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Yield and economic feasibility of ajwain (*Trachyspermum ammi* L.) under varying irrigation and nutrient levels

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Abstract

Ajwain is an important non-risky and highly remunerative crops of arid and semi-arid regions of Gujarat. An experiment was laid in split plot design to study the irrigation and nutrient requirement of ajwain at Seed Spices Research Station, S. D. A. U. Jagudan during 2011-12 to 2013-14 by comprising two levels of irrigation based on IW: CPE ratio in main plot as well as three nitrogen levels and two levels of phosphorus were kept as sub plot treatments with three replications. Higher seed yield was recorded when ajwain was irrigated at 0.4 IW: CPE ratio. Application of 40 kg N ha^{-1} recorded the significantly higher seed yield of ajwain and was at par with 20 N ha^{-1}, but these both the levels were significantly superior than 60 kg N ha^{-1}. The application of nitrogen at higher rate induce profuse vegetative growth resulted in extension of reproductive stage affected slightly reduction in seed yield. Application of phosphorus recorded the significantly higher yield over no application. Combine application of irrigation water at 0.4 IW / CPE ratio with 40 kg N ha^{-1} found an optimum.

Key words : Ajwain, irrigation, nutrient requirement, seed yield, CPE ratio.

Introduction

India is one of the richest floristic regions of the world and is well-known for its ancient heritage regarding medicinal plant and plant drugs. There are about 20 seed spices grown in India, therefore, India is known as 'land of spices'. Ajwain also known as carom seed (*Trachyspermum ammi* L.) belongs to the family *Apiaceae* which is a native from Egypt and popular seed spice crop in India. It is an annual herbaceous plant bearing small egg shaped grayish brown fruits. Plant parts usually consumed are herb, volatile oil and seeds. Seeds contain medicinal values specially for curing indigestion, stomach pain and elements concerning digestive system (Meena *et. al*.2010). Ajwain contains 2.5 to 4.0 per cent volatile oil which is yellow brownish in colour used in many Ayurvedic medicines and industries of which 'thymol' is main constituent. In India, it is grown on a commercial scale in Rajasthan, Madhya Pradesh, Andhra Pradesh, Gujarat, Maharashtra,Uttar Pradesh and to considerable extent in Bihar and West Bengal. It is an important long duration, highly remunerative and non risky crops of arid and semi-arid regions of Gujarat which requires less costly and scares inputs *i.e*. fertilizer, irrigation, labour *etc*. as compared to other *rabi* crops. The productivity of this crop is low due to its cultivation on marginal lands with low fertility level, lack of improved varieties, and being neglected for developing advance production and protection technology. Water is considered to be the vital input because crop responses to all other inputs chiefly depend on the availability of required quantity of water at right time. Nitrogen is an essential constituent of protein, chlorophyll and played important role in crop metabolism such as nucleotides, phospholipids, alkaloids, enzymes, hormones and vitamins *etc*. Adequate supply of nitrogen promotes higher photosynthetic activity and vigorous vegetative growth resulted more conversion of carbohydrate into protein promotes the formation of protoplasm. Protoplasm, being highly hydrated, is conducive for the succulent plant growth (Balasubramaniyam and Palaniappan, 2005). Phosphorus, being the constituent of nucleic acid, phospholipids, is also very essential for proper development of crops. It imparts hardness to shoot, improves grain quality, regulates photosynthesis, governs physicochemical processes and help in growth of plant at cellular level. It is also known for developing resistant to diseases. The information about irrigation and nutrient requirement of ajwain is meager. Hence, an experiment was planned to study the influence of irrigation and nutrients on ajwain at Seed Spices Research Station, Jagudan.

