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Studies on effect of integrated nutrient management and Spacing on yield of ajowan (*Trachyspermum ammi* L. Sprague) in Southern zone of Telangana

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ABSTRACT: A field experiment on effect of integrated nutrient management and Spacing on yield attributes of ajowan was conducted at College of Horticulture, Rajendranagar, Hyderabad during *late kharif* season of 2019-20. 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 spacings (S_1, S_2 and S_3). The results of present study demonstrated that significantly maximum number of days to 50% flowering (49.79), days to harvest from transplanting (109.56), more number of umbels per plant (226.24), umbellate per umbel (16.70), number of seeds per umbel (159.97) and seeds per umbellate (18.24) was recorded in T_3(INM_1+ S_3). However, the test weight (1.66 g) and seed yield per plant (8.58 g) were found significant and also maximum with the application of T_2 (INM_1 + S_2) while, minimum was noticed in T_7 (INM_3 + S_1). Maximum seed yield per plot (1543.73 g/plant) and seed yield per hectare (2575.03 kg ha^{-1}) were recorded in T_1 (INM_1+ S_1) where as, T_9 (INM_3+ S_3) recorded the minimum.

Keywords: Umbel, Hectare, Umbellate, seed, spacing, test weight.

INTRODUCTION

Ajowan is an annual, aromatic and herbaceous plant. It is profusely branched with a height of 60–90 cm small, erect with soft fine hair. It has many branched leafy stems, feather like leaves 2–3 pinnately divided segments linear with flowers terminal and compound. The fruits are small, ovoid, muricate, around cremocarps, 2–3 mm long, with greyish-brown compressed mericarps with distinct five ridges and tubercular surface. The fruits have a very pungent aromatic taste and when rubbed, they evolve a strong aromatic odour resembling that of thyme (*Thymus vulgaris*). Ajowan seeds are consumed as a spice because of its characteristic aromatic smell and pungent taste. It is used as a household remedy for indigestion. Ajowan is much valued for its antispasmodic, stimulant, tonic and carminative properties. It is administered in flatulence, dyspepsia, diarrhoea and often recommended for cholera. Spacing is an important factor for better growth and yield of the plant. Optimum number of plants are required per unit area to utilize efficiently the available production factors such as water, nutrient, light and CO_2. Maximum exploitation of these factors is achieved when the plant population put forth maximum pressure on all the factors of production. As a result, individual plants are put under severe stress because of inter-plant competition. Normally maximum yields are obtained from plant populations which do not allow plants to achieve their individual maximum potential. Thus, the entire community of plants considered for higher production rather than individual plant performance (Balasubramaniyam and Palaniappan 2005). Organic manures produce food of high quality, encourage and enhance biological cycles within the farming system involving micro-organisms, soil flora and fauna, plants and animals and maintain and increase the long term fertility of soils (Mahapatra and Thirumalaiandi 2009).

MATERIALS AND METHODS

A field experiment was carried out during 2019-20 at College of Horticulture, Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, Hyderabad. The experiment was laid out in a factorial randomized block design with 12 treatments, replicated thrice. The treatments include four INM levels [INM_1] 100% NPK (20:40:20 kg/ha) + FYM (12 t/ha) + VC (6 t/ha) + NC (3 t/ha) + AMC (7.5 litres/ha), [INM_2] 75% NPK (15:30:15 kg/ha) + FYM (12 t/ha) + VC (6 t/ha) + NC (3 t/ha) + AMC (7.5 litres/ha), [INM_3] 50% NPK (10:20:10 kg/ha) + FYM (12 t/ha) + VC (6 t/ha) + NC (3 t/ha) + AMC (7.5 litres/ha), [INM_4] 100% NPK + FYM (12 t/ha) (Control) and three spacings (S_1) 30 cm x 10 cm, (S_2) 30 cm x 30 cm and (S_3) 45 cm x 30 cm. One fourth of N, K_2O and entire dose of P_2O_5 were applied as basal application. Remaining dose of $3/4^{th}$ nitrogen and potassium was applied in three equal splits at 30, 60 and 90 days after transplanting. Organic manures *viz.*, well decomposed farm yard manure (12 t/ha), vermicompost (6 t/ha) and neem cake (3 t/ha) were incorporated in to respective plots one week before sowing of seed and thoroughly mixed with soil. The biofertilizer *viz*., Arka Microbial Consortium (7.5 lit/ha) was mixed with 500 kg FYM and applied during land preparation. Observation on days to 50 % flowering, number of umbels per plant, number of umbellate per umbel, number of seeds per umbel, number of seeds per umbellate, seed yield per plant, seed yield per plot, seed yield per hectare and weight of 1000 seeds were taken. To ascertain the economic feasibility of different treatments, economics of treatments was worked out in terms of net profit per hectare so that most remunerative treatment could be recommended. The net return was calculated by subtracting cost of cultivation of each treatment from gross return. The B:C ratio was computed by dividing gross return with cost of cultivation of each treatment.

