ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 4, Issue, 7, pp. 1424-1427, July, 2014

International Journal of
DEVELOPMENT RESEARCH

Full Length Research Article

EFFECT OF SPACING AND NPK ON GROWTH, YIELD AND NUTRIENT UPTAKE BY MAKOI (*SOLANUM NIGRUM* L.) UNDER HILL ZONE OF KARNATAKA

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ARTICLE INFO

Article History:
Received 13th April, 2014
Received in revised form
11th May, 2014
Accepted 28th June, 2014
Published online 20th July, 2014

Key words:
NPK,
Investigation,
Horticultural Sciences,
Horticulture Research Station,
Fresh and dry yield.

ABSTRACT

An investigation was carried out to study the effect of spacing and NPK on growth, yield and nutrient uptake by makoi under hill zone-9 of Karnataka at Horticulture Research Station, Thirthahalli, University of Horticultural Sciences, Bagalkot during the year 2013-14. The results revealed that, spacing of 60 x 45 cm and application of NPK fertilizer @ 125:75:75 kg /ha was found beneficial for getting higher growth, fruit yield and uptake of nutrients by makoi. Among different spacing levels**,** maximum plant height (70.41 cm) was noticed in S1 (60 x 45 cm) and the spacing of 60 x 60 cm (S2) recorded maximum number of branches (14.22) and maximum number of leaves (233.77), higher fresh and dry fruit yield (14.33 and 2.58 t/ha, respectively), N (92.41 kg/ha), P (13.13 kg/ha) and K (43.94 kg/ha) uptake by makoi. Among the different fertilizer levels, application of 125:75:75 kg NPK / ha (F8) recorded maximum plant height (74.27 cm), higher number of branches (15.23), higher number of leaves (269.77), fresh and dry yield (16.03 t and 3.71 t/ha, respectively) and higher uptake of N (132.56 kg/ha), P (15.34 kg/ha) and K (66.85 kg/ha) by makoi compared to other levels and control.

INTRODUCTION

Makoi (*Solanum nigrum* L.) is a newly emerging medicinal crop, belongs to the family Solanaceae. Among different species of *Solanum* known for their medicinal value *Solanum nigrum* L. is one such species, which has tremendous medicinal uses. It is an herbaceous medicinal plant found throughout India, particularly in drier parts up to an elevation of 2,100 m and is distributed in all tropical and temperate regions of the world (Anonymous, 1969). Plant is reported to occur in parts of Srilanka, China, Guinea, Madagascar, Rhodesia and South Africa. Makoi is an annual herb growing to a height of 30-45 cm; stem is erect, glabrous and more or less pubescent. Leaves are 2.5-9.0 cm in length and 2.5 cm wide, ovate to lanceolate, sub-acute or acuminate, glabrous, thin, entire, sinuate, toothed, tapering petiole of 2 cm long. Flowers are small white sub-umbellate, 3-8 flowered cymes; peduncles are 6-20 mm long, slender, pedicels are 6-10 mm long very slender. Fruit is botanically berry and has a diameter of 6 mm, globose and purplish black colour.

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Seeds are discoid, 1.5 mm in diameter, minutely pitted and yellow in colour (Kirthikar and Basu, 1975). The leaves, berries and the whole herb of the plants are economically important. The alkaloids, alpha- solamargine and alpha-solasonine have been isolated and identi fied from the green, unripe fruits (Ridout *et al.,* 1989). The berries also contain four steroidal glycoalkaloids namely alpha-solanigrine, beta-solanigrine, solamargine and solasonine. Solamargine and solasonine are present in leaves. Although, work has been done on the therapeutic uses of this crop, the information on the cultural and nutrient management practices suited to the hill zone condition of Karnataka is very meagre. Hence, th e present investigation is planned to standardize the optimum s pacing and nutrient requirement of this crop for enhancing the growth, yield and nutrient uptake by makoi.