Material and methods

To find out the irrigation and nitrogen requirement of ajwain crop, an investigation was carried out at Seed Spices

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Research Station, Sardar krushinagar Dantiwada Agricultural University, Jagudan during *rabi* 2010-11 to 2013-14. Soil texture was loamy sand in nature, neutral in soil reaction (7.90) with low in organic carbon (0.18 per cent), medium in available phosphorus (38 Kg P_2O_5 ha^{-1}) and potassium (265 kg K_2O ha^{-1}). An experiment was carry out in split plot design comprising two levels of irrigation based on IW: CPE ratio (0.4 and 0.6 IW: CPE ratio) as main plot and three nitrogen levels (20, 40 and 60 kg N ha^{-1}) and two levels of phosphorus (00 kg P_2O_5 ha^{-1} and 20 kg P_2O_5 ha^{-1}) were kept as sub plot treatments with three replication. The ajwain seeds of variety Gujarat Ajwain 1 were sown manually at about 2-3 cm deep in furrow at 45 cm apart by keeping uniform seed rate. One surface irrigation amounting 50 mm was given for better crop establishment during experimentation period. Total six and eight irrigation of 50 mm depth were applied for 0.4 and 0.6 IW: CPE ratio, respectively. Application of irrigation was based on cumulative pan evaporation. Full dose of phosphorus and half dose of nitrogen were applied as basal whereas, remaining half dose of nitrogen was applied at 30 DAS after scheduling of irrigation for treatments under study. All the cultural operations were carried out as per need of crop and as per recommendation. Observations on growth attributes, yield components and yields were recorded at harvest. The volatile oil content (per cent) of seed was estimated as per steam distillation method (A.O.C.A., 1970).The data have been analyzed for individual years as well as pooled as per standard statistical procedure.

Results and discussion

Growth and yield attributes

All the growth and yield attributes were significantly higher when crop received irrigation at 0.4 IW: CPE ratio than that of with 0.6 IW: CPE ratio except number of branches per plant (Table 1). Mehta *et al* (2013) for ajwain and Patel *et al* (2000) for fennel observed similar tendency for growth and yield attributes. Application of 40 kg N ha^{-1} recorded significantly the maximum growth and yield attributes except number of branches/plant whereas increased nitrogen levels beyond 40 kg N ha^{-1} influenced adversely. Application of phosphorus on growth and quality attributes was found non-significant except number of seeds per umbellate. The results are in conformity with those of Krishnamoorthy and Madalageri (2000) who found significant increase in yield attributes of ajwain with increased levels of N and P_2O_5.The similar trend was also reported by Amin *et al* (2016) for cumin crop, Mehta *et al* (2013) and Muvel (2015) for ajwain crop.

Seed yield

Application of irrigation at 0.4 IW: CPE ratio recorded significantly higher seed yield than that of with 0.6 IW: CPE ratio. The application of irrigation at longer interval in ajwain produced significantly higher seed yield (Mehta *et al*, 2013). Correspondingly, Patel *et al* 2007 also found similar trend for fennel. Effect of nitrogen levels on seed yield of ajwain was significant (Table 1) and increased with increase in nitrogen level up to 40 kg ha^{-1}, whereas, it was lowest under application of 60 kg N ha^{-1}. Application of phosphorus showed a beneficial effect on seed yield and was significantly higher with application of 20 kg P ha^{-1} than no application. Application of increasing levels of N and P enhanced yield attributes which resulted increase in seed and biological yield of ajwain. Eetela Sathyanarayana (2015) observed that increasing NPK application was of great advantage and derived the maximum benefit from the crop of ajwain. Similarly, Mehta *et al* (2013) reported that application of 50 + 25 kg ha^{-1} N and P_2O_5 in ajwain crop exhibited 20.3 and 10.3 percent higher seed yield over 30 + 15 kg ha^{-1} N and P_2O_5 and 40 + 20 kg N and P_2O_5, respectively. Among the various levels tried by Muvel *et al* (2015), application of 60:30:30 kg NPK/ ha significantly increased the ajwain yield. The results are also in conformity with those reported by Amin *et al* (2016) for cumin crop. Volatile oil was not influenced due to different treatments of irrigation, nitrogen and phosphorus under study.

Economics

Irrigation applied at 0.4 IW: CPE ratio secured the maximum net realizations and BCR values. These results are in conformity with the findings of Patel *et al* (2007) in fennel. Similarly, these values were higher when crop was fertilized with nitrogen and phosphorus at 40 kg N ha^{-1} and 20 kg P_2O_5 ha^{-1}, respectively. (Table 1).The results are in line with those reported by Mehta *et al* (2013) and Muvel *et al* (2015).

