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Full Research Article

Effect of Row Spacing and Nitrogen Levels on Growth and Yield of Dill (*Anethum graveolens* L.)

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Abstract

An experiment was conducted at the Horticulture Research Farm, RVSKVV College of Horticulture, Mandsaur (Madhya Pradesh) during the *rabi* season of 2013–2014 to study the effect of row spacing and nitrogen levels on the growth and yield of dill (*Anethum graveolens* L.). The experiment consisted of 3 levels of row spacing (40×10 cm^2, 50×10 cm^2 and 60×10 cm^2) and 4 levels of nitrogen (0, 25, 50 and 75 kg N ha^{-1}). These treatments were evaluated under factorial Randomized Block Design with three replications. Different levels of row spacing and nitrogen significantly affect the plant height, branches, umbels, umbellate, seeds $umbel^{-1}$, days to 50% flowering, chlorophyll content in leaves, fresh and dry weight of plant, test weight, seed, straw and biological yield, harvest index, gross return, net return and B:C ratio of dill. Among various levels of row spacing tried, 50×10 cm^2 row spacing exhibited significantly higher growth and yield attributes and recorded significantly maximum seed yield of 15.04 q ha^{-1} which was 42.56% higher as compare to row spacing of 40×10 cm^2. Among the various nitrogen levels tried, 75 kg N ha^{-1} exhibited significant maximum growth, yield attributes and quality of dill. Further treatment observed significant higher seed yield of 14.48 q ha^{-1} which was 57.22% higher with B:C ratio of 3.08 in comparison to other nitrogen levels (control).

1. Introduction

Dill, popularly known as sowa, is one of the oldest cultivated seed spices of India. Dill seed are used, both as such and in ground form for its application as a condiment in soups, salads, processed meat, sausages, sauces and pickling. Ground seed is an ingredient of seasoning. Both seed and oils are used in formulation of various ayurvedic medicines. The gripe water is prepared from its seed, which is used to improve digestion and control vomiting in infants and children. In India dill seed is cultivated in about 22 thousand ha with production of about 23.6 thousand mt (DASD, 2012). It is cultivated commercially in Rajasthan, Gujarat, Maharashtra, Andhra Pradesh and Madhya Pradesh states of India. Spacing is an important factor for better growth and yield of the plant. Optimum number of plants is required $unit^{-1}$ 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 puts forth maximum pressure on all the factors of production (Mehta et al., 2012). Nitrogen is another most important factor for proper growth, yield and quality of crop. It's a constituent of proteins, enzymes, hormones, vitamins, alkaloid, chlorophyll etc. Plant growth is adversely affected due to deficiency of nitrogen as it is a constituent of enzyme, chlorophyll and proteins (Reddy and Reddi, 2002). Keeping the above fact in view, this experiment was conducted for knowing the optimum row spacing with the nitrogen fertilization for achieving the higher productivity of this important seed spice crop.

2. Materials and Methods

The experiment was conducted at the Horticulture Research Farm, College of Horticulture, Mandsaur during the year 2013–2014. The soil of the experimental field was light black loamy in texture with low nitrogen (243.2 kg ha^{-1}), medium in phosphorus (19.75 kg ha^{-1}) and high in potassium (448.0 kg ha^{-1}) and alkaline in reaction (pH 7.2). The experiment consisted of 3 levels of row spacing 40×10 cm^2 (S_1), 50×10 cm^2 (S_2) and 60×10 cm^2 (S_3) and 4 levels of nitrogen 0 kg ha^{-1} (N_1), 25 kg N ha^{-1} (N_2), 50 kg N ha^{-1} (N_3), and 75 kg N ha^{-1} (N_4). These treatments were evaluated in factorial RBD design with three replications. The sowing of crop was done on 22nd November, 2013 and harvested on 30th April, 2014. The seeds were treated with carbendezim @ 3 g kg^{-1} seed and then sown at a depth of 5 cm in row spaced as $treatment^{-1}$ using 5 kg seed ha^{-1} of cultivar NRCSS AD-1. FYM @ 10 t ha^{-1} was incorporated in the soil one month before sowing and a uniform dose of 40 kg P_2O_5 and 20 kg K_2O ha^{-1} was applied as basal. The oil content was estimated by using essential oil distillation assembly (A.O.A.C. 1995).