MATERIAL AND METHODS

The present investigation was carried out during December 2012 to March 2013 to study the effect of spacing and NPK on growth, yield and nutrient uptake by makoi under hill zone of Karnataka at Horticulture Research Station, Thirthahalli. In all, there were sixteen treatments comprised of two levels of spacing and eight levels of fertilizer. The spacing levels used

in the study were S1: 60 × 45 cm (thirty seven thousand thirty seven plants per hectare) and S2: 60 × 60 cm (twenty seven thousand seven hundred and seventy seven plants per hectare) and the fertilizer doses were F1: 100:50:50 kg NPK ha-1 (Control), F2: 100:50:75 kg NPK ha-1, F3:100:75:50kg NPK ha-1, F4: 100:75: 75 kg NPK ha-1, F5: 125:50:50 kg NPK/ha, F6: 125:50:75 kg NPK/ha, F7: 125:75:50 kg NPK/ha and F8: 125:75:75 kg NPK/ha. The gross plot size was 3.0 x 3.0 m (9 m^2). The treatments were allocated to individual plots at random. Ridges and furrows were formed as per the row spacing. Farm yard manure of 9 kg / plot (@10 tons/ha) was evenly spread in all plots and thoroughly mixed in to the soil. Before sowing, the seeds were pre soaked in 500 ppm GA3 solution for 12 hours to overcome the dormancy and to e nsure good germination. Thirty days old healthy, uniform sized seedlings were transplanted in the experimental plots as per the treatments. The experimental plots were applied with the calculated quantity of fertilizers as per the treatments. Out of total quantity, 50% of Nitrogen and full dose of Phosph orous and Potash were supplied as basal dose a day before tran splanting. The remaining 50% of Nitrogen was given as top dressing at 30 days after transplanting. The crop was harvested 3 months after planting at mature green berry stage. Observations on growth and yield parameters were recorded on five randomly selected plants in the net plot. The data collected on different parameters were subjected to st atistical analysis.

RESULTS AND DISCUSSION

The data pertaining to the effect of spacing and NPK on vegetative parameters are presented in Table 1. Among different growth parameters, maximum plant height (70.41 cm) was observed at closer spacing of 60 x 45 cm (S_1) and the spacing of 60 x 60 cm (S_2) recorded the lowest plant height of 67.63 cm. Whereas, plants spaced at 60 x 60 cm (S_2) recorded maximum number of branches and leaves per plant (14.22 and 233.77, respectively). The least number of branches and leaves per plant (13.58 and 219.21, respectively) was noticed in 60 x 45 cm (S_1) spacing. The increased plant height in closer spacing might be due to competition among plants for solar energy due to increased plant density. The increased branching could be attributed to the more interception of light due to higher surface area. The increase in leaf production may be attributed to more number of branches put forth by the plants at this spacing. These results are in line with the observation smade by Lokesh and Gangadharappa (2007) in makoi. Among the different fertilizer levels, treatment F_8 (125:75:75 k g NPK/ha) recorded maximum plant height (74.27 cm), number of branches (15.23) and number of leaves (269.77).

While, minimum plant height (66.70 cm), number of branches (12.63) and number of leaves (187.13) was recorded in control (F_1). The positive influence of the nutrients on plant height may be due to the fact that nitrogen is required for cell division and cell elongation. Whereas, phosphorus increases the Plant height by increasing the cell multiplication in the plant tissue and the potassium is involved in protein and carbohydrates metabolism, which leads to cell enlargement an d trigger the growth of meristamatic tissue. The production of more number of branches may be due to the split application o f N, which influenced the availability of N. The production of more number of leaves may be to the enhanced availability of