Water Use Efficiency

Irrigation applied at 0.4 IW: CPE ratio, nitrogen at 40 kg N ha^{-1} and phosphorus applied at 20 kg P_2O_5 ha^{-1} achieved significantly higher water use efficiency on pooled data basis (Table 2).

Conclusion

In the light of results summarized above, it is observed that application of six irrigation (0.4 IW: CPE ratio) at 50 mm depth is of great advantage. It is also quite clear that application of 40 kg N ha^{-1} and 20 kg P_2O_5 ha^{-1} also very

Table 1. Growth, yield attributes, yield (kg ha^{-1}),economics and quality of ajwain crop as influenced by different treatments of irrigation,nitrogen and phosphorus levels (Mean data of three years)

Treatments	Number of branches plant^{-1}	Plant height (cm)	Number of umbels plant^{-1}	Number of umbelates umbel^{-1}	No. of seeds umballate^{-1}	Test weight (g)	Vol. oil (%)	Seed yield (Kg ha^{-1})	Net realization	BCR
Main plot (Irrigation level)										
I_1 : 0.4 IW : CPE ratio	5.22	106.5	33.8	15.16	20.3	0.96	3.57	1128	43001	2.74
I_2 : 0.6 IW : CPE ratio	5.19	101.7	30.2	13.69	17.9	0.94	3.59	1020	32624	2.14
C.D. at 5 %	NS	2.6	0.9	0.46	0.7	0.02	NS	68	-	-
C.V. (%)	10.78	6.6	7.9	8.48	10.0	6.52	7.14	12.99	-	-
Sub plot (Nitrogen and phosphorus levels)										
N_1 : 20 kg N / ha	5.10	101.5	30.3	13.56	19.1	0.94	3.55	1078	38417	2.46
N_2 : 40 kg N / ha	5.29	107.7	35.2	15.57	20.3	0.96	3.59	1152	42394	2.59
N_3 : 60 kg N / ha	5.23	103.1	30.6	14.14	17.9	0.95	3.61	992	32626	2.21
C.D. at 5 %	NS	3.4	1.7	0.76	0.9	0.02	NS	62	-	-
P_2O_5 : 00 kg P / ha	5.16	102.8	32.0	14.35	18.7	0.94	3.57	1039	27118	2.17
P_2O_5 : 20 kg P / ha	5.25	105.3	32.1	14.50	19.5	0.96	3.60	1109	36529	2.22
C.D. at 5 %	NS	NS	NS	NS	0.8	NS	NS	50	-	-
C.V.%	4.05	2.7	4.4	4.34	4.1	1.84	2.56	4.73	-	-
Interaction	NS	-	-	-	-	NS	NS	S	-	-

essential to get good results. Thus, irrigation applied at 0.4 IW:CPE ratio, nitrogen applied at 40 kg N ha^{-1} and phosphorus at 20 kg P_2O_5 ha^{-1} should as of the integral part of ajwain and package of practices for getting a good harvest and net return with higher water use efficiency under the North Gujarat climatic conditions of Gujarat.

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Table 2. Water Use Efficiency of different irrigation and nutrient levels for ajwain

Treatments	Water Use Efficiency (Kg ha^{-1}-mm)			
	2011-12	2012-13	2013-14	Pooled
Main plot (Irrigation level)				
I_1 : 0.4 IW : CPE ratio	3.85	4.11	3.33	3.76
I_2 : 0.6 IW : CPE ratio	2.59	2.76	2.30	2.55
C.D. at 5 %	0.75	0.39	0.33	0.22
C.V. (%)	25.37	12.47	12.93	18.14
Sub plot (Nitrogen and phosphorus levels)				
N_1 : 20 kg N / ha	3.25	3.49	2.84	3.19
N_2 : 40 kg N / ha	3.43	3.64	3.08	3.38
N_3 : 60 kg N / ha	2.98	3.18	2.52	2.89
C.D. at 5 %	NS	0.21	0.24	0.19
$P_2 O_5$: 00 kg P / ha	3.10	3.36	2.72	3.06
$P_2 O_5$: 20 kg P / ha	3.35	3.51	2.90	3.25
C.D. at 5 %	NS	NS	NS	0.16
C.V.%	21.35	8.64	11.61	4.98
Significant Interaction				
I x N	-	-	-	S

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