Original Research Article

Influence of integrated nutrient management and plant geometry on nutrient uptake of ajowan (*Trachyspermum ammi* L. Sprague) in Southern zone of Telangana

ABSTRACT

An experiment was conducted during *late kharif* season of 2019-20 at College of Horticulture, Rajendranagar, Hyderabad, to find out influence of integrated nutrient management and plant geometry on nutrient uptake of ajowan (*Trachyspermum ammi* L. Sprague) in Southern zone of Telangana. The experiment was laid out in a factorial randomized block design with 12 treatments, replicated thrice. The treatments include four Integrated nutrient management levels (INM_1, INM_2, INM_3 and INM_4) and three plant geometries (S_1, S_2 and S_3). Results showed that available nitrogen (351.33 kg ha^{-1}), phosphorous (96.94 kg ha^{-1}) and potassium (231.88 kg ha^{-1}) content in soil were found significantly higher in T_3 (INM_1+ S_3) over other treatments where as, T_{10} (INM_4+ S_1) recorded the lowest. The nutrient content in plant *i.e.* nitrogen (1.65%), phosphorous (0.93%), and potassium content (1.20%) in plant was found significantly maximum in T_3 (INM_1+ S_3) while, the minimum was recorded in T_7 (INM_3+ S_1). Regarding nutrient uptake by the crop, nitrogen (87.79 kg ha^{-1}) phosphorous (61.10 kg ha^{-1}) and potassium (61.99 kg ha^{-1}) were found significantly higher in T_1(INM_1+ S_1), while it was the lowest in T_8 (INM_3+ S_2).

Keywords: Nutrient uptake, integrated nutrient management, soil, late kharif, phosphorous.

Introduction

Ajowan is widely grown in arid and semi-arid regions where soils contain high level of salts. The essential oil from seeds is used in perfumery, essence and medicinal preparations (Nath *et al.,* 2008). It is known as adjuncts, used in small quantities for flavouring the numerous foods as antioxidant and also as a preservative in confectionary, beverages and pan mixtures. The paste of crushed fruits is applied externally for relieving colic pains. The roots of Ajowan plant are reported to possess diuretic and carminative properties and are used in febrile conditions and in stomach disorders. On application of biofertilizers to the seeds, root or soil helps in fixing the nitrogen, mobilizes the availability of nutrient and also helps in build-up of the micro flora. The application of combined form of N fixing, P solubilizing and mobilizing, growth promoting microbes are difficult for farmers due to lack of availability at one place. To overcome these problems, Arka Microbial Consortium (AMC) bio fertilizer was developed and released from IIHR, Bengaluru. This is recommended for media preparation, seed treatment and soil application. AMC contains N fixing, P and Zn solubilizing and plant growth promoting microbes as a single formulation. Combination effect of organic manures and nitrogen fixing bio fertilizers and phosphate solubilizing bacteria helps to increase the availability of nutrients (Devi and Limi, 2005). Addition of organic manures like farm yard manure, vermicompost, neem cake, poultry manure, *etc.*, not only supplies most of the essential plant nutrients, but also improves the soil structure by providing binding substance to soil aggregates leading to increase in cation exchange capacity and water holding capacity of the soil. (Mahapatra and Thirumalaiandi Ramasubramanian, 2009).

Materials and methods

The experiment was conducted at College of Horticulture, Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, Hyderabad in *late kharif* season of 2019-2020. Lam Selection-2 variety is used as a seed and Arka Microbial consortium as a source of biofertilizers, FYM, Neem cake, vermicompost as organic manures, Urea (46% N), SSP (16% P_2O_5) and MOP (60% K_2O) as a source of fertilizers during the experiment.

The experimental site, Rajendranagar is situated at an altitude of 536 m above mean sea level on 78°.40' East longitude and 17°.32' North latitude. The climate of Rajendranagar is semi-arid. The soil of the experimental site had loamy texture with a pH of 6.7 and electrical conductivity of 0.12 dSm^{-1}. The organic carbon content was very low. The availability of nitrogen, phosphorous and potash per hectare was 215.30, 35 and 107.23 kg respectively.

