

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

## ABSTRACT

An experiment was conducted during late kharif season of 2019-20 at College of Horticulture, Rajendranagar, Hyderabad, to find out the influence of integrated nutrient management and plant geometry on nutrient uptake of ajowan (*Trachyspermum ammi* L. Sprague) in the 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<sub>1</sub>, INM<sub>2</sub>, INM<sub>3</sub> and INM<sub>4</sub>) and three plant geometries (S<sub>1</sub>, S<sub>2</sub> and S<sub>3</sub>). Results showed that available nitrogen (351.33 kg ha<sup>-1</sup>), phosphorous (96.94 kg ha<sup>-1</sup>) and potassium (231.88 kg ha<sup>-1</sup>) content in soil were found significantly higher in T<sub>3</sub> (INM<sub>1</sub>+ S<sub>3</sub>) over other treatments where as, T<sub>10</sub> (INM<sub>4</sub>+ S<sub>1</sub>) 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<sub>3</sub> (INM<sub>1</sub>+ S<sub>3</sub>) while, the minimum was recorded in T<sub>7</sub> (INM<sub>3</sub>+ S<sub>1</sub>). Regarding nutrient uptake by the crop, nitrogen (87.79 kg ha<sup>-1</sup>) phosphorous (61.10 kg ha<sup>-1</sup>) and potassium (61.99 kg ha<sup>-1</sup>) were found significantly higher in T<sub>1</sub>(INM<sub>1</sub>+ S<sub>1</sub>), while it was the lowest in T<sub>8</sub> (INM<sub>3</sub>+ S<sub>2</sub>).

**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 a high of salts. The essential oil from seeds is used in the perfumery, essence and medicinal preparations" (Nath *et al.*, 2008). "It is known as adjuncts, used in small quantities for flavouring the numerous foods as an 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 a 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". (Srikanth *et. Al.*, 2021) "The combination effect of organic manures and nitrogen fixing bio fertilizers and phosphate solubilizing bacteria helps to increase the availability of



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<sup>-1</sup>)

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<sup>-1</sup>)

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<sup>-1</sup>) followed by plant grown at  $INM_2$  (301.49 kg ha<sup>-1</sup>) however lower nitrogen content in the soil was observed at  $INM_4$  (Control) (248.06 kg ha<sup>-1</sup>). Among the different plant geometries, maximum nitrogen content (311.73 kg ha<sup>-1</sup>) was found with ( $S_3$ ) 45cm x 30cm followed by ( $S_2$ ) 30cm x30 cm (290.72 kg ha<sup>-1</sup>). The least nitrogen content in the soil was found with the ( $S_1$ ) 30 cm x 10 cm (263.08 kg ha<sup>-1</sup>). Among the interactions maximum nitrogen content was found with  $T_3$  (  $INM_1 + S_3$  ) (351.33 kg ha<sup>-1</sup>), followed by  $T_6$  ( $INM_2 + S_3$ )(323.04 kg ha<sup>-1</sup>), and was on par with  $T_2$  ( $INM_1 + S_2$ ) (322.86 kg ha<sup>-1</sup>). The least content of nitrogen in soil was observed in  $T_{10}$ (  $INM_4 + S_1$ ) (223.10 kg ha<sup>-1</sup>).

### **Estimation of Phosphorous in soil (Kg ha<sup>-1</sup>)**

The maximum content of phosphorous is present at INM<sub>1</sub> (89.34 kg ha<sup>-1</sup>) followed by plant grown at INM<sub>2</sub> - (83.11 kg ha<sup>-1</sup>) however lower phosphorous content in the soil was observed at INM<sub>4</sub> ( Control ) (67.07 kg ha<sup>-1</sup>). Among the different plant geometries, maximum phosphorous content (88.39 kg ha<sup>-1</sup>) was found with 45cm x 30 cm followed by (S<sub>2</sub>) 30cm x30 cm (83.17 kg ha<sup>-1</sup>).The least nitrogen content in the soil was found with the (S<sub>1</sub>) 30 cm x 10 cm (63.99 kg ha<sup>-1</sup>).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<sub>3</sub> ( INM<sub>1</sub> + S<sub>3</sub> ) (96.94 kg ha<sup>-1</sup>) followed by T<sub>2</sub>( INM<sub>1</sub> + S<sub>2</sub>)(95.05 kg ha<sup>-1</sup>) which were on par with T<sub>6</sub> (INM<sub>2</sub> + S<sub>3</sub>) (94.82 kg ha<sup>-1</sup>). The least content of phosphorous in soil was observed in T<sub>10</sub> ( INM<sub>4</sub> + S<sub>1</sub> ) (54.62 kg ha<sup>-1</sup>).

