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Cutting Management and Application of Bio-Stimulants on Leaf Yield and Quality of Curry Leaf (*Murraya koenigii* Spreng.)

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A B S T R A C T

An experiment was conducted to cutting management and application of bio-stimulants on leaf yield and quality of curry leaf (*Murraya koenigii* Spreng.) during the period from 2015 to 2017. Biometrical observations were recorded from randomly selected five plants and the data were subjected to statistical analysis. The results have shown that among the harvesting techniques and bio-stimulants the highest growth characters *viz.*, plant height (127.84 cm and 124.78 cm at first and second harvest) and number of secondary branches (7.01 and 13.67 at first and second harvest). It was also observed that yield characters viz., leaf yield per plant (643.50 g and 714.21 g at first and second harvest), leaf yield per hectare (4468.46 kg and 4959.47 kg at first and second harvest), leaf nitrogen (1.36 and 1.61 per cent of leaf nitrogen at first and second harvest), leaf phosphorous (0.56 and 0.64 per cent at first and second harvest) and leaf potassium (2.74 and 3.05 per cent at first and second harvest).

Introduction

Curry leaf (*Murraya koenigii S*preng.) is a perennial herbal spice crop grown for its aromatic leaves. Besides, being a spice crop curry leaf plays a major role in the Ayurveda and Unani systems of medicine due to its wide range of medicinal properties. Fresh leaves of curry leaves on distillation give a yellow coloured volatile oil with a strong spicy, odoured, pungent and clove like taste. The essential oil has very good antibacterial and antifungal activity. There is less production of fresh curry leaves during winter season due to unfavourable environmental conditions especially due to low temperature. During that time curry leaf fetches very high market price. Hence, there is a need to promote the production of this crop during winter season to get more profit. It would not only improve the supply of fresh curry leaf but also help the growers to get high profit during the winter months.

In dill, Waldemar Kmiecik *et al.*, (2005) observed maximum leaf blade length (97.0 cm), leaf petiole (44.5 cm) and total yield (423.0 kg per ha) and marketable yield (408.0 kg per ha) when the plants were pruned at in 60 cm height. In *Cymbopogon flexuosus*,

longer intervals between cuts generated more dry mass accumulated throughout the cultivation cycle. The dry mass of the aerial part was found to be 329. 04 g per plant during 40 days of cut while the dry mass was recorded as 704.16 g per plant during 100 days of aerial cut (Andre May *et al.*, 2008). In lettuce, Zakaria Fouad Fawzy (2010) reported that the highest amount of humic acid sprayed @ 4 ml per litre was found to improve the growth, yield and quality.

Materials and Methods

An experiment consists of sixteen treatment combinations of two level of harvest height (L_1-15 cm and L_2-30 cm), two harvest intervals (H_1-2 months and H_2-3 months) and four levels of bio-stimulants (N_1-0.25 per cent $ZnSO_4$, N_2-0.25 per cent $FeSO_4$, N_3-2 per cent seaweed extract and N_4-0.3 per cent humic acid) were allocated in split-split plot design replicated three times. Biometrical observations *viz.*, leaf yield per plant (g) estimated leaf yield per hectare (kg), leaf nitrogen (per cent), leaf phosphorous (per cent) and leaf potassium (per cent) were taken from each treatment and replication. The data were subjected to statistical analysis as suggested by Panse and Sukhatme, 1985.

Results and Discussion

Effect of harvesting techniques and bio-stimulants on leaf yield and estimated leaf yield

Among the two harvest heights, the treatment L_2 (30 cm harvest height) recorded the higher green leaf yield (517.65 g and 576.16 g per plant at first harvest and second harvest and estimated green leaf yield of 3594.54 and 4000.87 kg per hectare at first harvest and second harvest respectively)**.** When treatments of harvest intervals are compared the treatment H_2 (three months harvest intervals) recorded higher green leaf yield (605.08 g and 653.60 g per plant at first harvest and second harvest and estimated leaf yield of 4201.65 kg and 4538.61 kg per hectare at first harvest and second harvest respectively).The higher green leaf yield (548.46 g and 612.35 g per plant at first harvest and second harvest and estimated green leaf yield of 3808.51 kg and 4252.14 kg per hectare at first harvest and second harvest respectively) were recorded by the treatment N_4 (0.3 per cent of humic acid). From the results it was noticed that different types of harvesting had significant influence on green leaf yield per plant and estimated green leaf yield per hectare of curry leaf. Increased green leaf yield was recorded by higher harvest height of 30 cm above the ground level (L_2). The green leaf yield was comparatively low in the lower harvest height (L_1- 15 cmharvest height) as a result of lower plant height, less number of branches and lesser spread of the plant canopy. This was in line with the findings of Mohammed Saifueddin *et al.*, (2010) in Bougainivillea. In cucumber, Rauthan and Schnttzer (1981) proved that application of humic acid had improved the growth of foliage and roots by increased cell elongation and increased water uptake by increased plant roots as well as root systems and increased nutrients uptake, increased leaf surface area.

