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Effect of irrigation, nutrient levels and crop geometry on growth and yield of dill (*Anethum sowa* L.)

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Abstract

A field experiment was conducted during rabi season at Ajmer (Rajasthan) to study the growth, profitability and productivity of dill (*Anethum sowa* L.) as influenced by irrigation and nutrient levels with varying crop geometry. Three irrigation levels (12, 15 and 18 days interval) in main plot, three nutrient levels (N and P_2O_5 each at 60 + 30, 90 + 40 and 120 + 50 kg ha^{-1}, respectively) in sub plot and three crop geometry patterns (40 × 25 cm, 50 × 25 cm and 60 × 25 cm) in sub-sub plot were studied. The highest plant height at all the growth stages was recorded with irrigation at 12 days interval but higher branches $plant^{-1}$, dry matter $plant^{-1}$, yield attributes, seed yield, straw and biological yield of 1.2, 2.1 and 3.3 t ha^{-1} respectively, as well as net return (Rs.15,428 ha^{-1}) and benefit : cost ratio (0.74) was recorded with irrigation at 15 days interval. Higher plant height, dry matter accumulation at all growth stages, yield attributes, seed yield (1.2 t ha^{-1}), straw (2.1 t ha^{-1}) and biological yield (3.3 t ha^{-1}) as well a net return (Rs. 14,464/-) and benefit : cost ratio (0.69) were obtained with application of 90 kg N and 40 kg P_2O_5 ha^{-1} being at par with 120 kg N and 50 kg P_2O_5 ha^{-1}. Crop geometry of 50 × 25 cm resulted in higher seed (1.2 t ha^{-1}), straw (2.1 t ha^{-1}) and biological yield (3.3 t ha^{-1}) over 60 × 25 cm. Thus, application of irrigation at 15 days interval with 90 kg N and 40 kg P_2O_5 ha^{-1} at 50 × 25 cm crop geometry was optimum for realizing higher yield, profitability and productivity of dill.

Keywords: *Anethum sowa* L., dill, irrigation, nutrition

Introduction

Information on integrated management of nutrient and water along with crop geometry for production of dill (*Anethum sowa* L) is lacking. Tripathi *et al*. (2009) reported significantly higher seed yield of dill with application of 75 kg nitrogen ha^{-1}. Thus, the present investigation was carried out to find out the optimum irrigation interval, fertilizer dose and crop geometry in dill.

Material and methods

The field experiment was conducted at National Research Centre on Seed Spices, Ajmer (Rajasthan) during three consecutive rabi seasons of 2003–04, 2004–05 and 2005–06. The soil of the experimental site was sandy loam with a pH of 8.92 having 0.21% organic carbon and 76.0, 33.4, and 234.1 kg ha^{-1} available N, P_2O_5 and K_2O, respectively. The experiment was laid out in split plot design with three levels of

irrigation (I_1-12 days interval, I_2-15 days interval and I_3-18 days interval) as main plot, three doses of nitrogen and phosphorus (N and P_2O_5 each of 60 + 30, 90 + 40 and 120 + 50 kg ha^{-1}, respectively) as sub plot and three crop geometry (40 × 25 cm, 50 × 25 cm and 60 × 25 cm) as sub-sub plot treatment and replicated thrice. Sowing of dill (var. Ajmer Dill-1) (4 kg seed ha^{-1}) was done at 60, 50 and 40 cm line to line spacing keeping 25 cm plant to plant distance. Immediately after sowing, light irrigation was applied for ensuring germination and establishment of the crop. Subsequently each irrigation of 50 mm depth (measured with Pashall flume 7.5 mm throat placed at the head irrigation channel) was provided as per irrigation intervals under study. Thus 8, 6 and 5 irrigations were provided at 12, 15 and 18 days interval, respectively. Full dose of P and 50% N under study was provided at the time of sowing and remaining half N was divided in two equal splits and applied at 30 and 60 days after sowing (DAS), respectively. N and P were supplied through urea and DAP respectively. Five plants were selected randomly from each plot and their dry weight was taken after drying in oven at 70°C for 72 h or till constant weight was obtained. Observations on plant height, number of branches plant^{-1}, yield attributing characters namely umbel plant^{-1}, umbellate umbel^{-1}, seed umbellate^{-1} and yield were recorded. Pooled analysis of the data was done using standard procedure prescribed by Panse & Sukhatme (1985).

