International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(4): 2768-2772

Received: 16-05-2018
Accepted: 23-06-2018

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Effect of nitrogen doses and row spacing on growth and seed yield of coriander (*Coriandrum sativum* L.)

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Abstract
The present investigation was carried out during *Rabi* season of 2017-2018 at the Horticulture complex, Department of Horticulture, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.). The treatment combinations consisting of five levels of nitrogen (50, 60, 70, 80 and 90 kg N ha^{-1}) and three row spacing (30, 40 and 50 cm) replicated thrice. Highest growth characters were higher in the treatment combination N_5S_3 (N: 90 kg N ha^{-1}, S: 50X10 cm) viz., number of branches, total biomass production of the plant on dry weight basis(g), days taken to 50% flowering, Days taken to maturity and yield attributes the treatment combination N_5S_3 (N: 90 kg N ha^{-1}, S: 50X10 cm) viz., umbels $plant^{-1}$, umbellets $plant^{1}$, seeds $umbel^{-1}$, test weight (g), Seed yield $plant^{-1}$ (g). Maximum seed yield of 16.66 q ha^{-1} was obtained in coriander (Jawahar Dhaniya -2) with treatment combination N_5S_1 (N: 90 kg N ha^{-1}, S: 30X10 cm) and maximum net return of Rs 79,221.06 ha^{-1} and cost benefit ratio 1:3.11.

Keywords: coriander (*Coriandrum sativum* L.), growth, nitrogen, row spacing, seed yield

Introduction

Coriander (*Coriandrum sativum* L.) is one of the most important vegetable, spice and medicinal plant. It is small seeded aromatic annual herb of family apiaceae. Coriander plant gives two primary products that are used for flavouring purposes: fresh green herb and spice. Coriander leaves are being used in cooking, flavouring, beverages etc., and seeds are being used for preparing value added products such as coriander powder, dhana dal, condiment, oleoresin, essential oil, medicine and cosmetic industries. The essential oil content of locally available seeds of coriander is 0.2–0.3 per cent whereas major chemical constituents of essential oil are d-linalool, linalyl acetate along with other important constituents such as thymol, geraniol, carophyllene and pinene [1]. It has traditionally been used for its anti-inflammatory, anti-diabetic, cholesterol lowering effects and also is good appetizer health benefits of coriander include treatment of swellings, diarrhoea, mouth ulcers, anaemia, digestion, menstrual disorders, small pox, eye care, conjunctivitis, skin disorders, blood sugar disorders, protects and soothes liver etc.

India is the largest producer, consumer and exporter of coriander in the world. In India the major coriander growing states are Rajasthan, Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka, Madhya Pradesh, Bihar, Uttar Pradesh [2, 3]. The area under coriander cultivation in India is 663 thousand hectare and production is 609 thousand MT and in Madhya Pradesh, coriander is cultivated over an area of 200 thousand hectare and production is 102.50 thousand MT [4].

Among the primary nutrients, nitrogen has a considerable effect, not only on quality of produce but on quantity of produce also. It is involved in photosynthesis, respiration, carbohydrate synthesis and protein synthesis. It impart the dark green colour of the leaves, promotes vigorous vegetative growth and more efficient use of available inputs finally leads to higher productivity. The various agronomic practices such as application of nitrogen fertilization and plant spacing are the important deciding factors influencing growth and yield parameters of coriander. Coriander plant could be used as indicator plant for rapid determination of N, P and K deficiency of Indian soils. Optimum crop geometry is one of the important factors for crop growth and production because of efficient utilization of resources. The aim of this work was to evaluate, growth and yield of coriander as influenced by different levels of nitrogen and plant spacing.