Table 1. Effect spacing and NPK on vegetative parameters of makoi

Treatments	Plant height (cm)	Number of branches	Number of leaves
Spacing level (S)			
S_1 : 60x45 cm	70.41	13.58	219.21
S_2 : 60x60 cm	67.63	14.22	233.77
S.Em±	0.71	0.17	4.56
CD @ 5 %	2.06	0.49	13.19
Fertilizer level (F)			
F_1 : 100:50:50 kg NPK/ha (control)	66.70	12.63	187.13
F_2 : 100:50:75 kg NPK/ha	66.87	13.52	208.03
F_3 : 100:75:50 kg NPK/ha	67.78	13.58	210.10
F_4 : 100:75:75 kg NPK/ha	67.88	13.65	221.38
F_5 : 125:50:50 kg NPK/ha	67.97	14.05	223.48
F_6 : 125:50:75 kg NPK/ha	69.47	14.11	240.17
F_7 : 125:75:50 kg NPK/ha	71.22	14.43	251.85
F_8 : 125:75:75 kg NPK/ha	74.27	15.23	269.77
S.Em±	1.42	0.34	9.13
CD @ 5 %	4.12	0.99	26.39
Interaction effects (S x F)			
S_1F_1	63.87	11.27	190.53
S_1F_2	66.60	12.10	207.93
S_1F_3	69.13	14.17	219.53
S_1F_4	70.67	13.30	211.10
S_1F_5	73.13	14.17	210.00
S_1F_6	69.20	13.87	227.20
S_1F_7	74.70	14.77	229.37
S_1F_8	76.00	15.03	258.00
S_2F_1	69.53	14.00	183.73
S_2F_2	67.13	14.93	208.13
S_2F_3	66.43	13.00	200.67
S_2F_4	65.10	14.00	231.67
S_2F_5	62.80	13.93	236.97
S_2F_6	69.73	14.34	253.13
S_2F_7	67.73	14.10	274.33
S_2F_8	72.53	15.43	281.53
S.Em±	2.02	0.48	12.92
CD @ 5 %	5.83	1.40	NS

Table 2. Effect spacing and NPK on yield of makoi

Treatments	Fresh yield		Dry yield	
	Kg/plot	t/ha	Kg/plot	t/ha
Spacing level (S)				
S_1 : 60x45 cm	12.90	14.33	2.32	2.58
S_2 : 60x60 cm	12.09	13.43	1.44	1.60
S.Em±	0.25	0.28	0.07	0.07
CD @ 5 %	0.74	0.82	0.20	0.22
Fertilizer level (F)				
F_1 : 100:50:50 kg NPK/ha (control)	10.96	12.18	1.18	1.31
F_2 : 100:50:75 kg NPK/ha	11.47	12.74	1.43	1.59
F_3 : 100:75:50 kg NPK/ha	11.85	13.16	1.56	1.74
F_4 : 100:75:75 kg NPK/ha	12.21	13.56	1.57	1.74
F_5 : 125:50:50 kg NPK/ha	12.62	14.02	1.95	2.17
F_6 : 125:50:75 kg NPK/ha	13.01	14.45	1.95	2.17
F_7 : 125:75:50 kg NPK/ha	13.41	14.90	2.06	2.29
F_8 : 125:75:75 kg NPK/ha	14.43	16.03	3.34	3.71
S.Em±	0.51	0.57	0.14	0.15
CD @ 5 %	1.48	1.65	0.40	0.45
Interaction effects (S x F)				
S_1F_1	11.07	12.30	1.30	1.44
S_1F_2	11.73	13.03	1.76	1.95
S_1F_3	12.23	13.59	1.93	2.14
S_1F_4	12.48	13.87	1.90	2.11
S_1F_5	13.13	14.59	2.51	2.79
S_1F_6	13.56	15.07	2.51	2.79
S_1F_7	13.93	15.47	2.60	2.89
S_1F_8	15.07	16.74	4.07	4.52
S_2F_1	10.85	12.05	1.07	1.19
S_2F_2	11.20	12.45	1.10	1.22
S_2F_3	11.46	12.74	1.20	1.33
S_2F_4	11.93	13.26	1.23	1.37
S_2F_5	12.10	13.44	1.39	1.55
S_2F_6	12.45	13.84	1.40	1.55
S_2F_7	12.90	14.33	1.53	1.70
S_2F_8	13.79	15.33	2.61	2.91
S.Em±	0.72	0.80	0.19	0.22
CD @ 5 %	NS	NS	NS	NS