Results and discussion

Growth

Irrigation levels significantly influenced plant height and dry matter accumulation plant^{-1} at all the growth stages. Irrigation at 12 days interval resulted in higher plant height of 8.23, 53.95, 93.28 and 101.23 cm at 40, 80, 120 DAS and at harvesting, respectively. But higher dry matter accumulation of 2.32, 15.65, 30.65, 40.65 g plant^{-1} at 40, 80, 120 DAS and at harvest, respectively, as well as branches plant^{-1} at harvest were recorded with irrigation at 15 days interval. The availability of adequate moisture in root zone of plant with irrigation at 15 days interval facilitated easy access of soil moisture by roots resulting in maintenance of optimum water potential in the plant system which helped in growth and development of plant. Application of 90 and 40 kg ha^{-1} N and P_2O_5 gave significantly higher plant height, number of branches plant^{-1} at all the growth stages. Significant increase in plant height and number of branches plant^{-1} and dry matter accumulation plant^{-1} was obtained with increase in N and P level. Closer spacing of 50 × 25 cm in dill promoted plant height, dry matter plant^{-1} and branches plant^{-1} at all the growth stages (Table 1).

Yield attributes

Maximum number of umbels plant^{-1} (38.15), seeds umbellate^{-1} (22.67), umbellate umbel^{-1} (18.20), test weight and seed yield plant^{-1} (17.99) were produced with irrigation at 15 days interval. Application of irrigation at 15 days interval maintained favourable moisture status in the soil resulting in easy availability of water to plant for growth and development leading to higher yield attributes. Application of 90 and 40 kg ha^{-1} N and P_2O_5 resulted in maximum number of umbel plant^{-1} (37.49), number of seeds umbellate^{-1}, umbellate umbel^{-1} and seed yield plant^{-1}, respectively over 60 and 30 kg ha^{-1} N and P_2O_5 respectively. Adequate availability of N and P at medium level of N + P_2O_5 resulted in proper growth and development of crop which in turn culminated in higher yield attributes. Bhist *et al*. (2000) also reported higher yield attributes of dill with application of 75 kg N ha^{-1}. Crop geometry of 50 cm × 25 cm resulted in maximum number of umbel plant^{-1} (37.9), number of seeds umbellate^{-1} (21.99), number of umbellate umbel^{-1} (17.81) and seed yield plant^{-1} (17.56 g plant^{-1}) (Table 2). Crop geometry of 50 × 25 cm facilitated optimum spacing for proper branching, growth and dry matter accumulation which in turn resulted in higher yield attributes.

Table1. Effect of irrigation, nitrogen and phosphorus levels and crop geometry on growth and yield attributes of dill (Pooled data of 3 years)

Treatment	Plant height (cm)				Branches plant^{-1}	Dry matter accumulation plant^{-1} (g)			
	40 DAS	80 DAS	120 DAS	Harvest		40 DAS	80 DAS	120 DAS	Harvest
Irrigation intervals									
12 days	8.23	53.95	93.28	101.23	19.47	1.82	12.47	27.47	37.47
15 days	6.75	51.60	87.92	99.53	22.65	2.32	15.65	30.65	40.65
18 days	6.40	50.05	85.34	99.07	21.34	1.93	14.34	29.34	39.34
SEm±	0.13	0.90	1.56	1.68	0.33	0.03	0.21	0.46	0.63
CD (P=0.05)	0.51	3.55	6.13	NS	1.28	0.11	0.82	1.81	2.47
N and P_2O_5 levels									
60, 30 kg ha^{-1}	6.14	49.81	87.76	99.03	19.83	1.88	12.83	27.83	37.83
90, 40 kg ha^{-1}	7.75	52.44	89.25	100.75	21.99	2.27	14.99	29.99	39.99
120, 50 kg ha^{-1}	7.48	53.35	89.54	100.04	21.64	1.92	14.64	29.64	39.64
SEm±	0.11	0.80	1.37	1.52	0.30	0.03	0.20	0.42	0.58
CD(P=0.05)	0.35	2.46	NS	NS	0.94	0.09	0.61	1.31	1.77
Crop geometry									
40 cm × 25 cm	6.97	51.67	88.25	99.86	20.24	1.94	13.24	28.24	38.24
50 cm × 25 cm	7.75	52.50	90.91	100.75	22.40	2.11	15.40	30.40	40.40
60 cm × 25 cm	6.66	51.43	87.38	99.21	20.82	2.03	13.82	28.82	38.82
SEm±	0.23	0.86	1.30	1.43	0.41	0.07	0.35	0.50	0.63
CD (P=0.05)	0.66	2.47	NS	NS	1.19	NS	1.00	1.44	NS

DAS=Days after sowing

Table 2. Effect of irrigation, nitrogen and phosphorus levels and crop geometry on growth parameters of dill (Pooled data of 3 years)