The twelve treatments were replicated three times in factorial randomized block design. The treatments comprising of T_1 : 100% NPK (20:40:20 kg/ha) + FYM (12t/ha)+Vermicompost (6t/ha)+Neem cake (3t/ha) + AMC (7.5 litres/ha) with Spacing S_1 (30X10 cm), T_2 : 100% NPK (20:40:20 kg/ha) + FYM (12t/ha) + Vermicompost (6t/ha) + Neem cake (3t/ha) + AMC (7.5 litres/ha) with spacing S_2 (30X30 cm), T_3 : 100% NPK (20:40:20 kg/ha) + FYM (12t/ha) + Vermicompost (6t/ha) + Neem cake (3t/ha) + AMC (7.5 litres/ha) with spacing S_3 (45X30 cm), T_4 : 75% NPK (15:30:15 kg/ha) + FYM (12t/ha) + Vermicompost (6t/ha) + Neem cake (3t/ha) + AMC (7.5 litres/ha) with spacing S_1 (30X10 cm), T_5 : 75% NPK (15:30:15 kg/ha) + FYM (12t/ha) + Vermicompost (6t/ha) + Neem cake (3 t/ha) + AMC (7.5 litres/ha) with spacing S_2 (30X30 cm). T_6 : 75% NPK (15:30:15 kg/ha) + FYM (12t/ha) + Vermicompost (6 t/ha) + Neem cake (3 t/ha) + AMC (7.5 litres/ha) with spacing S_3 (45X30 cm), T_7 : 50% NPK (10:20:10 kg/ha) + FYM (12 t/ha) + Vermicompost (6 t/ha) + Neem cake (3 t/ha) + AMC (7.5 litres/ha) with spacing S_1 (30X10 cm), T_8 : 50% NPK (10:20:10 kg/ha) + FYM (12 t/ha) + Vermicompost (6 t/ha) + Neem cake (3 t/ha) + AMC (7.5 litres/ha) with spacing S_2 (30X30 cm), T_9 : 50% NPK (10:20:10 kg/ha) + FYM (12 t/ha) + Vermicompost (6 t/ha) + Neem cake (3t/ha) + AMC (7.5 litres/ha) with spacing S_3 (45X30 cm), T_{10} : 100%NPK + FYM (12 t/ha) (Control) + Spacing S_1 (30X10 cm), T_{11} : 100%NPK + FYM (12 t/ha) (Control) + Spacing S_2 (30X30 cm), T_{12} : 100%NPK + FYM (12 t/ha) (Control) + Spacing S_3 (45X30 cm).

Nutrient uptake (Kg ha^{-1})

The nutrient uptake was calculated by using the percentage of N, P and K in the whole plant and dry weight of whole plant using the following formula.

$$\text{Uptake of nutrient} = \frac{\text{Percentage of nutrient in dry matter} \times \text{Total dry matter (Kg ha}^{-1}\text{)}}{100}$$

Results and Discussion

Soil analysis

Estimation of Nitrogen in soil (Kg ha-1)

The status of nitrogen in soil is presented in the table 1. Significant differences were observed in the soil N status due to application of integrated nutrient management, plant geometry and their interactions.The maximum content of nitrogen is present at INM_1 (323.81 kg ha^{-1}) followed by plant grown at INM_2 (301.49 kg ha^{-1}) however lower nitrogen content in the soil was observed at INM_4 (Control) (248.06 kg ha^{-1}). Among the different plant geometries, maximum nitrogen content (311.73 kg ha^{-1}) was found with (S_3) 45cm x 30cm followed by (S_2) 30cm x30 cm (290.72 kg ha^{-1}). The least nitrogen content in the soil was found with the (S_1) 30 cm x 10 cm (263.08 kg ha^{-1}).Among the interactions maximum nitrogen content was found with T_3 (INM_1 + S_3) (351.33 kg ha^{-1}), followed by T_6 (INM_2 + S_3)(323.04 kg ha-1), and was on par with T_2 (INM_1 + S_2) (322.86 kg ha^{-1}). The least content of nitrogen in soil was observed in T_{10}(INM_4 + S_1) (223.10 kg ha^{-1}).