Materials and Methods

A field experiment was carried out during Rabi season of 2017-2018 at the Horticulture complex, Department of Horticulture, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.). The experimental material for the present investigation was sown in Factorial Randomized Block Design and it was comprised of fifteen treatments to observe growth and yield characters and to estimate the economic viability. The treatment combinations consisting of four levels of nitrogen (50, 60, 70, 80 and 90 kg N ha^{-1}) and three row spacing (30, 40 and 50 cm) replicated thrice. The experimental field was divided into 45 plots of each 7.2 m^2 (3 m × 2.4 m) size. Representative sample of surface soil (0–15 cm depth) was collected from the experimental field before start of the experiment was analyzed. The soil characteristics of the experimental site was Organic Carbon % (0.24%), available nitrogen (332.50 kg ha^{-1}), available phosphorus (40.60 kg ha^{-1}), available potash (312.95 kg ha^{-1}), Soil pH 7.03 and Electrical conductivity (m mhos per cm) 0.14. Coriander seed was sown on 28^{th} November, 2017 and harvested on last week of March, 2018. The FYM was applied before sowing based on treatments and also all phosphorus and potassium was applied as basal during final land preparation. The nitrogen was applied in two splits *i.e.* at 15 days after sowing and at the time of flowering initiation as the top dress. The seeds (fruits) were rubbed for separating the two mericarps (seeds) and were soaked in water for 24 hours to enhance germination. Seed were also treated with Bavistin at 2g/kg of seeds before sowing. All necessary intercultural operations were followed as needed by the experiment. Seeds were harvested when half of the fruits on the plant changed from green to brown colour [5]. To avoid shattering of fruits during harvest, the seed plants were cut at the base by sickles in the early morning. Then the stalks with seeds were dried in the sun. Seeds were separated by beating with sticks, cleaned by winnowing and dried properly up to 10% moisture of seed.

Data on different parameters from five randomly selected plants from each treatment were collected from the inner rows of each plot to avoid the border effect and recorded in time. The data was collected on plant growth stage 30, 60 and 90 DAS: Number of basal leaves, length of the longest basal leaf (cm), habits of the basal leaves (Very flat or prostrate, Raised with an arcus of about 45 ^{0}, Very erect), shape of longest basal leaves (Deeply serrated or serrated), plant height (cm), primary branches $plant^{-1}$, Total biomass production per plant on dry weight basis (g), days taken to 50 % flowering, days taken to maturity, number of umbels per plant, number of umbellets per plant, number of seeds per umbel, mean weight of 1000 seeds (g), seed yield (g $plant^{-1}$), seed yield (kg ha^{-1}), and also calculated cost of cultivation (Rs. ha^{-1}), net returns (Rs. ha^{-1}), benefit cost ratio (BCR).

Results and Discussion

Coriander is mainly grown for its leaves and seeds. Due to the increased demand of coriander seed for use in confectionery, perfumery and medicine, efforts are in progress to improve the seed yield of coriander, through breeding programmes and fertilizer management etc. It has been attempted to establish effect and cause relationship in the light of variable evidences and literature. Optimum fertilization and row spacing is one of the major factors to improve the seed yield of coriander. Seed yields could be boosted with the application of nitrogen and proper spacing. It has been attempted to establish effect and cause relationship in the light of variable evidences and literature. Hence a need was felt to investigate the response of coriander (Jawahar Dhaniya - 2) to the application of different levels of nitrogen and row spacing in respect of growth, yield and yield attributes. Among studied factors, nitrogen fertilization and row spacing had a definite effect on the differentiation of morphometric features of plants included in the evaluation, as well as of the yield-forming abilities of coriander.

Growth Parameters

THE differences in number of basal leaves are medium in range i.e. 4-6 basal leaves $plant^{-1}$, Shapes of the longest basal leaves $plant^{-1}$ were visually observed that they were deeply serrated in shape and growth habit of the basal leaves were raised with an arcus of about 45^0 in its growth habit. It might be due to the morphological character of the same variety of plant coriander [6].

Effect of Nitrogen

Under the effect of nitrogen fertilization, application of nitrogen significantly increased plant height throughout the growth period and it was more pronounced with increased levels of nitrogen. Plants receiving more nitrogen i.e., $N_{90\ kg}$ (9.55, 67.25, 97.34 cm) recorded significantly maximum plant height at 30, 60 and 90 DAS respectively than any other treatments (Table 1). This might be due to the adequate supply of nitrogen associated with high photosynthetic activity leading to vigorous vegetative growth and physiologically more stout and healthy plant morphology. The higher nitrogen $N_{90\ kg}$ (7.77, 9.64) at 60 and 90 DAS respectively produced significantly higher number of primary branches per plant. This might be due to adequate supply of nitrogen associated with high photosynthetic activity leading to vigorous vegetative growth and physiologically more stout and healthy plant morphology. The results of the present investigations are in close agreement with the findings of [7, 8, 9, 10, 11].