The interaction effect of harvest height and harvest interval was compared and the higher green leaf yield values of 612.07g and 664.97 g per plant at first and second harvest and estimated green leaf yield value of 4250.20 kg and 4617.58 kg per hectare at first harvest and second harvest respectively was recorded by the treatment L_2H_2 (30 cm harvest height and three months harvest intervals). The higher green leaf yield values of 550.94 g per plant at first harvest and 621.02 g per plant at second harvest and estimated leaf yield of 3825.69 kg at first harvest and4312.33 kg at

second harvest were registered by the treatment L_2N_4 (30 cm harvest height with 0.3 per cent of humic acid).The treatment H_2N_4 (three month harvest interval + 0.3 per cent of humic acid) registered the highest green leaf yield of 642.02 g and 700.87 g per plant at first harvest and second harvest and estimated green leaf yield of 4458.15 kg and 4866.81 kg per hectare at first harvest and second harvest respectively. It was also understood that interception of maximum light would had also increased photosynthetic activities and resulted in higher availability of net photosynthates which enabled the plants to produce higher green leaf yield. Further, foliar application of humic acid would have also helped in transport of metabolites and increased uptake of water nutrients which would have resulted in higher green leaf yield in curry leaf. Corroborative results were also made by Saini (1994) in coriander.

Among the different treatment, the highest green leaf yield were registered by the treatment combination of $L_2H_2N_4$ (30 cm harvest height + three months harvest intervals + 0.3 per cent of humic acid) green leaf yield of 643.50 g and 714.21 g per plant at first harvest and second harvest and estimated green leaf yield of 4468.46 kg per hectare (first harvest) and 4959.47 kg per hectare (second harvest). This could be attributed due to increased vegetative growth *viz*., plant height, number of branches per plant, leaf size, leaflets, number of leaves registered by the respective treatments. These results were in agreement with Haropinder and Bal (2006) who have opined that pruning had increased the vitamin c content in guava fruits.

This might be due to increased plant height, number of branches, leaflets size and number of leaves per plant registered by the same treatment. Regarding foliar nutrition application of humic acid @ 0.3 per cent (N_4) recorded significantly higher green leaf yield per plant and estimated green leaf yield per hectare. Enhancement of significant fresh leaf yield of curry leaf due to humic acid application was also confirmed by Adani *et al.*, (1998) in tomato.

Effect of pruning techniques and foliar nutrition leaf nitrogen, leaf phosphorous and leaf potassium at first and second harvest

The leaf nitrogen content showed highly significant difference among the treatments of harvest heights. Among the two harvest heights, the treatment L_2 (30 cm harvest height) recorded the higher leaf nitrogen (1.23 and 1.46 per cent), leaf phosphorous (0.42 and 0.51 per cent) and leaf potassium (2.39 and 2.73 per cent) at first harvest and second harvest). When two harvest intervals were compared the treatment H_2 (three months harvest intervals) registered the higher leaf nitrogen (1.24 and 1.48 per cent), leaf phosphorous (0.43 and 0.51 per cent) and leaf potassium (2.42 and 2.76 per cent) at first harvest and second harvest respectively. In respect of four foliar nutrients of the study, application of 0.3 per cent of humic acid (N_4) recorded the highest leaf nitrogen (1.33 and 1.63 per cent), leaf phosphorous (0.52 and 0.59 per cent) and leaf potassium (2.63 and 2.96 per cent) at first harvest and second harvest respectively. This might be due to the improvement of plant growth characters *viz.*, plant height, number of branches per plant, number of leaves per plant, leaf length etc. These findings were noted to be in line with the findings of Erik *et al.,* (2000) in onion

The treatment L_2H_2 (30 cm harvest height + three months harvest intervals) registered the highest leaf nitrogen (1.24 and 1.50 per cent), leaf phosphorous (0.44 and 0.52 per cent) and leaf potassium (2.44 and 2.79 per cent) at first harvest and second harvest respectively (Tables 1 and 2).