The data was analysed as per ANOVA outlined by Panse and Sukhatme[3], 1985. Statistical significance was tested by 'F' value at 5 per cent level of significance. The critical difference at 0.05 levels was worked out for the effects which were significant.

RESULTS AND DISCUSSION

The data enunciated on days taken to 50% flowering as affected by the integrated nutrient management, plant geometry and their interaction is tabulated in the Table 1. The plants grown with INM_1 (47.88) needed significantly more number of days for 50% flowering, followed by INM_2 (46.74), which were on par with INM_4 (Control) (46.69), where as INM_3 recorded less number of days taken to 50% flowering (43.84). Similarly, the plant geometry of (S_3) 45 cm × 30cm required significantly more number of days for 50% flowering (48.28) compared to the other two arrangements. Among the interactions, maximum number of days required for 50% flowering (49.79) was recorded with the application of T_3 (INM_1 + S_3), followed by T_6(INM_2 + S_3) (48.72), T_{12}(INM_4 + S_3) (48.08) and T_{11} (INM_4 + S_2)(47.45). Minimum number of days taken for 50% flowering is (41.14 days) was observed in the T_7 (INM_3 + S_1) treatment. Similar results were also reported by Kalidasu *et al*. (2008) in coriander and Sunanda[5] *et al*. (2014) in kasuri methi.

Table 1: Effect of integrated nutrient management (INM) and plant geometry(S) on yield attributes of ajowan.

Treatments	Days to 50 % flowering	Days to harvest	Number of umbels per plant	Number of umbellates per umbel	Number of seeds per umbel
INM					
INM_1	47.88 ^{a}	107.69 ^{a}	218.88 ^{a}	14.95 ^{a}	152.31 ^{a}
INM_2	46.74 ^{b}	106.38 ^{b}	208.54 ^{b}	14.11 ^{b}	144.28 ^{b}
INM_3	43.84 ^{c}	105.20 ^{d}	175.66 ^{d}	11.35 ^{d}	136.07 ^{d}
INM_4	46.69 ^{b}	105.68 ^{c}	180.62 ^{c}	13.12 ^{c}	142.11 ^{c}
S Em ±	0.019	0.032	0.35	0.02	0.28
CD at 5%	0.058	0.095	1.05	0.06	0.84
Spacings					
S_1	44.42 ^{c}	104.89 ^{c}	188.57 ^{c}	12.37 ^{c}	139.83 ^{c}
S_2	46.16 ^{b}	105.90 ^{b}	195.59 ^{b}	13.20 ^{b}	143.78 ^{b}
S_3	48.28^a	107.92^a	203.60 ^{a}	14.57 ^{a}	147.46 ^{a}
S Em ±	0.017	0.028	0.31	0.01	0.24
CD at 5%	0.050	0.082	0.90	0.05	0.73
INM X S Interaction					
T_1	46.60	106.35	209.49	13.60	146.14
T_2	47.27	107.16	220.91	14.56	150.82
T_3	49.79	109.56	226.24	16.70	159.97
T_4	45.40	105.12	198.31	13.18	142.25
T_5	46.08	106.09	209.78	13.87	144.89
T_6	48.72	107.93	217.53	15.28	145.71
T_7	41.14	103.69	171.53	10.15	132.13
T_8	43.85	105.29	174.55	11.63	136.75
T_9	46.54	106.63	180.91	12.29	139.33
T_{10}	44.56	104.41	174.96	12.58	138.82
T_{11}	47.45	105.07	177.15	12.77	142.69
T_{12}	48.08	107.57	189.75	14.02	144.83
S Em ±	0.034	0.056	0.62	0.03	0.49
CD at 5%	0.10	0.165	1.81	0.11	1.46

