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Effect of spacing and fertilizer levels on growth, yield and yield attributes of different ajwain (*Trachyspermum ammi* L.) genotypes

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Abstract

The present study was conducted at research farm of NRCSS, Ajmer (Rajasthan), India, to study the effect of spacing and fertilizer levels on different genotypes of ajwain. The treatments comprised of two spacing *viz.,* 30 cm x 15 cm (S1), 40 cm x 20 cm (S2) and two fertilizer levels *viz.,* F1 - 80: 50: 50 kg NPK ha^{-1}, F2 - 100: 62.5: 62.5 kg NPK ha^{-1} and three genotypes *viz.,* – Ajmer Ajwain-2 (V1), Ajmer Ajwain-93 (V2) and Ajmer Ajwain-73 (V3). The experiment was laid out in Randomized Block Design with factorial concept in three replications. Results revealed that significantly higher seed yield (1340.1 kg ha^{-1}), straw yield (2517.5 kg ha^{-1}) and biological yield (3857.6 kg ha^{-1}) and harvest index (34.81%) were recorded at a spacing of 30 cm x 15 cm (S1) as compared to 40 cm x 20 cm (S2) spacing. The numbers of umbels/plant (220.6), test weight (1.01 g) were higher in 40 cm x 20 cm (S2) spacing and harvest index (34.81) was higher in 30 cm x 15 cm (S1). Irrespective of spacing and genotypes, the fertilizer levels of NPK 100: 62.5: 62.5 (F2) recorded significantly more umbels (221.0) $plant^{-1}$, seeds (342.28) $umbel^{-1}$, seed yield (1275.9 kg ha^{-1}), straw yield (2396.0 kg ha^{-1}), biological yield (3671.9 kg ha^{-1}), 1000 seed weight (1.06 g) and harvest index (34.72) as compared to F1 fertilizer level. Significantly higher number of umbels (249.5 $plant^{-1}$), seed (21.1 $umbel^{-1}$), seed yield (1321.0 kg ha^{-1}), straw yield (2427.5 kg ha^{-1}) and biological yield (3748.5 kg ha^{-1}) were recorded in AA-73 (V3) as compared to AA-2 (V1) genotypes. The interaction effect of V3 x S2 x F2 recorded significantly more umbels (285.87 $plant^{-1}$) and total number of seed (377.04 $umbel^{-1}$) and seed (22.47 $umbellate^{-1}$) was higher and equal in V3 x S2 x F2 and V3 x S2 x F1, test weight (1.40 g) was equal and higher in V1 x S2 x F2 and V1 x S1 x F2, seed yield ha^{-1} (1508.49 kg ha^{-1}) in V3 x S1 x F2 straw yield (2770.00 kg ha^{-1}) in V1 x S1 x F2, whereas, biological yield (4258.49 kg ha^{-1}) in V3 x S1 x F2.Theinteraction effect of V3 x S1x F1 were recorded maximum net-return ₹ 131336 and B: C ratio (5.25). From the it is inferred that genotype AA-72 sown at narrow spacing of 30x15 cm with application of 125 % RDF(NPK: 100:62.5:62.5) is found better for realizing higher, yield, net return and benefit followed by genotype AA-93 sown at narrowing spacing with application of 100 % RDF.

Key words : Ajwain, fertilizers, genotypes , net return, spacing, yield

Introduction

Ajwain (*Trachyspermum ammi* L.) also known as Bishop's weed is an annual herbaceous plant belonging to family Apiaceae bearing grayish brown fruits. The major ajwain producing countries are India, Persia, Iran, Egypt, Afghanistan, Pakistan and North Africa. In India it is grown in Gujarat, Rajasthan, M.P. and A.P. Major Parts of ajwain production in Rajasthan are in Chittorgarh, Udaipur, Jhalawar, Rajsamand, Kota, and Bhilwara. Large quantity of this spice is consumed in our country itself. In seed production of field crops, it is most desirable and also essential to achieve the twin objective of maximum crop growth and seed yield simultaneously and this could be achieved largely by providing the most optimum plant population per unit area and balanced nutrient under field conditions, which could be provided by optimizing the spacing and fertilizer levels. Obviously these two factors will not only enhance the productivity of seed but also decide the ultimate commercial success of ajwain crop. It is essential to provide optimum plant population density per unit area by adjusting the spacing levels in ajwain crop unlike in normal spacing the plants grown in closer spacing exhibited more vertical growth but give less yield and poor quality seeds for need of sufficient space, light, nutrient and moisture due to heavier plant population pressure (Dhanraj *et al.,* 2001). Whereas, the plants grown in the wider spacing exhibit more horizontal and continuous vegetative growth due to less population pressure per unit area but, they also give less yield per unit area. However, plants grown under normal spacing will have optimum population density per unit area which provides optimum conditions for luxuriant crop growth and better plant canopy area due to maximum light interception, photosynthetic activity, assimilation and accumulation of more

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photosynthates into plant system and hence they produce more seed yield of best quality traits (Mazumdar *et al.,* 2007).