The application of nitrogen had significantly increased the biomass production per plant (g) in coriander. The biomass production was lower till 75 DAS and was rapid thereafter. Dry weights of plant were observed under $N_{90\ kg}$ (0.53 g, 4.11 g and 23.56 g) recorded highest at 30, 60 and 90 DAS respectively. In the present study it was observed that till 60 DAS, the production of biomass was slow and thereafter it picked up. This slow production of biomass at early stage might be due to weed competition and reduced supply of water. Similar findings were observed by [12, 11].

The maximum days to 50% flowering were recorded with $N_{90\ kg}$ (54.81 days) and maximum days to maturity were recorded under highest dose of $N_{90\ kg}$ (46.42 days), while the gradual decrease in days to 50 percent flowering was enumerated with the lower doses of nitrogen. This might be due to the fact that days taken to flowering are decided by C: N ratio. The plants tend to flower earlier with higher C: N ratio and higher levels of nitrogen enhanced the vegetative growth and delayed the reproductive stage. These results are in agreement with the finding of [13, 14, 9].

Effect of row spacing

Under the effect of row spacing highest value of plant height was recorded with $S_{(30\ x\ 10\ cm)}$ (9.66, 69.92, 101.75 cm), at 30, 60 and 90 DAS respectively. Higher plant height under closer spacing may be attributed to more competition for light amongst the plants 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 observed crop behavior under closer spacing is in close conformity with the findings that in many crops up to a certain level of population, plant elongates rapidly due to mutual shading but beyond this, elongation is checked due to reduced availability of photosynthates. Numbers of primary branches were significantly increased with increase in spacing between the rows. The wider row spacing $S_{(50 \times 10\ cm)}$ (7.04, 8.93) at 60 and 90 DAS respectively produced significantly higher number of primary branches per plant and maximum dry weight of plant recorded at 30, 60 and 90 DAS were 0.43, 3.28 and 18.18 g. The increase in number of branches plant^{-1} and total biomass production of plant may be attributed to more space plant^{-1} available under wider spacing. 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}, which has resulted in better growth and development of coriander in terms of producing more number of branches plant^{-1} and total biomass production. Significant improvement in growth with increase in spacing is in close conformity with the findings of [15, 16, 17, 18, 19, 20, 21, 13].

Closer spacing $S_{(30 \times 10\ cm)}$ had significantly higher days (55.11 days) to 50% flowering and the maximum number of days i.e. 45.56 days taken to maturity. Significant improvement in aforesaid parameters due to increase in spacing or in other words reduction in plant population per unit 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 $S_{(40 \times 10\ cm)}$ and $S_{(50 \times 10\ cm)}$ resulted in profuse branching which in turn might have helped in larger canopy development and delayed plants to attain reproductive phase. Similar result was observed by [13, 21].

Table 1: Effect of different nitrogen dose and row spacing on growth parameters of coriander

Treatment	Plant Height(cm)			Primary branches		Total biomass production			Days taken to 50 % flowering	Days taken to maturity
Nitrogen dose (kg)	30 DAS	60 DAS	90 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS		
$N_{(50\ kg)}$	8.51	57.45	90.48	5.70	7.26	0.20	1.93	8.64	48.18	40.38
$N_{(60\ kg)}$	8.53	59.52	90.63	6.25	8.19	0.29	2.21	9.92	49.66	40.47
$N_{(70\ kg)}$	9.28	66.35	95.64	7.05	9.06	0.44	2.69	13.54	53.06	44.41
$N_{(80\ kg)}$	9.48	67.17	96.41	7.43	9.36	0.48	3.49	18.53	53.66	45.62
$N_{(90\ kg)}$	9.55	67.25	97.34	7.77	9.64	0.53	4.11	23.56	54.81	46.42
S.Em.±	0.024	0.093	0.079	0.033	0.080	0.004	0.082	0.268	0.224	0.082
C.D.@ 5%	0.071	0.272	0.230	0.098	0.234	0.013	0.239	0.782	0.651	0.239
Spacing (cm)										
$S_{(30x10)}$	9.66	69.92	101.75	6.48	8.33	0.33	2.33	10.55	55.11	45.56
$S_{(40X10)}$	9.44	66.12	96.52	7.00	8.85	0.40	3.05	15.78	51.26	42.89
$S_{(50X10)}$	8.12	54.61	84.04	7.04	8.93	0.43	3.28	18.18	49.25	41.93
S.Em.±	0.019	0.072	0.061	0.026	0.062	0.003	0.064	0.208	0.173	0.064
C.D.@ 5%	0.055	0.210	0.179	0.076	0.181	0.010	0.185	0.605	0.504	0.185