Table.1a Effect of pruning techniques and foliar nutrition on green leaf yield in curry leaf at first harvest

Treatments	L_1			L_2			H X N		
	H_1	H_2	Mean	H_1	H_2	Mean	H_1	H_2	Mean
N_1	393.39	551.03	**472.21**	402.93	583.11	**493.02**	398.16	567.07	**482.62**
N_2	407.29	586.97	**497.13**	407.88	606.87	**507.38**	407.59	596.92	**502.25**
N_3	422.96	613.80	**518.38**	423.72	614.79	**519.26**	423.34	614.30	**518.82**
N_4	451.44	640.53	**545.99**	458.37	643.50	**550.94**	454.91	642.02	**548.46**
Mean	**418.77**	**598.08**	**508.43**	**423.23**	**612.07**	**517.65**	**421.00**	**605.08**	
	L	**H**	**N**	**LX H**	**LX N**	**H X N**	**L X H X N**		
SE (d)	0.04	1.67	0.25	1.67	0.31	1.70	1.73		
CD (0.05)	0.18	4.64	0.53	4.64	0.66	4.68	4.72		

Table.1b Effect of pruning techniques and foliar nutrition on green leaf yield in curry leaf at second harvest

Treatments	L_1			L_2			H X N		
	H_1	H_2	Mean	H_1	H_2	Mean	H_1	H_2	Mean
N_1	452.58	573.30	**512.94**	463.98	610.69	**537.34**	458.28	592.00	**525.14**
N_2	469.76	638.60	**554.18**	469.68	663.54	**566.61**	469.72	651.07	**560.40**
N_3	486.78	669.50	**578.14**	487.92	671.46	**579.69**	487.35	670.48	**578.92**
N_4	519.84	687.52	**603.68**	527.82	714.21	**621.02**	523.83	700.87	**612.35**
Mean	**482.24**	**642.23**	**562.24**	**487.35**	**664.98**	**576.16**	**484.80**	**653.60**	
	L	**H**	**N**	**LX H**	**LX N**	**H X N**	**L X H X N**		
SE (d)	0.38	1.54	0.30	1.59	0.53	1.58	1.63		
CD (0.05)	1.61	4.29	0.62	4.55	1.68	4.35	4.40		

Table.2a Effect of pruning techniques and foliar nutrition on estimated green leaf yield in curry leaf at first harvest

Treatments	L_1			L_2			H X N		
	H_1	H_2	Mean	H_1	H_2	Mean	H_1	H_2	Mean
N_1	2731.68	3826.38	3279.03	2797.95	4049.12	3423.54	2764.82	3937.75	3351.28
N_2	2828.19	4075.93	3452.06	2832.32	4214.11	3523.22	2830.26	4145.02	3487.64
N_3	2937.02	4262.23	3599.63	2942.31	4269.10	3605.71	2939.67	4265.67	3602.67
N_4	3134.80	4447.84	3791.32	3182.92	4468.46	3825.69	3158.86	4458.15	3808.51
Mean	2907.92	4153.10	3530.51	2938.88	4250.20	3594.54	2923.40	4201.65	
	L	**H**	**N**	**LX H**	**LX N**	**H X N**	**L X H X N**		
SE (d)	0.60	11.49	1.81	11.51	2.29	11.71	11.91		
CD (0.05)	2.58	31.92	3.74	32.01	5.09	32.21	32.50		

Table.2b Effect of pruning techniques and foliar nutrition on estimated green leaf yield in curry leaf at second harvest

Treatments	L_1			L_2			H X N		
	H_1	H_2	Mean	H_1	H_2	Mean	H_1	H_2	Mean
N_1	3142.72	3980.98	3561.85	3221.88	4240.61	3731.25	3182.30	4110.80	3646.55
N_2	3262.01	4434.44	3848.23	3261.46	4607.62	3934.54	3261.74	4521.03	3891.38
N_3	3380.20	4649.01	4014.61	3388.12	4662.62	4025.37	3384.16	4655.82	4019.99
N_4	3609.77	4774.14	4191.96	3665.18	4959.47	4312.33	3637.48	4866.81	4252.14
Mean	3348.68	4459.64	3904.16	3384.16	4617.58	4000.87	3366.42	4538.61	
	L	H	N	LX H	LX N	H X N	L X H X N		
SE (d)	2.71	10.58	1.91	10.92	3.59	10.84	11.09		
CD (0.05)	11.67	29.39	3.95	31.37	12.00	29.74	30.10		