3. Results and Discussion

3.1. Effect of row spacing

3.1.1. Growth attributes

It was observed that plants under closer spacing (40×10 cm^2) attained greater plant height as compared to the plants that were grown at other spacing (50×10 cm^2 and 60×10 cm^2) (Table 1). However, fresh and dry weight of plant and number of branches were improving due to increase in spacing from 50×10 cm^2 to 60×10 cm^2. Significant increase in plant height right from early stage of crop growth under closer spacing seem to be due to mutual shading because of dense population. This might have decreased the availability of light to the plants. The reduced light intensity at the base of the plant stem might have accelerated elongation of lower internodes resulting in greater plant height. The results indicated that crop raised under optimum row spacing (50×10 cm^2) recorded highest number of branches, fresh and dry weight of plant. Significant improvement in aforesaid parameters due to increase in spacing or in other words reduction in plant population $unit^{-1}$ area could be ascribed to availability of more area $plant^{-1}$ which implied that individual plant at wider spacing received higher growth inputs (sunlight, water and nutrients) with least competition as compared to the plants grown under closer spacing. Thus greater inputs under spacing (50×10 cm^2 and 60×10 cm^2) resulted in profuse branching which in turn might have helped in larger canopy development and delayed plants to attain reproductive phase. The larger canopy development associated with profuse branching has increased interception, absorption and utilization of solar energy resulting in formation of higher photosynthates and finally dry matter $plant^{-1}$. Significant improvement in growth with increase in spacing is in close conformity with the findings of Meena et al. (2013); Mehta et al. (2012) in dill crop Bagari et al. (2010) in fennel and Naruka et al. (2012) in ajowan.

3.1.2. Yield and yield attributes

It was observed that increase in spacing from 40×10 cm^2 to 50×10 cm^2 significantly improved various yield attributes of the crop. Days to 50% flowering, number of umbels $plant^{-1}$, number of umbellet $umbel^{-1}$, test weight were improved due to each increase in spacing and the maximum value for these estimates were obtained at the spacing (50×10 cm^2), while least under closer spacing (40×10 cm^2). However, results in respect to productivity revealed that crop grown under wider spacing (50×10 cm^2) produced higher seed yield (15.04 q ha^{-1}), straw

Table 1: Effect of row spacing and nitrogen levels on growth and quality of dill

Treatments	Plant height (cm)			Branches $plant^{-1}$ at harvest	Umbels $plant^{-1}$	Umbellet $umbel^{-1}$	Seeds $umbel^{-1}$	Days to 50% flowering	Essential oil content in seed (%)	Chlorophyll content in leaves (SPAD)	
	40 DAS	80 DAS	120 DAS							60 DAS	90 DAS
Row spacing											
S_1 (40×10)	19.82	71.06	158.39	35.42	44.05	29.88	390.66	92.5	1.71	3.49	1.31
S_2 (50×10)	17.27	69.22	152.47	41.70	60.23	41.45	494.33	80.08	3.42	5.02	2.02
S_3 (60×10)	14.79	66.56	141.55	39.03	54.36	39.65	450.00	82.75	2.64	4.69	1.80
SEm±	0.25	0.31	0.54	0.25	0.67	1.22	5.74	0.51	0.06	0.13	0.04
CD (p=0.05)	0.73	0.93	1.60	0.75	1.99	3.58	16.86	1.50	0.19	0.40	0.13
Nitrogen levels (kg ha^{-1})											
N_1 (0)	15.94	66.76	145.15	37.00	47.25	33.64	387.67	80.22	2.15	3.57	1.50
N_2 (25)	16.61	68.26	149.60	37.89	51.38	34.93	439.78	82.89	2.47	4.17	1.61
N_3 (50)	17.67	69.75	151.52	39.20	53.89	37.36	465.11	87.78	2.73	4.69	1.79
N_4 (75)	18.96	71.02	156.97	40.79	59.03	42.04	487.44	89.56	3.02	5.19	1.96
SEm±	0.29	0.36	0.63	0.29	0.78	1.40	6.63	0.59	0.07	0.16	0.05
CD (p=0.05)	0.85	1.07	1.85	0.87	2.30	4.13	19.46	1.73	0.22	0.46	0.15