Among the integrated nutrient management evaluated (Table 1), significantly more number of days taken to harvest was observed in INM_1 (107.69), followed by INM_2(106.38), however minimum number of days (105.20) required for harvesting was recorded with INM_3. Plant grown with plant geometry (S_3) required significantly more number of days (107.92) for harvesting. The minimum (104.89) was recorded with plant geometry (S_1). Regarding the interaction effect, plants grown with T_3 (INM_1 + S_3) required more number of days (109.56) for harvesting, followed by T_6 (INM_2 + S_3) (107.93) and T_{12} (INM_4 + S_3) (107.57). The minimum number of days for harvesting was observed with T_7 (INM_3 + S_1) (103.69). These findings are in close conformity of Yadav and Khurana (2000), Yadav *et al.* (2002) in fennel.

Regarding the number of umbels per plant and umbellates per umbel was significantly influenced by the integrated nutrient management, plant geometry and their interactions is presented in table 1. Significantly maximum number of umbels per plant (218.88) and umbellate per umbel (14.95) was noticed with the application of INM_1 followed by (208.54) and (14.11) respectively at INM_2. Among the different plant geometries evaluated, significantly more number of umbels per plant and umbellates per umbel was observed with 45 cm × 30 cm spacing (203.60) and (14.57) respectively, where as, (S_1) 30 cm × 10 cm recorded minimum number of umbels per plant (188.57) and umbellates per umbel (12.37). Regarding the interaction effect, significantly more number of umbels per plant (226.24) and umbellates per umbel (16.70) was found at T_3 (INM_1 + S_3), While the minimum number of umbels per plant (171.53) and umbellates per umbel (10.15) was observed with T_7 (INM_3 + S_1). The results are in accordance with Yadav *et al.* (2000) in fennel.

Significantly maximum number of seeds per umbel (Table 1) (152.31) and seeds per umbellate (Table 2) (16.14) was noticed with the application of INM_1 followed by (144.28) and (15.30) respectively at INM_2. Among the different plant geometries evaluated, significantly more number of seeds per umbel and seeds per umbellate was observed with 45 cm x 30 cm spacing (147.46) and (15.67) respectively, where as, (S_1) 30 cm x 10 cm recorded minimum number of seeds per umbel (139.83) and seeds per umbellate (13.59). Regarding the interaction effect, significantly more number of seeds per umbel (159.97) and seeds per umbellate (18.24) was found at T_3 (INM_1 + S_3), While the minimum number of seeds per umbel (132.13) and seeds per umbellate (12.71) was observed with T_7 (INM_3 + S_1). Similar results was noticed by Yadav *et al.* (2000) in fennel and Naruka *et al.* (2012) in ajowan.

Table 2: Effect of integrated nutrient management (INM) and plant geometry(S) on yield attributes of ajowan.