### **Estimation of Potassium in soil (Kg ha<sup>-1</sup>)**

The data on potassium content in the soil are furnished in the table 1. showed that maximum potassium content was observed at INM<sub>1</sub> (206.21 kg ha<sup>-1</sup>) followed by plant grown at INM<sub>2</sub> (193.85 kg ha<sup>-1</sup>) however lower potassium content in the soil was observed at INM<sub>4</sub> : ( Control ) (163.32 kg ha<sup>-1</sup>). Among the different plant geometry maximum content of potassium in the soil was observed with (S<sub>3</sub>) 45 cm x 30 cm (212.43 kg ha<sup>-1</sup>) followed by (S<sub>2</sub>) 30 cm x 30 cm (185.93 kg ha<sup>-1</sup>) but the least potassium content in the soil was observed with plant geometry (S<sub>1</sub>) 30 cm x 10 cm (161.56 kg ha<sup>-1</sup>).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<sub>3</sub>( INM<sub>1</sub> + S<sub>3</sub> ) (231.88 kg ha<sup>-1</sup>) followed by T<sub>2</sub>( INM<sub>1</sub> + S<sub>2</sub>)(204.09 kg ha<sup>-1</sup>) however lower potassium content in the soil was observed at T<sub>10</sub>( INM<sub>4</sub> + S<sub>1</sub> ) (139.02 kg ha<sup>-1</sup>).

### **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<sub>1</sub> (1.41%) compared to all other integrated nutrient management levels, followed by INM<sub>2</sub> (1.16%), however lower nitrogen content in the plant was observed at INM<sub>3</sub> (0.77%).Significantly higher N content in plant was recorded with the plant geometry (S<sub>3</sub>) 45cm x 30 cm (1.24%) compared to other plant geometries evaluated. Among the interactions maximum nitrogen content in plant was recorded with T<sub>3</sub> (1.65%), followed by T<sub>6</sub> (INM<sub>2</sub> + S<sub>3</sub>) (1.44%). The lowest nitrogen content in plant was found at T<sub>7</sub> ( INM<sub>3</sub> + S<sub>1</sub> ) (0.71%).

### **Phosphorous content in plant (%)**

The phosphorous content in the plant at harvest was significantly higher at INM<sub>1</sub> (0.89%) over all other integrated nutrient management levels under consideration, followed by INM<sub>2</sub> (0.82%), however lower phosphorous content in the plant was observed at INM<sub>3</sub> (0.50%). Regarding plant geometries evaluated, significantly higher phosphorous content was observed with plant geometry (S<sub>3</sub>) 45 cm x 30 cm (0.77%), followed by (S<sub>2</sub>) 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<sub>3</sub> (INM<sub>1</sub> + S<sub>3</sub>) (0.93%), followed by T<sub>2</sub> (INM<sub>1</sub> + S<sub>2</sub>) (0.90%). The lowest phosphorous content was found at T<sub>7</sub> (INM<sub>3</sub> + S<sub>1</sub>) (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<sub>1</sub> (1.06%) over all other integrated nutrient management levels investigated. Regarding plant geometries evaluated, significantly higher Potassium content was observed with plant geometry (S<sub>3</sub>) 45 cm x 30 cm (1.05%), followed by (S<sub>2</sub>) 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<sub>3</sub> (INM<sub>1</sub> + S<sub>3</sub>) (1.20%), followed by T<sub>6</sub> (INM<sub>2</sub> + S<sub>3</sub>) (1.14%). The lowest Potassium content was found at T<sub>7</sub> (INM<sub>3</sub> + S<sub>1</sub>) (0.75%).

### **Nutrient uptake (kg ha<sup>-1</sup>)**

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<sub>1</sub> (74.60, 48.60 and 50.65 respectively), followed by INM<sub>2</sub> (58.30, 43.49 and 41.79 respectively) however minimum nutrient uptake was recorded in INM<sub>3</sub> (32.92, 22.62 and 20.91 respectively). Since nutrient uptake is a function of its concentration in crop plants, as well as seed and straw production, an increase in these parameters owing to fertilization resulted in enhanced nutrient uptake in the current 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<sub>1</sub>) 30 cm x 10 cm (61.67, 43.34 and 42.13 respectively), followed by (S<sub>3</sub>) 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<sub>2</sub>) 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<sub>1</sub> (INM<sub>1</sub> + S<sub>1</sub>), although least nitrogen, phosphorous and potassium uptake (28.44, 19.90 and 19.46 respectively) was at T<sub>8</sub>( INM<sub>3</sub> + S<sub>2</sub>). This could be as a result of increased plant density, increased seed yield, which increased dry matter production, and increased 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 orchoides* & 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<sub>3</sub> (INM<sub>1</sub>+ S<sub>3</sub>) over other treatments. Regarding nutrient uptake by the crop, nitrogen, phosphorous and potassium were found significantly higher in T<sub>1</sub>(INM<sub>1</sub>+ S<sub>1</sub>) 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<sup>-1</sup>) in soil of ajowan**