Fig.1 Effect of pruning techniques and foliar nutrition leaf nitrogen at first and second harvest

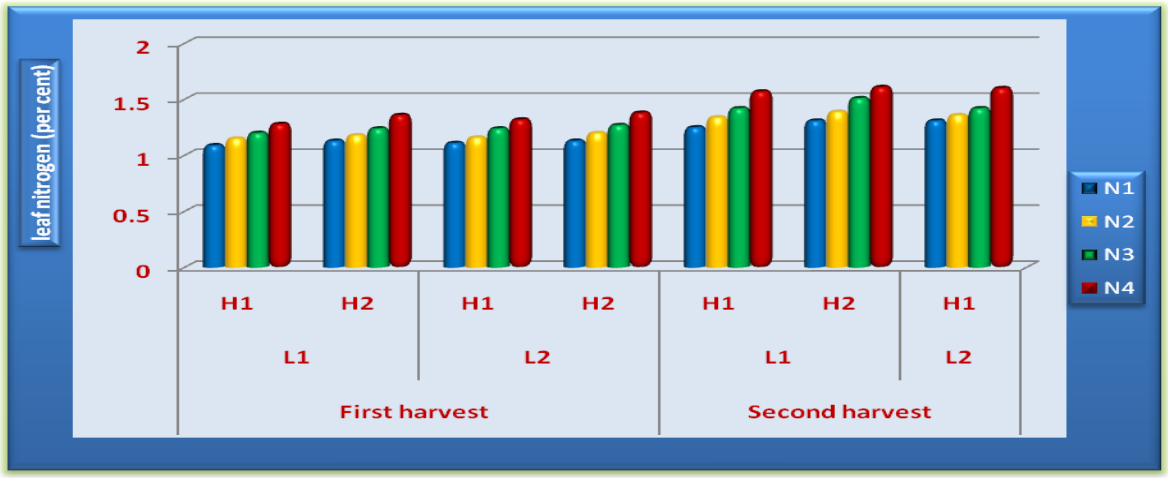


Fig.2 Effect of pruning techniques and foliar nutrition leaf phosphorous at first and second harvest

