280 days after planting, respectively. T_1 (45 x 45 cm) recorded the least leaf weight of 31.13, 36.05, 37.05, 38.93, 42.25, 43.85, 45.30 and 46.85 (g), respectively over the stages of evaluation. The leaf weight in different treatments showed an increasing trend over the stages of evaluation. Regarding herbage yield per plant, the treatment T_5 (120 x 120 cm) recorded the highest herbage yield per plant of 124.00, 178.98, 216.03, 242.40, 241.92, 234.19, 233.20 and 231.62 (g) at 35, 70, 105, 140, 175, 210, 245 and 280 days after planting, respectively. It was followed by T_4 (90 x 90cm) which recorded 115.63, 145.95, 195.60, 215.15, 231.44, 216.09, 203.11 and 214.39 (g) at 35, 70, 105, 140, 175, 210, 245 and 280 DAP, respectively. T_1 (45 x 45 cm) recorded the least herbage yield per plant of 89.40, 98.10, 116.15, 124.50, 161.96, 161.08, 157.73 and 159.91 (g), respectively over the stages of evaluation (Table 2). In this study, leaves were harvested at an interval of 35 days, harvesting at subsequent intervals will promote the development of new shoots. Subsequent harvesting can be done at every 35-40 days. The results are in confirmity with the finding of Amaglo (2006) and Isah *et al.* (2015).

The highest herbage yield plant^{-1} was observed in the treatment T_5 (120 x 120cm) 242.40 g followed by T_4 (90 x 90 cm) which recorded 231.44g. In the present investigation, evaluation of five treatments based on the herbage yield showed that the highest herbage yield plant^{-1} was obtained in 120 x120 cm wider spacing. Since the leaves were harvested at 35 days interval, plants at closer spacing had less reserves. The results are in agreement with the finding of Lavanya *et al.* (2014) in radish; Choudhari and Choudhary, (2013) in *Artemisia annua* and Kaium *et al.* (2015). The increase in growth and yield under wider spacing is due the fact that more space is available for vegetative growth and less competition for nutrients, sunlight and aeration. Similar results were reported by Mane *et al.* (2008) in palak who also reported higher green yield under wider spacing.

The data recorded on total chlorophyll content at eight stages of evaluation (35, 70, 105, 140, 175, 210, 245, 270) days after planting are furnished in the Table 3 which showed significant variation for the trait among different treatments. The treatment T_5 (120 x 120cm) recorded the highest total chlorophyll content of 20.60, 20.57, 20.54, 20.37, 20.24, 20.44, 20.42 and 20.34 (mg g^{-1}) at 35, 70, 105, 140, 175, 210, 245 and 270 days after planting, respectively. It was followed by T_4 (90 x 90cm) which recorded 19.18, 19.56, 19.78, 18.93, 18.79, 18.73, 18.85 and 18.81 (mg g^{-1}) at 35, 70, 105, 140, 175, 210, 245 and 270 DAP, respectively. T_1 (45 x 45 cm) recorded the least total chlorophyll content

Table 1 : Effect of various spacing levels on leaf weight (g) in moringa cv. PKM-1

Treatment number	Leaf weight (g)							
	35 DAP	70 DAP	105 DAP	140 DAP	175 DAP	210 DAP	245 DAP	280 DAP
T_1 - 45 x 45	31.13	36.05	37.05	38.93	42.25	43.85	45.30	46.85
T_2 - 60 x 60	34.15	38.50	41.33	43.90	45.53	45.95	47.60	49.50
T_3 - 75 x 75	37.73	42.93	45.55	46.15	49.58	49.78	51.15	53.35
T_4 - 90 x 90	42.58	48.23	50.65	52.80	55.00	55.65	55.65	58.70
T_5 – 120 x120	46.30	53.45	56.90	57.85	59.35	61.80	63.85	67.30
Grand mean	38.38	43.83	46.30	47.93	50.34	51.41	52.71	55.14
S.E.±	0.64	0.40	0.35	1.16	0.50	0.40	0.37	0.34

Table 2 : Effect of various spacing levels on herbage yield per plant (g) in moringa cv. PKM-1

Treatment number	Herbage yield per plant (g)							
	35 DAP	70 DAP	105 DAP	140 DAP	175 DAP	210 DAP	245 DAP	280 DAP
T_1 - 45 x 45	89.40	98.10	116.15	124.50	161.96	161.08	157.73	159.91
T_2 - 60 x 60	96.15	107.15	141.85	156.95	189.75	189.26	182.55	184.24
T_3 - 75 x 75	108.00	127.08	172.15	178.35	218.24	199.89	188.17	193.28
T_4 - 90 x 90	115.63	145.95	195.60	215.15	231.44	216.09	203.11	214.39
T_5 - 120x120	124.00	178.98	216.03	242.40	241.92	234.19	233.20	231.62
Grand mean	106.64	131.45	168.36	183.47	208.66	200.10	192.95	196.69
S.E.±	1.12	1.77	3.01	3.74	3.34	5.20	4.72	3.50
C.D. (P=0.05)	2.43	3.85	6.55	8.16	7.27	11.32	10.27	7.64

Table 3 : Effect of various spacing levels on total chlorophyll content (mg g^{-1}) in moringa cv. PKM-1

Treatment number	Total chlorophyll content (mg g^{-1})							
	35 DAP	70 DAP	105 DAP	140 DAP	175 DAP	210 DAP	245 DAP	280 DAP
T_1 - 45 x 45	15.77	15.97	15.37	15.34	16.47	15.88	15.68	15.82
T_2 - 60 x 60	17.37	17.36	16.95	16.79	16.96	16.82	16.83	16.82
T_3 - 75 x 75	18.41	18.72	18.26	17.92	17.96	17.86	17.88	17.84
T_4 - 90 x 90	19.18	19.56	19.78	18.93	18.79	18.73	18.85	18.81
T_5 - 120x120	20.60	20.57	20.54	20.37	20.24	20.44	20.42	20.34
Grand mean	18.27	18.44	18.17	17.87	18.08	17.94	17.93	17.92
S.E.±	0.12	0.06	0.05	0.14	0.10	0.12	0.14	0.11
C.D. (P=0.05)	0.25	0.13	0.11	0.30	0.23	0.27	0.16	0.23

of 15.77, 15.97, 15.37, 15.34, 16.47, 15.88, 15.68 and 15.82 (mg g^{-1}), respectively over the stages of evaluation. The total chlorophyll content in different treatments showed an increasing trend over the stages of evaluation.

The treatment (T_5) 120 x120 cm recorded higher values for chlorophyll content though, the leaves under close planting looked dark green and thick, they lacked chlorophyll and thus were less productive. These results are in agreement with the finding of Lavanya *et al*. (2014). Based on the results of the present experiment, a spacing of 120 x 120 cm is recommended for maximizing leaf production of moringa cv. PKM-1.

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