Similar to spacing, judicious application of nutrients play a decisive role in deciding the ultimate success of seed production of ajwain by realizing higher growth and seed yield. Altering the soil nutrients and fertility status by providing balanced and adequate major nutrients like nitrogen, phosphorus and potassium as per the crop requirement is one of the easiest ways to boost up productivity of ajwain seed. Under this backdrop scenario, there is a need to develop a suitable production technology in ajwain by optimizing the spacing and fertilizer levels to get higher crop growth and higher seed yield. In view of above aspects, the present study on effect of spacing and fertilizer levels on different genotypes of ajwain (*Trachyspermum ammi* L.) was undertaken.

Materials and methods

The experiment on effect of spacing and fertilizer levels on different genotypes of ajwain (*Trachyspermum ammi* L.) was conducted on sandy loam soil during '*Rabi*' season 2012-13 of research farm of NRCSS, Ajmer (Rajasthan) India. The field experiment consisted of two spacing *viz.,* 30 cm x 15 cm (S1), 40 cm x 20 cm (S2) and two fertilizer levels *viz.,* F1 - 80: 50: 50 kg NPK ha^{-1}, F2 - 100: 62.5: 62.5 kg NPK ha^{-1} and three genotypes *viz.,* – Ajmer Ajwain-2 (V1), Ajmer Ajwain-93 (V2) and Ajmer Ajwain-73 (V3). The experiment was laid out in Randomized Block Design with factorial concept in three replications. The soil of the experimental field was sandy loam sand having low organic matter (0.23 %), available nitrogen (178.65 kg ha^{-1}), phosphorus (12.0 kg ha^{-1}) and enough available potassium (165 kg ha^{-1}), slightly alkaline with pH (8.04) and EC (0.076 dS m^{-1}). The crop was shown on 8th October. Irrigation was applied immediately after sowing. All other standard rpackage of practices were followed during whole cropping season. Yield parameter and growth parameter were recorded in five plant of each plot and average was worked out. Statistical analysis was done through procedure prescribed by (Panse and Sukhatme, 1985).

Results and discussion

Growth Parameters

Growth parameters *viz.* plant height, number of branches plant^{-1}, number of secondary branches plant^{-1}, number of nodes plant^{-1} and days taken to 50 percent flowering were significantly influenced with varying crop geometry. Sowing of ajwain at a crop geometry of 40 cm x 20 cm exhibited more number of branches plant^{-1} (14.0), number of secondary branches plant^{-1} (164.2), number of nodes plant^{-1} (14.34) and more number of days to 50% flowering (77.) over crop geometry of 30 cm x15 cm but higher plant height at harvest was recorded at closer spacing. The marked increase in plant height in narrow spacing may be attributed to its higher plant population density which might have resulted in less plant canopy and exhibited more vertical growth by producing weak, lanky and taller plants due to stiff competition for space, light, nutrients and moisture (Pandey*et al.*, 1996). At harvest, number of primary branches, number of secondary branches, and nodes plant^{-1} were significantly more in spacing of 40 cm x 20 cm which might be due to the better growth of plants under broader spacing due to less plant population density and competition and it resulted in more horizontal growth and plant canopy area compared to those under narrow spacing. The similar increase in number of branches and plant dry matter production under wider spacing were also confirmed by Kanwar and Saimbhi (1989) and Mohammed (1990) in fenugreek, Mehta *et al.,* (2013).

Growth parameters at harvest were significantly influenced with application of varying levels of fertilizer. Application of 125% RDF resulted higher plant height, number of branches plant^{-1}, number of secondary branches plant^{-1}, number of nodes plant^{-1} at harvest and days taken to 50 percent flowering over application of 100% RDF. The significant rise in growth parameters noticed under higher fertilizer level may be ascribed to greater uptake of nutrients by the plants favoring better cell division, elongation, amino acid and protein synthesis and it might have produced more plant height, number of branches, number of nodes and plant dry matter production compared to recommended fertilizer level. The similar increase in growth parameters under higher fertilizer levels were also noticed by Thakral *et al.*, (1991) and Patil *et al.*, (1995) in coriander.