Treatment	Umbel plant^{-1}	Seeds umbellate^{-1}	Umbellate umbel^{-1}	Test weight (g)	Seed yield plant^{-1} (g)
Irrigation intervals					
12 days	34.97	19.50	16.37	4.59	16.79
15 days	38.15	22.67	18.20	4.90	17.99
18 days	36.84	21.33	17.04	4.60	15.52
SEm±	0.59	0.33	0.27	0.08	0.28
CD (P=0.05)	2.30	1.29	1.07	0.30	1.09
N and P_2O_5 levels					
60, 30 kg ha^{-1}	35.33	20.23	16.53	4.54	16.30
90, 40 kg ha^{-1}	37.49	22.10	17.54	4.89	17.44
120, 50 kg ha^{-1}	37.14	21.17	17.54	4.66	16.57
SEm±	0.54	0.31	0.25	0.07	0.25
CD (P=0.05)	1.66	0.95	0.77	0.22	0.76
Crop geometry					
40 cm × 25 cm	35.74	20.18	16.57	4.49	16.32
50 cm × 25 cm	37.90	21.99	17.81	4.90	17.56
60 cm × 25 cm	36.32	21.33	17.23	4.71	16.43
SEm±	0.59	0.38	0.30	0.08	0.29
CD(P=0.05)	1.70	1.08	0.86	0.22	0.82

Yield

Seed, straw and biological yield of dill was significantly influenced with varying irrigation intervals. Application of irrigation at 15 days interval resulted in highest seed, straw and biological yield of 1.2, 2.1 and 3.3 t ha^{-1}, respectively. Favourable moisture status in the root zone of the crop through irrigation at 15 days interval favored growth and development of plant which ultimately resulted in higher yield attributes, seed, straw and biological yield of dill over 12 and 18 days interval. The highest seed yield was obtained with irrigation at 15 days interval owing to increase in umbels plant^{-1}, umbellate umbel^{-1}, seed yield plant^{-1} and test weight (Tables 2 and 3). Irrigation at 15 days interval exhibited 15.6% higher seed yield over 12 and 18 days interval, respectively. Application of increasing levels of N and P enhanced vegetative growth, yield attributes which resulted in increased seed and biological yield of dill. Application of 90 + 40 kg ha^{-1} N and P_2O_5 respectively resulted in the highest seed yield (1.2 t ha^{-1}), straw yield (2.1 t ha^{-1}) and biological yield (3.3 t ha^{-1}). Significantly higher seed, straw and biological yield was recorded with crop geometry of 50 × 25 cm which was on account of higher dry matter accumulation and yield attributes. Sowing of dill at 50 × 25 cm spacing resulted in the highest seed yield of 1.8 t ha^{-1} which is 9.0% higher than 40 × 25 cm crop geometry.

Economics

Irrigation and nutrient levels significantly influenced the net return and benefit cost ratio in dill (Table 3). Net return and BCR increased with increasing levels of N and P_2O_5. The highest net return (Rs 15428 ha^{-1}) and BCR (0.74) was recorded with application of irrigation at 15 days interval.

Overall, the study indicated that irrigation at 15 days interval and 90 kg N + 40 kg P_2O_5 ha^{-1} with 50 × 25 cm crop geometry is optimum for realizing higher yield, profitability and productivity of dill.

Table 3. Effect of irrigation, nitrogen and phosphorus levels and crop geometry on yield, return and benefit : cost ratio of dill

Treatment	Seed yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)	Cost of cultivation (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	BCR
Irrigation intervals								
12 days	1.05	1.92	29.64	34.06	22975	31468	8493	0.37
15 days	1.21	2.09	33.01	36.76	20975	36403	15428	0.74
18 days	1.16	2.06	32.22	36.02	19975	34847	14872	0.74
SEm±	0.02	0.03	0.05	0.75	388	518	152	0.01
CD (P=0.05)	0.07	0.12	0.19	NS	1522	2034	595	0.03
N and P_2O_5 levels								
60, 30 kg ha^{-1}	1.08	19.28	30.06	34.51	20803	32354	11551	0.57
90, 40 kg ha^{-1}	1.19	20.90	32.82	36.32	21308	35772	14464	0.69
120, 50 kg ha^{-1}	1.15	20.45	31.98	36.02	21813	34592	12779	0.59
SEm ±	0.02	0.03	0.047	0.75	332	510	191	0.01
CD (P=0.05)	0.05	0.09	0.14	NS	1024	1571	589	0.03
Crop geometry								
40 cm × 25 cm	1.09	19.56	30.53	35.89	21308	32937	11629	0.56
50 cm × 25 cm	1.18	20.86	32.64	34.78	21308	35353	14045	0.67
60 cm × 25 cm	1.15	20.22	31.69	36.18	21308	34428	13119	0.62
SEm±	0.02	0.035	0.06	0.94	329	672	439	0.02
CD (P=0.05)	0.06	010	0.16	NS	943	1927	1258	0.03

BCR=Benefit:cost ratio

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