Treatments	Number of seeds per umbellates	Test weight (g $plant^{-1}$)	Seed yield per plant (g $plant^{-1}$)	Seed yield per plot (g $plant^{-1}$)	Seed yield per hectare (kg ha^{-1})
INM					
INM_1	16.14 ^{a}	1.46 ^{a}	8.37 ^{a}	805.84 ^{a}	1345.24 ^{a}
INM_2	15.30 ^{b}	1.28 ^{b}	6.76 ^{b}	614.45 ^{b}	1024.56 ^{b}
INM_3	12.84 ^{d}	0.89 ^{d}	4.34 ^{d}	410.68 ^{d}	687.49 ^{d}
INM_4	13.97 ^{c}	1.11 ^{c}	5.44 ^{c}	504.81 ^{c}	840.39 ^{c}
S Em ±	0.06	0.008	0.036	3.52	3.36
CD at 5%	0.20	0.024	0.10	10.34	9.86
Spacings					
S_1	13.59 ^{c}	1.05 ^{c}	5.85 ^{c}	1098.09 ^{a}	1832.94 ^{a}
S_2	14.41 ^{b}	1.29 ^{a}	6.68 ^{a}	398.60 ^{b}	665.04 ^{b}
S_3	15.67 ^{a}	1.21 ^{b}	6.15 ^{b}	255.14 ^{c}	425.28 ^{c}
S Em ±	0.05	0.007	0.031	3.05	2.91
CD at 5%	0.17	0.021	0.09	8.96	8.54
INM X S Interaction					
T_1	14.76	1.24	8.17	1543.73	2575.03
T_2	15.43	1.66	8.58	535.99	895.47
T_3	18.24	1.48	8.38	337.81	565.23
T_4	13.81	1.14	6.13	1162.97	1938.45
T_5	15.34	1.38	7.72	424.05	706.78
T_6	16.76	1.33	6.43	256.34	428.47
T_7	12.71	0.85	4.16	743.10	1247.49
T_8	12.88	0.93	4.48	281.32	468.97
T_9	12.91	0.91	4.40	207.62	346.03
T_{10}	13.10	1.00	4.96	942.59	1570.82
T_{11}	14.02	1.20	5.94	353.06	588.97
T_{12}	14.79	1.14	5.42	218.8	361.40
S Em ±	0.11	0.014	0.063	6.12	5.82
CD at 5%	0.35	0.043	0.18	17.92	17.09

The data on test weight, and Seed yield per plant (g $plant^{-1}$) which is furnished in the table 2. Regarding the integrated nutrient management evaluated, it was observed that highest test weight (1.46) and Seed yield per plant (g $plant^{-1}$) (8.37) was recorded with INM_1, followed by INM_2(1.28 and 6.76 respectively), where as INM_3 (0.89 and 4.34 respectively) recorded the lowest test weight and Seed yield per plant. Among the different plant geometries evaluated, significantly higher test weight (1.29) and Seed yield (g $plant^{-1}$) (6.68) was observed with plant geometry of (S_2) 30 cm × 30 cm. With respect to the interaction effect, maximum test weight (1.66) and Seed yield per plant (8.58) was observed with T_2 (INM_1 + S_2), followed by T_3 (INM_1 + S_3) (1.48 and 8.38 respectively). However, minimum test weight (0.85) and Seed yield (g $plant^{-1}$) (4.16) was found at T_7 (INM_3 + S_1). The overall improvement in plant growth by cell division, cell enlargement and production of sufficient photosynthates through increased chlorophyll content of leaves on one hand and efficient utilization/ mobilization of photosynthates towards development of flowers and fruits on the other hand, might have been responsible for increased yield attributes like test weight and Seed yield (g $plant^{-1}$). Similar results was noticed by Valadabadi and Farahani (2011) on *Nigella sativa* L.