Table 3. Effect of spacing and levels of NPK on nutrient uptake by makoi

Treatments	Nutrient uptake (kg / ha)		
	N	P	K
Spacing level (S)			
S_1 : 60x45 cm	92.41	13.13	43.94
S_2 : 60x60 cm	71.12	6.80	30.65
S.Em±	2.29	0.31	1.43
CD @ 5 %	6.62	0.89	4.13
Fertilizer level (F)			
F_1 : 100:50:50 kg NPK/ha (control)	41.43	4.36	19.27
F_2 : 100:50:75 kg NPK/ha	53.21	5.54	24.55
F_3 : 100:75:50 kg NPK/ha	59.87	6.43	28.77
F_4 : 100:75:75 kg NPK/ha	64.19	6.93	30.77
F_5 : 125:50:50 kg NPK/ha	92.78	9.11	40.01
F_6 : 125:50:75 kg NPK/ha	101.60	9.59	42.11
F_7 : 125:75:50 kg NPK/ha	108.46	10.43	46.00
F_8 : 125:75:75 kg NPK/ha	132.56	15.34	66.85
S.Em±	4.58	0.62	2.86
CD @ 5 %	13.24	1.79	8.27
Interaction effects (S x F)			
S_1F_1	46.22	4.69	20.58
S_1F_2	65.31	6.48	28.38
S_1F_3	74.77	7.57	33.15
S_1F_4	79.58	7.96	36.01
S_1F_5	96.67	11.33	48.11
S_1F_6	106.67	11.84	51.21
S_1F_7	116.59	12.67	55.18
S_1F_8	153.47	18.49	78.88
S_2F_1	36.63	4.02	17.97
S_2F_2	41.12	4.60	20.72
S_2F_3	44.98	5.29	24.40
S_2F_4	48.80	5.90	25.53
S_2F_5	88.89	6.90	31.91
S_2F_6	96.53	7.35	33.02
S_2F_7	100.33	8.19	36.82
S_2F_8	111.65	12.19	54.82
S.Em±	6.48	0.87	4.05
CD @ 5 %	NS	NS	NS

nutrients at the appropriate time, which might have resulted in increased photosynthetic rate and accumulation of metabolit e in plants. These results are in comparison with the findings of Mann and Vyas (1999) in *Plantago ovate,* Pushapalatha *et al.* (2003) in makoi and Lokesh and Gangadharappa (2007) in makoi. Significant variation in plant height was observed among the interaction. The treatment combination 60 X 45 cm spacing and 125: 75: 75:kg NPK/ha (S_1F_8) recorded maximum plant height (76 cm). While, S_2F_8 recorded the highest number of branches (15.43). The interaction effect bet ween spacing and fertilizer levels did not show any significant variation on number of leaves per plant. However, maximum (281.53) number of leaves per plant was recorded in treatment S_2F_8. While, S_1F_1 (control) treatment combination was recorded the minimum plant height (63.87 cm), number of branches (11.27) and number of leaves (190.53).

This may be due to positive effect of spacing and NPK individually on the plant height and number of branches and the same beneficial effect has been reflected in the combination also. Similar, findings were observed by Lokesh and Gangadharappa (2007) in makoi. The data pertaining to the effect of spacing and NPK on yield parameters are presented in Table 2. Among the different spacing levels, plants spaced at 60 x 45 cm (S1) recorded significantly higher fresh and dry yield per hectare (14.33 t and 2.58 t, respectively). While, lowest fresh and dry yield per hectare (13.43 t and 1.60 t, respectively) was noticed in S2. This was due to the fact that the more number of plants per unit area at this spacing helps to accumulate higher fresh and dry yield per hectare. These findings are in line with the results of Lokesh and Gangadharappa (2007) in makoi. Among the different fertilizer levels, application of 125:75:75 kg NPK/ha (F8) recorded the maximum fresh and dry yield per hectare (16.03 t and 3.71 t, respectively). While, lowest fresh and dry yield per hectare (12.18 t and 1.31 t, respectively) was observed in control (F1). This was due positive role played by nutrient on growth and metabolism of plants, which increased the accumulation of matter in the plant. These results are comparable with the results noticed by Ramesh et al. (1996) and Muniramappa et al. (1997) in kalmegh, Khode et al. (2000) in periwinkle and Lokesh and Gangadharappa (2007) in makoi. Among the interaction no significant difference was noticed in fresh and dry yield per hectare was due to interaction of spacing and fertilizer.