Estimation of Phosphorous in soil (Kg ha^{-1})

The maximum content of phosphorous is present at INM_1 (89.34 kg ha^{-1}) followed by plant grown at INM_2 - (83.11 kg ha^{-1}) however lower phosphorous content in the soil was observed at INM_4 (Control) (67.07 kg ha^{-1}). Among the different plant geometries, maximum phosphorous content (88.39 kg ha^{-1}) was found with 45cm x 30 cm followed by (S_2) 30cm x30 cm (83.17 kg ha^{-1}).The least nitrogen content in the soil was found with the (S_1) 30 cm x 10 cm (63.99 kg ha^{-1}).The interaction effect between the integrated nutrient management and plant geometry recorded to be significant with respect to phosphorous content in the soil. Maximum phosphorous content was found with T_3 (INM_1 + S_3) (96.94 kg ha^{-1}) followed by T_2(INM_1 + S_2)(95.05 kg ha^{-1}) which were on par with T_6 (INM_2 + S_3) (94.82 kg ha^{-1}). The least content of phosphorous in soil was observed in T_{10} (INM_4 + S_1) (54.62 kg ha^{-1}).

Estimation of Potassium in soil (Kg ha-1)

The data on potassium content in the soil are furnished in the table 1. showed that maximum potassium content was observed at INM_1 (206.21 kg ha^{-1}) followed by plant grown at INM_2 (193.85 kg ha^{-1}) however lower potassium content in the soil was observed at INM_4 : (Control) (163.32 kg ha^{-1}). Among the different plant geometry maximum content of potassium in the soil was observed with (S_3) 45 cm x 30 cm (212.43 kg ha^{-1}) followed by (S_2) 30 cm x 30 cm (185.93 kg ha^{-1}) but the least potassium content in the soil was observed with plant geometry (S_1) 30 cm x 10 cm (161.56 kg ha^{-1}).The interaction effect between the integrated nutrient management and plant geometry found to be significant. Higher dose of potassium content in the soil was observed at T_3(INM_1 + S_3) (231.88 kg ha^{-1}) followed by T_2(INM_1 + S_2)(204.09 kg ha^{-1}) however lower potassium content in the soil was observed at T_{10}(INM_4 + S_1) (139.02 kg ha^{-1}).

Plant analysis

Nitrogen content in plant (%)

The data of nitrogen content in plant is presented in the Table 2. The effect of integrated nutrient management, plant geometry and their interaction on N content in plant was found significant.The data indicated that among the integrated nutrient management evaluated, significantly higher N content in plant at harvest was recorded with INM_1 (1.41%) compared to all other integrated nutrient management levels, followed by INM_2 (1.16%), however lower nitrogen content in the plant was observed at INM_3 (0.77%).Significantly higher N content in plant was recorded with the plant geometry (S3) 45cm x 30 cm (1.24%) compared to other plant geometries evaluated. Among the interactions maximum nitrogen content in plant was recorded with T_3 (1.65%), followed by T_6 (INM_2 + S_3) (1.44%). The lowest nitrogen content in plant was found at T_7 (INM_3 + S_1) (0.71%).

Phosphorous content in plant (%)

The phosphorous content in the plant at harvest was significantly higher at INM_1 (0.89%) over all other integrated nutrient management levels under consideration, followed by INM_2 (0.82%), however lower phosphorous content in the plant was observed at INM_3 (0.50%). Regarding plant geometries evaluated, significantly higher phosphorous content was observed with plant geometry (S_3) 45 cm x 30 cm (0.77%), followed by (S_2) 30 cm x 30 cm (0.72%). Among the interactions between integrated nutrient management and plant geometry, significantly highest phosphorous content in plant was recorded at T_3(INM_1 + S_3) (0.93%), followed by T_2 (INM_1 + S_2) (0.90%).The lowest phosphorous content was found at T_7 (INM_3 + S_1) (0.39%).