Treatments	NPK (kg ha <sup>-1</sup> )											
	Nitrogen				Phosphorous				Potassium			
	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean
INM <sub>1</sub>	297.2 4	322.86	351.33	<b>323.81</b> a	76.03	95.05	96.94	<b>89.34</b> <sup>a</sup>	182.68	204.09	231.88	<b>206.21</b> <sup>a</sup>
INM <sub>2</sub>	277.0 6	304.38	323.04	<b>301.49</b> b	66.45	88.06	94.82	<b>83.11</b> <sup>b</sup>	166.89	195.28	219.4	<b>193.85</b> <sup>b</sup>
INM <sub>3</sub>	254.9 4	286.28	300.85	<b>280.69</b> c	58.88	78.91	85.88	<b>74.55</b> <sup>c</sup>	157.67	181.43	210.44	<b>183.18</b> <sup>c</sup>
INM <sub>4</sub>	223.1	249.37	271.72	<b>248.06</b> d	54.62	70.66	75.93	<b>67.07</b> <sup>d</sup>	139.02	162.94	188.02	<b>163.32</b> <sup>d</sup>
Mean	<b>263.0</b> c	<b>290.72</b> b	<b>311.73</b> a		<b>63.99</b> <sup>c</sup>	<b>83.17</b> <sup>b</sup>	<b>88.39</b> <sup>a</sup>		<b>161.56</b> c	<b>185.93</b> b	<b>212.43</b> a	
	<b>S Em ±</b>		<b>CD at 5%</b>		<b>S Em ±</b>		<b>CD at 5%</b>		<b>S Em ±</b>		<b>CD at 5%</b>	
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 <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean
INM <sub>1</sub>	1.20	1.40	1.65	<b>1.41<sup>a</sup></b>	0.84	0.90	0.93	<b>0.89<sup>a</sup></b>	0.96	1.02	1.20	<b>1.06<sup>a</sup></b>
INM <sub>2</sub>	0.96	1.08	1.44	<b>1.16<sup>b</sup></b>	0.78	0.81	0.87	<b>0.82<sup>b</sup></b>	0.81	0.96	1.14	<b>0.97<sup>b</sup></b>
INM <sub>3</sub>	0.71	0.75	0.84	<b>0.77<sup>d</sup></b>	0.39	0.51	0.60	<b>0.50<sup>d</sup></b>	0.75	0.78	0.84	<b>0.79<sup>d</sup></b>
INM <sub>4</sub>	0.90	0.94	1.03	<b>0.95<sup>c</sup></b>	0.57	0.67	0.69	<b>0.64<sup>c</sup></b>	0.84	0.90	1.02	<b>0.92<sup>c</sup></b>
Mean	<b>0.94<sup>c</sup></b>	<b>1.04<sup>b</sup></b>	<b>1.24<sup>a</sup></b>		<b>0.64<sup>c</sup></b>	<b>0.72<sup>b</sup></b>	<b>0.77<sup>a</sup></b>		<b>0.84<sup>c</sup></b>	<b>0.91<sup>b</sup></b>	<b>1.05<sup>a</sup></b>	
	<b>S Em ±</b>		<b>CD at 5%</b>		<b>S Em ±</b>		<b>CD at 5%</b>		<b>S Em ±</b>		<b>CD at 5%</b>	
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<sup>-1</sup>) in plant of ajowan**

Treatments	NPK uptake in plant (kg ha <sup>-1</sup> )											
	Nitrogen				Phosphorous				Potassium			
	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Mean
INM <sub>1</sub>	87.79	61.95	74.08	<b>74.60<sup>a</sup></b>	61.10	38.53	46.19	<b>48.60<sup>a</sup></b>	61.99	43.27	46.7	<b>50.65<sup>a</sup></b>
INM <sub>2</sub>	66.77	46.09	62.04	<b>58.30<sup>b</sup></b>	48.92	38.21	43.34	<b>43.49<sup>b</sup></b>	49.29	37.57	38.51	<b>41.79<sup>b</sup></b>
INM <sub>3</sub>	38.97	28.44	31.36	<b>32.92<sup>d</sup></b>	26.50	19.90	21.46	<b>22.62<sup>d</sup></b>	22.74	19.46	20.55	<b>20.91<sup>d</sup></b>
INM <sub>4</sub>	53.18	37.99	46.88	<b>46.01<sup>c</sup></b>	36.85	31.51	32.01	<b>33.45<sup>c</sup></b>	34.51	28.84	31.24	<b>31.53<sup>c</sup></b>
<b>Mean</b>	<b>61.67<sup>a</sup></b>	<b>43.61<sup>c</sup></b>	<b>53.59<sup>b</sup></b>		<b>43.34<sup>a</sup></b>	<b>32.03<sup>c</sup></b>	<b>35.75<sup>b</sup></b>		<b>42.13<sup>a</sup></b>	<b>32.28<sup>c</sup></b>	<b>34.25<sup>b</sup></b>	
	<b>S Em ±</b>		<b>CD at 5%</b>		<b>S Em ±</b>		<b>CD at 5%</b>		<b>S Em ±</b>		<b>CD at 5%</b>	
<b>INM</b>	0.34		1.00		0.35		1.04		0.34		1.00	
<b>S</b>	0.29		0.87		0.30		0.90		0.29		0.87	
<b>INM X S</b>	0.59		1.74		0.61		1.80		0.59		1.74	

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