



Influence of Integrated Nutrient Management and Plant Geometry on Nutrient Uptake of Ajowan (*Trachyspermum ammi* L. Sprague) in the Southern Zone of Telangana, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i133002

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/98973>

Original Research Article

Received: 22/02/2023
Accepted: 25/04/2023
Published: 22/05/2023

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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 (INM₁, INM₂, INM₃ and INM₄) and three plant geometries (S₁, S₂ and S₃). 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 T₃ (INM₁+ S₃) over other treatments where as, T₁₀ (INM₄+ S₁) 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 T₃ (INM₁+ S₃) while, the minimum was recorded in T₇ (INM₃+ S₁). 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 T₁(INM₁+ S₁), while it was the lowest in T₈ (INM₃+ S₂).

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

1. INTRODUCTION

“Ajowan is widely grown in arid and semi-arid regions where soils contain high salts. The essential oil from seeds is used in the perfumery, essence and medicinal preparations” [1]. “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” [2]. “The combination effect of organic manures and nitrogen fixing bio fertilizers and phosphate solubilizing bacteria helps to increase the availability of nutrients” [3,4]. “The 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 an increase in cation

exchange capacity and water holding capacity of the soil” [5]. So, this study aimed to determine the effects of integrated nutrition management and plant geometry on the absorption of nutrients by ajowan (*Trachyspermum ammi* L. Sprague) in Telangana's southern region.

2. 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% P₂O₅) and MOP (60% K₂O) 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” [2]. 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 T₁ : 100% NPK (20:40:20 kg/ha) + FYM (12t/ha)+Vermicompost (6t/ha)+Neem cake (3t/ha) + AMC (7.5 litres/ha) with Spacing S₁ (30X10 cm), T₂ : 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).

2.1 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.

Uptake of nutrient = (Percentage of nutrient in dry matter x Total dry matter (Kg ha⁻¹)) / 100

3. RESULTS AND DISCUSSION

3.1 Soil Analysis

3.1.1 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 INM₁ (323.81 kg ha⁻¹) followed by plant grown at INM₂ (301.49 kg ha⁻¹) however lower nitrogen content in the soil was observed at INM₄ (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 (INM₁ + S_3) (351.33 kg ha⁻¹), followed by T_6 (INM₂ + S_3)(323.04 kg ha⁻¹), and was on par with T_2 (INM₁ + S_2) (322.86 kg ha⁻¹). The least content of nitrogen in soil was observed in T_{10} (INM₄ + S_1) (223.10 kg ha⁻¹).

3.1.2 Estimation of phosphorous in soil (Kg ha⁻¹)

The maximum content of phosphorous is present at INM₁ (89.34 kg ha⁻¹) followed by plant grown at INM₂ - (83.11 kg ha⁻¹) however lower phosphorous content in the soil was observed at INM₄ (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 (INM₁ + S_3) (96.94 kg ha⁻¹) followed by T_2 (INM₁ + S_2) (95.05 kg ha⁻¹) which were on par with T_6 (INM₂ + S_3) (94.82 kg ha⁻¹). The least content of phosphorous in soil was observed in T_{10} (INM₄ + S_1) (54.62 kg ha⁻¹).

3.1.3 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 INM₁ (206.21 kg ha⁻¹) followed by plant grown at INM₂ (193.85 kg ha⁻¹) however lower potassium content in the soil was observed at INM₄ : (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 (INM₁ + S_3) (231.88 kg ha⁻¹) followed by T_2 (INM₁ + S_2)(204.09 kg ha⁻¹) however lower potassium content in the soil was observed at T_{10} (INM₄ + S_1) (139.02 kg ha⁻¹).

3.2 Plant Analysis

3.2.1 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 INM₁ (1.41%) compared to all other integrated nutrient management levels, followed by INM₂ (1.16%), however lower nitrogen content in the plant was observed at INM₃ (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 T₃ (1.65%), followed by T₆ (INM₂ + S₃) (1.44%). The lowest nitrogen content in plant was found at T₇ (INM₃ + S₁) (0.71%).

3.2.2 Phosphorous content in plant (%)

The phosphorous content in the plant at harvest was significantly higher at INM₁ (0.89%) over all other integrated nutrient management levels under consideration, followed by INM₂ (0.82%), however lower phosphorous content in the plant was observed at INM₃ (0.50%). Regarding plant geometries evaluated, significantly higher phosphorous content was observed with plant geometry (S₃) 45 cm x 30 cm (0.77%), followed by (S₂) 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 T₃ (INM₁ + S₃) (0.93%), followed by T₂ (INM₁ + S₂) (0.90%). The lowest phosphorous content was found at T₇ (INM₃ + S₁) (0.39%).

3.2.3 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 INM₁ (1.06%) over all other integrated nutrient management levels investigated. Regarding plant geometries evaluated, significantly higher Potassium content was

observed with plant geometry (S₃) 45 cm x 30 cm (1.05%), followed by (S₂) 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 T₃ (INM₁ + S₃) (1.20%), followed by T₆ (INM₂ + S₃) (1.14%). The lowest Potassium content was found at T₇ (INM₃ + S₁) (0.75%).

3.2.4 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 INM₁ (74.60, 48.60 and 50.65 respectively), followed by INM₂ (58.30, 43.49 and 41.79 respectively) however minimum nutrient uptake was recorded in INM₃ (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. [6], Dadheech & Sumeriya [7] in isabgol and Anwar et al. [8] in French basil and Wankhade et al. [9] in musk mallow.

Among the different plant geometries evaluated, significantly maximum nitrogen, phosphorous and potassium uptake was at (S₁) 30 cm x 10 cm (61.67, 43.34 and 42.13 respectively), followed by (S₃) 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 (S₂) 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 T₁ (INM₁ + S₁), although least nitrogen, phosphorous and potassium uptake (28.44, 19.90 and 19.46 respectively) was at T₈ (INM₃ + S₂). 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. [10] in isabgol, Joy et al. [11] in *Curculigo orchoides* & Meena et al. [12] in chandrasur.

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 | S ₃ | 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 | S ₃ | 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 | S ₃ | Mean |
| INM₁ | 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 |
| INM₂ | 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 |
| INM₃ | 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 |
| INM₄ | 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 |

4. CONCLUSION

The outcome of the present investigation revealed that available nitrogen, phosphorous and potassium content in soil and plant were found significantly higher in T₃ (INM₁+ S₃) over other treatments. Regarding nutrient uptake by the crop, nitrogen, phosphorous and potassium were found significantly higher in T₁(INM₁+ S₁) due to more population per unit area.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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