Yield Parameters

Effect of Nitrogen

The influence of different levels of nitrogen on number of umbels, umbellets and seeds plant^{-1} was found to be significant. Application of nitrogen at 90 kg ha^{-1} was recorded maximum number of umbels plant^{-1} (38.99), umbellets plant^{-1} (210.91) weight of 1000 seeds (15.30 g), seeds plant^{-1} (5.56 g) and seed yield hectare^{-1} (1426 kg ha^{-1}) showed positive correlation with the increased levels of nitrogen from $N_{50\ kg}$ to $N_{90\ kg}$ ha^{-1}. This might be due to the effect of nitrogen achieved indirectly through an increase in the supply of assimilates to the floral parts. This suggests that the maintenance of a large and photo synthetically efficient leaf area during the period of flowering is necessary for producing the maximum weight of seeds. These results are in conformity with the findings by [22, 23, 24, 25, 8, 11, 12, 14].

Effect of row spacing

It was observed that successive increase in spacing from $S_{(30 \times 10\ cm)}$ to $S_{(50 \times 10\ cm)}$ significantly improved various yield attributes of the crop; number of umbels plant^{-1} (40.87), number of umbellets plant^{-1} (216.16), number of seeds umbel^{-1} (40.34), weight of 1000 seeds (15.30 g) and seeds plant^{-1} (5.56 g) were improved due to each increase in spacing and the maximum value for these estimates were obtained at the spacing $S_{(50 \times 10\ cm)}$, while least under closer spacing $S_{(30 \times 10\ cm)}$. However, results in respect to productivity revealed that crop grown under wider spacing $S_{(30 \times 10\ cm)}$ produced higher seed yield ha^{-1} (1355 kg ha^{-1}) due to high plant population per unit area as compared to $S_{(40 \times 10\ cm)}$ and $S_{(50 \times 10\ cm)}$. 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} with high nutrient uptake. The profuse branching seems to have led to greater initiation of flowering and adequate supply of metabolites due to the increase in biomass per plant might have helped in retention of flower thereby greater seed formation and seed growth. This was ultimately reflected in increased seed yield plant^{-1}. It may be due to wider spacing as it provides sufficient water, nutrients, air and light which promotes better growth of plants. The present findings are close accordance with those reported by [17, 19, 20, 21, 25].

Table 2: Effect of different nitrogen dose and row spacing on yield parameters of coriander

Treatment	No. of umbels plant^{-1}	No. of umbellets plant^{-1}	No. of seeds umbel^{-1}	Test weight (g)	Seed yield (g plant^{-1})	Seed yield per plot (kg ha^{-1})	Seed yield (kg ha^{-1})
Nitrogen (kg)							
$N_{(50\ kg)}$	27.12	159.28	26.97	13.45	3.52	0.66	913
$N_{(60\ kg)}$	29.15	167.59	27.59	13.61	3.80	0.71	985
$N_{(70\ kg)}$	33.62	183	29.91	14.25	4.54	0.84	1170
$N_{(80\ kg)}$	34.13	202.51	32.69	14.70	5.27	0.97	1349
$N_{(90\ kg)}$	38.99	210.91	37.70	15.30	5.56	1.03	1426
S.Em.±	0.075	0.301	0.117	0.020	0.015	0.010	0.135
C.D.@ 5%	0.219	0.877	0.341	0.059	0.044	0.028	0.394
Spacing (cm)							
$S_{(30x10)}$	29.94	174.29	28.75	13.79	4.06	1.00	1355
$S_{(40X10)}$	33.65	188.37	31.67	14.40	4.70	0.98	1214
$S_{(50X10)}$	34.22	191.31	32.50	14.60	4.86	0.67	936
S.Em.±	0.058	0.233	0.091	0.016	0.012	0.008	0.105
C.D.@ 5%	0.170	0.679	0.264	0.046	0.034	0.022	0.305