At harvest, a genotypes of AA-73 exhibited significantly the more umber of primary branches plant^{-1} (14.3), number of secondary branches (188.7) but higher plant height (118.4 cm) and more number of nodes (14.90), and least days taken to 50 % flowering (65 days) were recorded in plant genotype AA-93 (Table-1). The significant variation in growth parameters due to different genotype might be due to their inbuilt genetic potentiality. (Table 1)

Yield attributes and yield

Significant variations due to spacing were seen for the yield attributes and seed yield. A crop geometry of wider spacing (40 cm x 20 cm) exhibited more number of umbels plant^{-1} (220.6), umbellate umbel^{-1} (19.3), seeds umbellate^{-1} (20.1), seeds umbel^{-1} (341.69) over narrow spacing of 30 cm x 15 cm (S1) (207.5, 18.0, 18.9 and

Table 1. Effect of spacing, fertilizer levels and genotypes on growth parameters in ajwain

Treatments	Plant height (cm)	No. of primary branches plant^{-1}	No. of secondary branches plant^{-1}	No. of Nodes plant^{-1}	Days taken to 50% flowering
Crop geometry					
30 cm x 15 cm (S1)	116.1	13.3	159.8	13.66	75.4
40 cm x 20 cm (S2)	114.1	14.0	164.2	14.34	77.0
S.Em±	1.8	0.2	2.4	0.22	1.1
CD (P = 0.05)	5.2	0.6	7.1	0.63	3.3
Fertilizer levels					
100% RDF (NPK: 80:50:50) (F1)	113.3	12.7	159.0	13.17	75.4
125% RDF (NPK: 100:62.5:62.5) (F2)	116.9	14.7	164.9	14.83	77.1
S.Em±	1.8	0.2	2.4	0.22	1.1
CD (P = 0.05)	5.2	0.6	7.1	0.89	3.3
Genotypes					
AA-2 (V1)	109.7	13.8	168.8	13.28	82.6
AA-93 (V2)	118.4	12.9	128.5	14.90	65.0
AA-73 (V3)	117.3	14.3	188.7	13.82	81.1
S.Em±	2.2	0.3	3.0	0.26	1.4
CD (P = 0.05)	6.4	0.7	8.7	0.77	4.1
CV %	6.6	6.4	6.3	6.53	6.3

Table 2. Effect of spacing, fertilizer levels and genotypes on yield attributes in ajwain

Treatments	No. of Umbels plant^{-1}	No. of Umbellates Umbel^{-1}	No. of Seeds Umbellate^{-1}	No. of Seeds Umbel^{-1}	Test Weight (g)
Crop geometry					
30 cm x 15 cm (S_1)	207.5	18.0	18.9	322.52	0.99
40 cm x 20 cm (S_2)	220.6	19.3	20.1	341.69	1.01
S.Em±	3.4	0.3	0.3	5.15	0.015
CD (P = 0.05)	10.1	0.9	0.8	15.11	0.043
Fertilizer levels					
100% RDF (NPK: 80:50:50) (F_1)	207.1	18.1	19.0	321.92	0.95
125% RDF(NPK: 100:62.5:62.5) (F_2)	221.0	19.2	20.0	342.28	1.06
S.Em±	3.4	0.3	0.3	5.15	0.015
CD (P = 0.05)	10.1	0.9	0.8	21.36	0.043
Genotypes					
AA-2 (V_1)	216.9	18.0	20.2	342.79	1.17
AA-93 (V_2)	175.8	17.3	17.2	291.11	0.88
AA-73 (V_3)	249.5	20.7	21.1	362.40	0.97
S.Em±	4.2	0.4	0.3	6.31	0.018
CD (P = 0.05)	12.4	1.2	1.0	18.50	0.053
CV %	6.8	7.3	6.0	6.58	6.237

Table 3. Effect of spacing, fertilizer levels and genotypes on grain yield, straw yield, biological yield and harvest index