Seed yield per plot and per hectare was significantly influenced by the integrated nutrient management, plant geometry and their interactions were presented in Table 2. Regarding integrated nutrient management, significantly higher seed yield per plot (805.84 g $plot^{-1}$) and per hectare (1345.24 Kg ha^{-1}) was recorded with the application of INM_1, over all other combinations. The lowest seed yield per plot (410.68 g $plot^{-1}$) and per hectare (687.49 kg ha^{-1}), was observed at INM_3, which was significantly inferior to all other combinations. Among the different plant geometries evaluated, significantly higher seed yield per plot (1098.09 g $plot^{-1}$) and per hectare (1832.94 Kg ha^{-1}) was recorded with the plant geometry 30 cm × 10 cm. The significantly lowest seed yield per plot and per hectare was observed with the plant geometry (S_3) 45 cm × 30 cm (255.14 g $plot^{-1}$ and 425.28 Kg ha^{-1} respectively). Among the interactions, significantly higher seed yield per plot (1543.73 g $plot^{-1}$) and per hectare (2575.03 Kg ha^{-1}) was recorded with the application of T_1 (INM_1 + S_1) followed by T_4 (INM_2 + S_1) (1162.97 g $plot^{-1}$ and 1938.45 Kg ha^{-1} respectively), which were significantly superior to all other treatments. The lowest seed yield per plot (207.62 g $plot^{-1}$) and per hectare (346.03 Kg ha^{-1}) was noticed at T_9 (INM_3 + S_3). The above results indicated that plant with closer spacing with integrated nutrient management leads to more seed yield per plot compared to wider spacing that might be due to more plant population per unit area resulted in higher yield per plot. Similar results were reported by Muvel *et al.* (2015), Tripathi and Diwedi (2009) and Premnath *et al.* (2008) in ajowan.

Economics

Net returns and benefit cost ratio worked out for the entire integrated nutrient management practices taking into consideration of the inputs used for crop production, and the crop produce (economic yield). The data regard to the net returns and benefit cost ratio of integrated nutrient management with plant geometries are furnished in Table 3. The maximum net returns (Rs. 2,32,305) with BC ratio of 3.02 was recorded in T_1 (INM_1 + S_1) followed by T_4 (INM_2 + S_1) and plant with T_9 (INM_3 + S_3) incurred the lower net returns (Rs. 638) and BC ratio (0.01).

Table 3: Effect of integrated nutrient management (INM) and plant geometry(S) on cost of cultivation in different treatments (₹ ha^{-1}).

Treatment combination	Cost of seedling and fertilizers (NPK) (₹)	Total cost of cultivation (₹)	Seed yield (q ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	Benefit cost ratio (B:C ratio)
T_1 (INM_1+ S_1)	36823	76695	25.75	309000	232305	3.02
T_2 (INM_1+ S_2)	14583	54455	8.95	107400	52945	0.97
T_3 (INM_1+ S_3)	10990	50862	5.65	67800	16938	0.34
T_4 (INM_2+ S_1)	35949	75821	19.38	232560	156739	2.06
T_5 (INM_2+ S_2)	13709	53581	7.06	84720	31139	0.58
T_6 (INM_2+ S_3)	10116	49988	4.28	51360	1372	0.02
T_7 (INM_3+ S_1)	35077	74946	12.47	149640	74694	0.99
T_8 (INM_3+ S_2)	12837	52709	4.68	56160	3451	0.06
T_9 (INM_3+ S_3)	9244	40882	3.46	41520	638	0.01
T_{10}(INM_4+ S_1)	36823	65723	15.70	188400	122677	1.86
T_{11}(INM_4+ S_2)	14583	43483	5.88	70560	27077	0.63
T_{12}(INM_4+ S_3)	10990	39890	3.61	43320	3430	0.08

Plants at 30 DAT

Plants at 60 DAT

Plants at 90 DAT

Plate 1: General view of the experiment at 30, 60 and 90 DAT.

CONCLUSION

It is clearly concluded that there is a good scope of increasing crop yields through the use of organic manures, bio-fertilizers with different NPK levels. It is extremely important for sustaining production and improving the fertility of soils. The present study indicated that crop grown with T_3 (INM_1+ S_3) recorded more number of umbels per plant, number of umbellate per umbel, number of seeds per umbel, number of seeds per umbellate due to profuse branching and more number of secondary and primary branches. However, the highest seed yield per plot and per hectare was recorded in T_1 (INM_1+ S_1) due to more population per unit area.

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