yield (25.19 q ha^{-1}) and biological yield (45.15 q ha^{-1}) compared to other spacing (40×10 cm^2 and 60×10 cm^2).

Marked improvement in yield attributes of the crop with increase in spacing appear to be on account of vigorous growth of the plants as evident from profuse branching and higher biomass accumulation plant^{-1}. The profuse branching seems to have led to greater initiation of flowering and adequate supply of metabolites due to the increase in biomass plant^{-1} might have helped in retention of flower thereby greater seed formation and seed growth. This was ultimately reflected in increased seed yield plant^{-1}. Under the closer spacing growth and development of yield components and number of plants positively interacted with each other and might be due to increased biomass resulting in higher seed yield. These findings in close conformity with Naruka et al. (2012) in ajowan and Mehta et al. (2012) in dill crop.

3.1.3. *Quality attributes*

Significantly higher chlorophyll content of leaves and essential oil content of seed under spacing (50×10 cm^2) could be ascribed due to availability of large space plant^{-1} resulted in profuse vegetative growth and delayed plants to attain reproductive growth. The similar results have also been reported by Bist et al. (2000) in dill.

3.2. *Effect of nitrogen*

3.2.1. *Growth attributes*

Significantly higher plant height at 40, 80 and 120 DAS, number of branches at harvest and days to 50% flowering was recorded as a result of higher levels of N fertilizer. Higher levels of N may be attributes to better nutritional environment in the root zone as well as in the plant system. It is an established fact that nitrogen is one of the essential constituent required for the synthesis of protein, chlorophyll and other organic compounds of physiological significance in the plant system. Since, in the plant system most of the nitrogen accumulated in the reproductive structure is translocated from vegetative parts, the assumption seems to be justified that nitrogen application lead to increased nitrogen content in the plants right from stage of crop growth. Thus, increased endogenous level of nitrogen in plant by virtue of its increased availability in the soil medium and there after efficient absorption and translocation in various growths by way of active cell division and elongation resulting in greater plant height, number of branches at harvest. The findings of this investigation are in close conformity with those of Krishnamoorthy and Madalgiri (2000); Naruka et al. (2012) in ajowan.

3.2.2. *Yield and yield attributes*

Data on yield components of the crop under influence of N application indicates that increasing level of Nitrogen up to 75 kg N ha^{-1} significantly improved fresh and dry weight of plant at 40, 80 and 120, number of umbels plant^{-1}, number of umbellet umbel^{-1}, number of seed umbel^{-1}, test weight (g), seed yield, straw yield, biological yield and harvest index % (Table 2). Application of 75 kg N ha^{-1} significantly increased

Table 2: Effect of row spacing and nitrogen levels on yield attributes, yield and economics of dill