Treatments	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest Index (%)
Crop geometry				
30cm × 15cm (S_1)	1340.1	2517.5	3857.6	34.81
40cm × 20cm (S_2)	1040.5	1964.3	3004.9	34.59
S.Em±	17.7	47.5	61.5	0.31
CD (P = 0.05)	52.0	139.3	180.3	0.91
Fertilizer levels				
100% RDF (NPK: 80:50:50) (F_1)	1104.8	2085.8	3190.6	34.68
125% RDF (NPK: 100:62.5:62.5) (F_2)	1275.9	2396.0	3671.9	34.72
S.Em±	17.7	47.5	61.5	0.31
CD (P = 0.05)	52.0	139.3	180.3	1.29
Genotypes				
AA-2 (V_1)	1202.8	2263.3	3466.1	34.80
AA-93 (V_2)	1047.2	2032.0	3079.2	33.96
AA-73 (V_3)	1321.0	2427.5	3748.5	35.33
S.Em±	21.7	58.2	75.3	0.38
CD (P = 0.05)	63.7	170.6	220.9	1.12
CV %	6.3	9.0	7.6	3.81

322.52 respectively). The superior values of yield attributes noticed under wider spacing may be attributed to better growth and development of individual plants under the density of less plant population which resulted into better source to sink relationship due to availability of balanced and adequate nutrients and better light, space and moisture unlike in wider spacing. Grain yield, straw yield, biological yield and harvest index was higher under narrow spacing due to higher plant density. These results are in conformity with those of Kumar (2004) in fenugreek and Mazumder *et al.*, (2007) in hyacinth bean.

Irrespective of plant genotype and crop geometry, application of varying level of fertilizer significantly influenced yield attributes and yield of ajwain. The more number of umbels plant^{-1}, umbellate umbel^{-1}, seeds umbellate^{-1}, seeds umbel^{-1}, test weight, grain yield, straw yield and biological yield were obtained with the application of higher level of fertilizer over 100 % recommended level of fertilizer**.** This might be ascribed to the efficient amino acid and protein synthesis and better source to sink relationship which resulted in better development of seeds giving rise to higher yield parameters with increasing levels of NPK from 80: 50: 50 kg ha^{-1} (F1) to 100:62.5:62.5 kg NPK ha^{-1} (F2). These results are in corroborative with the findings of Dataram *et al.*, (2001) in fenugreek and Kumar *et al.*, (2004) in Frenchbean.

Different genotype significantly influenced yield attributes and yield of ajwain. AA-2 exhibited significantly the number of umbels plant^{-1}, umbellate umbel^{-1}, seeds umbellate^{-1}, seeds umbel^{-1}, test weight, grain yield, straw yield and biological yield followed by AA-2. The AA-93 resulted the lowest yield attributes and yield but it being shortest duration, per day yield is higher. The yield attributes and yield difference in different genotypes might be due to their genetic makeup and yield potentiality (Table 2,3)

Economic analysis

The economic of different treatments was compared on the basis of returns over operational cost and returns per rupee of operational cost. Gross value of produce (GVP) was calculated on the basis of prevailed average market prices of Ajwain during April-May *i.e.* 50 Rs. kg^{-1} and straw valued at 1 Rs kg^{-1}. Genotype AA-72 (V3) at narrow spacing of 30 x 45 cm with 125% of RDF yielded per ha heighly return over operational cost (Rs 53162 ha^{-1}) results in RS 3.13 return per rupee operational cost followed by T5. (Table 4)

Thus, from the current study it is inferred that genotype AA-72 sown at narrow spacing of 30x15cm with application of 125 % RDF (NPK: 100:62.5:62.5) is better for realizing higher, yield, net return and benefit followed by genotype AA-93 sown at narrowing spacing with application of 100 % RDF.

Table 4. Economics analysis of different treatments for ajwain production

Treat ments	Seed Yield (Kg ha^{-1})	Straw Yield (Kg ha^{-1})	GVP (₹ ha^{-1})	Operational cost (₹ ha^{-1})	Returns over operational cost (₹ ha^{-1})	Returns per rupee operational cost (₹ ha^{-1})
1	1369	2586	71053	23802	47251	2.99
2	1474	2770	76474	25013	51461	3.06
3	660	1229	34229	23952	10277	1.43
4	1308	2468	67843	25163	42680	2.70
5	1415	2725	73488	23802	49686	3.09
6	1082	2084	56197	25013	31184	2.25
7	754	1495	39183	23952	15231	1.64
8	938	1824	48699	25163	23536	1.94
9	1191	2190	61742	23802	37940	2.59
10	1508	2750	78175	25013	53162	3.13
11	1239	2290	64228	23952	40276	2.68
12	1346	2480	69762	25163	44599	2.77

Note: GVP denotes gross value of output at prevailing market price of ajwain during April-May, 2012 i.e. @50 ₹ Kg^{-1}and straw price at @1₹ Kg^{-1}

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