Potassium content in plant (%)

The data pertaining to potassium content in the plant at harvest is furnished in the Table 2. The Potassium content in plant was significantly influenced by integrated nutrient management, plant geometry and their interaction.The Potassium content in the plant was significantly higher at INM_1 (1.06%) over all other integrated nutrient management levels investigated. Regarding plant geometries evaluated, significantly higher Potassium content was observed with plant geometry (S_3) 45 cm x 30 cm (1.05%), followed by (S_2) 30 cm x 30 cm (0.91%).Among the interactions between integrated nutrient management and plant geometry, maximum Potassium content in plant was recorded with T_3 (INM_1 + S_3) (1.20%), followed by T_6 (INM_2 + S_3) (1.14%). The lowest Potassium content was found at T_7 (INM_3 + S_1) (0.75%).

Nutrient uptake (kg ha-1)

The data presented in table 3 clearly showed that the integrated nutrient management and plant geometry played significant role in directly affecting nutrient uptake in plant.The maximum total uptake of nitrogen, phosphorous and potassium after harvest was recorded in INM_1 (74.60, 48.60 and 50.65 respectively), followed by INM_2 (58.30, 43.49 and 41.79 respectively) however minimum nutrient uptake was recorded in INM_3 (32.92, 22.62 and 20.91 respectively). Since the nutrient uptake is a function of its concentration in crop plant and seed and straw yield of the crop, the increase in these parameters due to fertilization led to an increased uptake of nutrient in the present study. These observations agree with the findings of Singh *et al.* (2001), Dadheech & Sumeriya (2004) in isabgol and Anwar *et al.* (2005) in French basil and Wankhade *et al.* (2005) in musk mallow.

Among the different plant geometries evaluated, significantly maximum nitrogen, phosphorous and potassium uptake was at (S_1) 30 cm x 10 cm (61.67, 43.34 and 42.13 respectively), followed by (S_3) 45 cm x 30 cm (53.59, 35.75 and 34.25 respectively) but the least nitrogen, phosphorous and potassium uptake (43.61, 32.03 and 32.28 respectively) was at (S_2) 30 cm x 30 cm. The interaction between the integrated nutrient management and plant geometry found to be significant. Maximum nitrogen, phosphorous and potassium uptake (87.79, 61.10 and 61.99 respectively) was at T_1 (INM_1 + S_1), although least nitrogen, phosphorous and potassium uptake (28.44, 19.90 and 19.46 respectively) was at T_8(INM_3 + S_2) .This might be due to higher plant density, higher seed yield which resulted in higher dry matter production and higher nutrient content in seed and stover. These observations agree with the findings of Singh *et* *al.* (2010) in isabgol, Joy *et al.* (1998) in *Curculigo orchioides* & Meena *et al.* (2017) in chandrasur.

Conclusion

The outcome of the present investigation revealed that available nitrogen, phosphorous and potassium content in soil and plant were found significantly higher in T_3 (INM_1+ S_3) over other treatments. Regarding nutrient uptake by the crop, nitrogen phosphorous and potassium were found significantly higher in T_1(INM_1+ S_1) due to more population per unit area.

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Table 1. Influence of integrated nutrient management (INM) and plant geometry(S) on NPK (kg ha^{-1}) in soil of ajowan

Treatments	NPK (kg ha^{-1})											
	Nitrogen				Phosphorous				Potassium			
	S_1	S_2	S_3	**Mean**	S_1	S_2	S_3	**Mean**	S_1	S_2	S3	**Mean**
INM_1	297.24	322.86	351.33	**323.81 [a]**	76.03	95.05	96.94	**89.34 [a]**	182.68	204.09	231.88	**206.21 [a]**
INM_2	277.06	304.38	323.04	**301.49 [b]**	66.45	88.06	94.82	**83.11 [b]**	166.89	195.28	219.4	**193.85 [b]**
INM_3	254.94	286.28	300.85	**280.69 [c]**	58.88	78.91	85.88	**74.55 [c]**	157.67	181.43	210.44	**183.18 [c]**
INM_4	223.1	249.37	271.72	**248.06 [d]**	54.62	70.66	75.93	**67.07 [d]**	139.02	162.94	188.02	**163.32 [d]**
Mean	**263.0 [c]**	**290.72 [b]**	**311.73 [a]**		**63.99 [c]**	**83.17 [b]**	**88.39 [a]**		**161.56 [c]**	**185.93 [b]**	**212.43 [a]**	