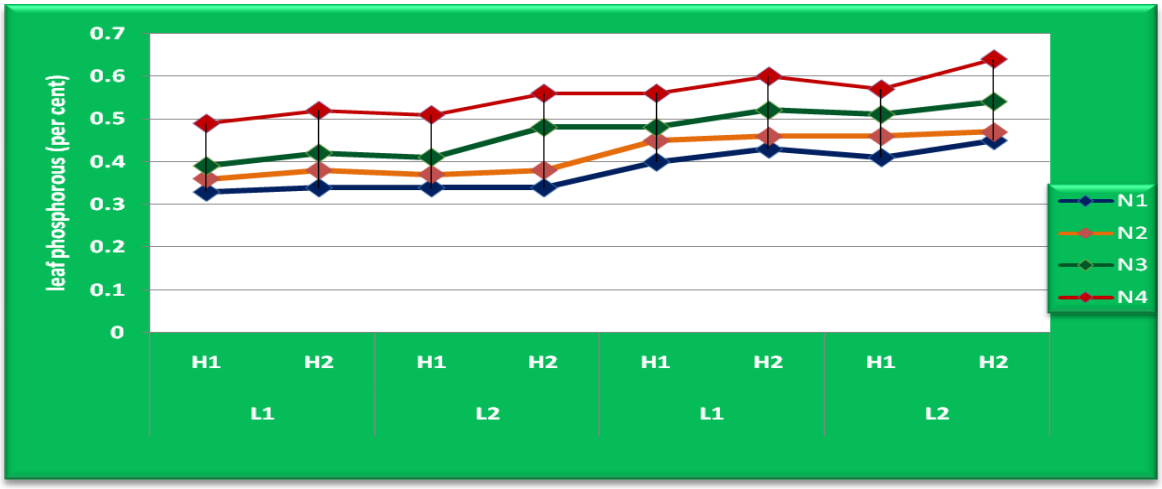
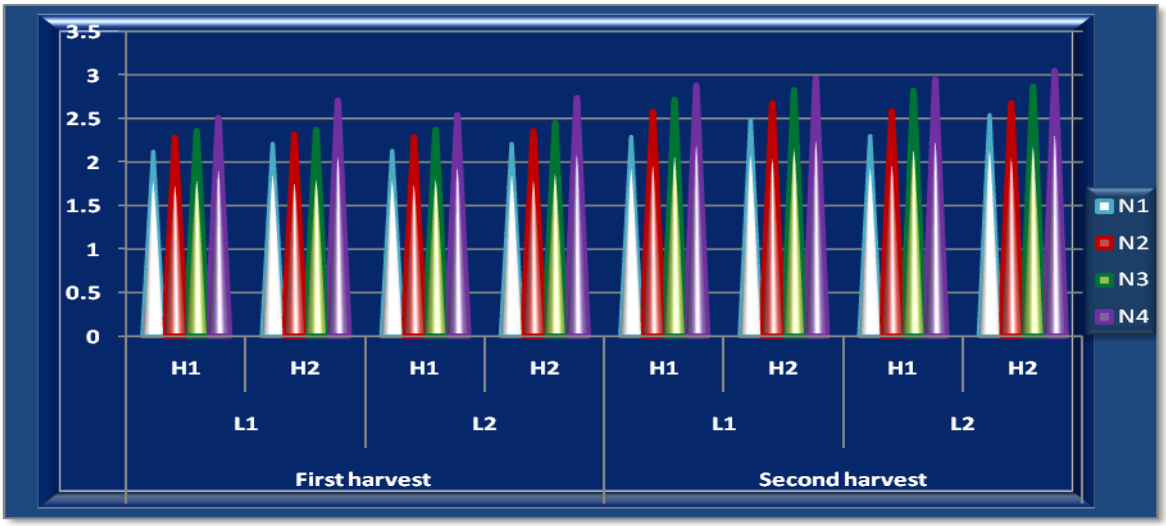


Fig.3 Effect of pruning techniques and foliar nutrition on leaf potassium at first and second harvest



The highest leaf nitrogen (1.35 and 1.67 per cent), leaf phosphorous (0.54 and 0.61 per cent) and leaf potassium (2.64 and 3.00 per cent) at first harvest and second harvest was recorded by the treatment L_2N_4 (30 cm harvest height + 0.3 per cent of humic acid) (Figs 1–3). The treatment H_2N_4 (three months harvest intervals + 0.3 per cent of humic acid) recorded the highest leaf nitrogen (1.37 and 1.68 per cent), leaf phosphorous (0.54 and 0.62 per cent) and leaf potassium (2.73 and 3.01 per cent) at first harvest and second harvest respectively. This might be due to the positive influences of humic acid in crop plants. The involvement of humic acid in the enhancement of enzyme catalysis, respiration, photosynthesis and nucleic acid metabolism might also be the possible reasons for enhanced leaf phosphorous content. Similar, reportswere also made by El-Nemr *et al.*, (2012) in cucumber.

Among the three different combinations studied, the treatment $L_2H_2N_4$ (30 cm harvest height + three months harvest intervals + 0.3 per cent of humic acid) registered the highest leaf nitrogen (1.38 and 1.74 per cent), leaf phosphorous (0.56 and 0.64 per cent) and leaf potassium (2.74 and 3.05 per cent) at first harvest and second harvest respectively. These results had indicated that wider harvest intervals and foliar nutrition of humic acid was noted to be better with respect of leaf potassium content. The involvement of humic acid in the enhancement of enzyme catalysis, respiration, photosynthesis and nucleic acid metabolism was found to be beneficial for enhanced leaf potassium content. Similar reports were also made by Serenella *et al.*, (2002).

In conclusion, the influence of three factors and their interactions *i.e.*, harvesting of curry leaf plants at 30 cm height at three months interval of harvests coupled with application of humic acid @ 0.3 per cent had exerted better leaf yield and quality. Hence it could be conducted that depending upon the growth of the plant either winter with less growth and more growth during the summer demand for leaf in the market, either one of the treatment combination.

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