Treatments	Fresh weight of plant (g)			Dry weight of plant (g)			Test weight (g)	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	Seed yield (q ha^{-1})	Harvest index (%)	Gross return ₹ ha^{-1}	Net return ₹ ha^{-1}	B:C ratio
	40 DAS	80 DAS	120 DAS	40 DAS	80 DAS	120 DAS								
Row spacing														
S_1 (40×10)	5.09	63.39	155.30	1.20	5.08	65.89	4.09	20.76	31.31	10.55	33.38	52587	29690	2.28
S_2 (50×10)	7.00	69.89	264.96	1.45	8.96	82.52	5.82	25.19	45.15	15.04	33.21	75220	52323	3.27
S_3 (60×10)	6.27	67.87	261.92	1.36	7.66	76.93	5.28	24.16	38.62	11.40	29.37	57025	34127	2.47
SEm±	0.13	0.31	0.45	0.01	0.10	0.56	0.20	0.36	0.29	0.18	0.48	906.8	906.8	0.04
CD (p=0.05)	0.40	0.92	1.32	0.051	0.29	1.66	0.60	1.07	0.86	0.54	1.42	2659.5	2659.7	0.11
Nitrogen levels (kg ha^{-1})														
N_1 (0)	5.27	64.83	223.93	1.25	6.68	71.60	4.27	17.62	36.05	9.21	25.73	46027	23627	2.05
N_2 (25)	6.02	66.10	226.50	1.32	7.02	73.94	4.69	21.91	38.15	11.92	31.16	59605	36845	2.61
N_3 (50)	6.48	67.72	228.51	1.37	7.41	75.94	5.05	26.14	39.06	13.74	35.30	68694	45641	2.97
N_4 (75)	6.75	69.56	230.66	1.42	7.85	78.98	6.26	27.84	40.20	14.48	35.77	72116	48738	3.08
SEm±	0.15	0.36	0.52	0.02	0.11	0.65	0.23	0.42	0.34	0.20	0.56	1047.0	1047.1	0.04
CD (p=0.05)	0.46	1.06	1.52	0.059	0.34	1.91	0.69	1.23	0.99	0.59	1.64	3071.0	3071.1	0.13

the seed yield (14.48 q ha^{-1}) by 57.22% as compare to control. Significant improvement in yield attributes of dill with the N fertilization could be ascribed to overall improvement in vigour and crop growth. The faster growth of plants evidenced from increased biomass plant^{-1} at successive stages of crop growth with N subscribe to the views that there was better availability of metabolites and nutrients, which synchronized to the demand for the growth and development of each reproductive structure of the dill plant. The present trend of increment in seed yield, straw yield and biological yield of dill with the application of N is in close conformity with the findings of Krishnamoorthy and Madalgari (2000); Tripathi et al. (2009); Naruka et al. (2012).

3.2.3. Quality attributes

Significantly higher chlorophyll content of leaves and essential oil of seed was recorded as a result of higher levels of N fertilization. The biological role of N as an essential constituent of chlorophyll in harvesting solar energy, phosphorylated compounds in energy transformations, nucleic acids in the transfer of genetic information and the regulation of cellular metabolism and of protein as structural units and biological catalysts is well known. The mark improvement in quality characters due to N is in close agreement with findings of Krishnamoorthy and Madalgari (2000) in ajowan.

3.2.4. Economics

The maximum gross return of ₹ 75220 ha^{-1} was recorded with the spacing 50×10 cm^2 and ₹ 72116 ha^{-1} was recorded with treatment of 75 kg N ha^{-1}. The maximum net return of ₹ 52323 ha^{-1} was recorded with the spacing 50×10 cm^2 and ₹ 48738 ha^{-1} was recorded with treatment of 75 kg N ha^{-1}. The highest B:C ratio of 3.27:1 was recorded with spacing 50×10 cm^2 and B:C ratio of 3.08:1 was recorded with 75 kg N ha^{-1}. These results are in the close conformity with those of Naruka et al. (2012) in ajowan crop and Meena et al. (2013) in dill crop.

4. Conclusion

Sowing of dill crop at spacing of 50×10 cm and application of 75 kg N ha^{-1} may realize for maximum production under Malwa plateau condition of Malwa region of Madhya Pradesh. Among various levels of row spacing tried, 50×10 cm row spacing recorded significantly maximum seed yield of 15.04 q ha^{-1} which was 42.56% higher as compare to row spacing of 40×10 cm^2. Among the various nitrogen levels tried, 75 kg N ha^{-1} recorded seed yield of 14.48 q ha^{-1} which was 57.22% higher as comparison to control.

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