	S Em ±	**CD at 5%**	**S Em ±**	**CD at 5%**	**S Em ±**	**CD at 5%**
INM	0.33	0.97	0.11	0.32	0.20	0.59
S	0.28	0.84	0.09	0.28	0.17	0.51
INM X S	0.57	1.68	0.19	0.56	0.35	1.02

Table 2. Influence of integrated nutrient management (INM) and plant geometry(S) on NPK (%) in plant of ajowan

Treatments	**NPK (%) in plant at harvest**											
	Nitrogen				Phosphorous				Potassium			
	S_1	S_2	S_3	**Mean**	S_1	S_2	S_3	**Mean**	S_1	S_2	S3	**Mean**
INM_1	1.20	1.40	1.65	**1.41** ^{a}	0.84	0.90	0.93	**0.89** ^{a}	0.96	1.02	1.20	**1.06** ^{a}
INM_2	0.96	1.08	1.44	**1.16** ^{b}	0.78	0.81	0.87	**0.82** ^{b}	0.81	0.96	1.14	**0.97** ^{b}
INM_3	0.71	0.75	0.84	**0.77** ^{d}	0.39	0.51	0.60	**0.50** ^{d}	0.75	0.78	0.84	**0.79** ^{d}
INM_4	0.90	0.94	1.03	**0.95** ^{c}	0.57	0.67	0.69	**0.64** ^{c}	0.84	0.90	1.02	**0.92** ^{c}
Mean	**0.94** ^{c}	**1.04** ^{b}	**1.24** ^{a}		**0.64** ^{c}	**0.72** ^{b}	**0.77** ^{a}		**0.84** ^{c}	**0.91** ^{b}	**1.05** ^{a}	
	S Em ±		**CD at 5%**		**S Em ±**		**CD at 5%**		**S Em ±**		**CD at 5%**	
INM	0.003		0.011		0.003		0.010		0.003		0.010	
S	0.003		0.009		0.003		0.009		0.003		0.008	
INM X S	0.006		0.019		0.006		0.018		0.006		0.017	

Table 3. Influence of integrated nutrient management (INM) and plant geometry(S) on NPK uptake (kg ha^{-1}) in plant of ajowan

Treatments	NPK uptake in plant (kg ha^{-1})											
	Nitrogen				Phosphorous				Potassium			
	S_1	S_2	S_3	**Mean**	S_1	S_2	S_3	**Mean**	S_1	S_2	S3	**Mean**
INM_1	87.79	61.95	74.08	**74.60 [a]**	61.10	38.53	46.19	**48.60 [a]**	61.99	43.27	46.7	**50.65 [a]**
INM_2	66.77	46.09	62.04	**58.30 [b]**	48.92	38.21	43.34	**43.49 [b]**	49.29	37.57	38.51	**41.79 [b]**
INM_3	38.97	28.44	31.36	**32.92 [d]**	26.50	19.90	21.46	**22.62 [d]**	22.74	19.46	20.55	**20.91 [d]**
INM_4	53.18	37.99	46.88	**46.01 [c]**	36.85	31.51	32.01	**33.45 [c]**	34.51	28.84	31.24	**31.53 [c]**
Mean	**61.67[a]**	**43.61 [c]**	**53.59 [b]**		**43.34 [a]**	**32.03 [c]**	**35.75 [b]**		**42.13 [a]**	**32.28 [c]**	**34.25 [b]**	
	S Em ±		**CD at 5%**		**S Em ±**		**CD at 5%**		**S Em ±**		**CD at 5%**	
INM	0.34		1.00		0.35		1.04		0.34		1.00	
S	0.29		0.87		0.30		0.90		0.29		0.87	
INM X S	0.59		1.74		0.61		1.80		0.59		1.74	