NPK uptake by Makoi Nitrogen uptake

The data pertaining to the effect of levels of spacing and NPK on nitrogen uptake are presented in Table 3. Plant spacing had significant effect on uptake of nitrogen. Plants spaced at 60 x 45 cm (S_1) was recorded significantly higher nitrogen uptake (92.41 kg/ha). The lowest nitrogen uptake (71.12 kg/ha) was observed in treatment S_2. Emphasizing the fact that the better growth of the plants at this spacing resulted in more uptake of nitrogen from the soil. Similar, results were also observed by Pushpalatha *et al.* (2003) in makoi. Application of 125:75:75 kg NPK/ha (F_8) recorded the higher nitrogen uptake (132.56 kg/ha) which was significantly superior over F_1 (41.43 kg/ha). The minimum nitrogen uptake (41.43 kg/ha) was observed in control (F_1). These results revealed more availability of nitrogen in the soil and their subsequent uptake by the crop. Similar, kinds of results were recorded earlier by Ramesh *et al.* (1996) in kalmegh, Pushpalatha *et al.* (2003) in makoi and Lokesh and Gangadharappa (2007) in makoi. Interactions did not show significant effect on uptake of nitrogen. However, maximum N uptake (153.47 kg/ha) was recorded due to S_1F_8 (60 x 60 cm + 125:75:75kg NPK/ha) treatment combination.

Phosphorus uptake

The data pertaining to the effect of spacing and NPK on phosphorus uptake are presented in Table 3. Plant spacing showed significant effect on uptake of phosphorus. The plants spaced at 60 x 45 cm (S_1) was recorded significantly higher phosphorus uptake (13.13 kg/ha). The lowest phosphorus uptake (6.80 kg/ha) was observed in S_2 spacing. Better growth of the plants at this spacing resulted in the higher uptake of phosphorus from the soil. Similar, results were observed by Pushpalatha *et al.* (2003) in makoi. Application of 125:75:75 kg NPK/ha (F_8) recorded higher phosphorus uptake of 15.34 kg/ha which was significantly superior over F_1 (4.36 kg/ha). The minimum phosphorus uptake (4.36 kg/ha) was observed in the control (F_1). This may be attributed to maximum availability of phosphorous in the soil in an easily soluble form and contributed to highest uptake by the crop. Similar, results were obtained by Pushpalatha *et al.* (2003) in makoi and Lokesh and Gangadharappa (2007) in makoi. Interactions showed no significant effect on uptake of phosphorus. However, the value found highest (18.49 kg P / ha) in S_1F_8 treatment combination.

Potassium uptake

The data pertaining to the effect of spacing and NPK on potassium uptake are presented in Table 3. Plant spacing level had significant effect on uptake of potassium. The plants spaced at 60 x 45 cm (S_1) recorded significantly higher potassium uptake of 43.94 kg/ha. The lowest potassium uptake (30.65 kg/ha) was observed in S_2 (60x60cm). Better growth of the plants at closer spacing resulted in the higher uptake of potassium from the soil (Pushpalatha *et al.,* 2003). Application of 125:75:75 kg NPK/ha (F_8) recorded the higher potassium uptake (66.85 kg/ha) compared to other levels. The minimum potassium uptake (19.27 kg/ha) was observed in control (F_1). This might be due to better K availability and their uptake. Similar, results were also reported by Bhuvaneshwari (2001) in anise, Pushpalatha *et al.* (2003) in makoi and Lokesh and Gangadharappa (2007) in makoi. Interactions effect showed no significant variation in the uptake of potassium. However, maximum uptake (78.88 kg K /ha) being recorded in S_1F_8 combination.

Conclusion

Field experiment was carried out to study the effect of spacing and NPK on growth, yield and nutrient uptake by makoi under hill zone of Karnataka during December 2012 to March 2013 at Horticulture Research Station, Thirthahalli. Spacing of 60 x 45 cm and application of 125:75:75 kg NPK/ha was found beneficial for better growth and yield of makoi.

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