Economics

While taking a decision regarding the adoption of a new technology, economics is the major consideration of the farmers. Hence, the gross and net realization and cost benefit ratio were computed for different spacing and nitrogen and their combination (Table 3).

In various spacing, spacing $S_{(30\ x\ 10\ cm)}$ recorded highest net return of Rs. 58,125 per hectare with CBR of 1:2.58. It might be due to higher seed yield. Similar results obtained by [15, 26]. In case of varying levels of nitrogen, $N_{90\ kg}$ ha^{-1} recorded maximum net realization of Rs. 64,189.97 hectare^{-1} with CBR of 1:2.80. The increase in profitability was mainly due to higher seed yield. Similar results obtained by [12, 20, 24, 27].

Table 3: Effect of different nitrogen dose and row spacing on economics of coriander

Treatment	Seed yield (q ha^{-1})	Gross income (Rs ha^{-1})	Expenditure (Rs ha^{-1})	Net income (Rs ha^{-1})	C:B ratio
Nitrogen (kg)					
$N_{(50\ kg)}$	9.13	63,910	35,098.94	28,811.36	1:1.82
$N_{(60\ kg)}$	9.85	68,950	35,223.66	33,726.34	1:1.96
$N_{(70\ kg)}$	11.70	81,900	35,360.45	46,539.55	1:2.32
$N_{(80\ kg)}$	13.49	94,430	35,503.24	58,926.76	1:2.66
$N_{(90\ kg)}$	14.26	99,820	35,630.03	64,189.97	1:2.80
Spacing (cm)					
$S_{(30x10)}$	13.55	94,850	36,725	58,125	1:2.58
$S_{(40X10)}$	12.14	84,980	36,250	48,730	1:2.34
$S_{(50X10)}$	9.36	65,520	35,865	29,655	1:1.83

Selling price: Coriander seed Rs. 70 kg-1

Conclusion

On the basis of present investigation, it may be concluded that the coriander variety Jawahar Dhaniya – 2 responded well in terms of morphological, growth and yield characters. The treatment combination N_5S_1 (N: 90 kg N ha^{-1}, S: 30X10 cm) was found significantly superior on plant height as compared to other treatments. Highest growth characters were higher in the treatment combination N_5S_3 (N: 90 kg N ha^{-1}, S: 50X10 cm) viz., number of branches, total biomass production of the plant on dry weight basis in g, days taken to 50% flowering, days taken to maturity and yield attributes the treatment combination N_5S_3 (N: 90 kg N ha^{-1}, S: 50X10 cm) viz., umbels plant^{-1}, umbellets plant^{1}, seeds umbel^{-1}, test weight (g), Seed yield plant^{-1} (g), produced maximum seed yield of 1666 kg ha^{-1} and realized the highest net profit of Rs. 79,221.06 ha^{-1} spacing 30 cm with application of nitrogen @ 90 kg N ha^{-1} as compared to other treatment combination.. Thus from the yield and economic point of view, it is concluded that for securing higher seed yield and net returns the coriander crop should be sown at 30 cm spacing and fertilized with 90 kg N ha^{-1}.

References

1. Gupta GK, Dhar KL and Atal CK. Chemical constituent of coriander (*Coriandrum sativum* L.) seeds. Indian Perfumer. 1977; 21:261-264.
2. Kader M, Abdul khader JBM, Muthuswami S. Corinader- A crop of good prospects for Tamilnadu. Ind. Cocoa Arecanut and Spices Journal. 1985; 8(1): 5-6.
3. Singh RN and Singh K. Coriander in Madhya Pradesh. Ind. Cocoa, Arecanut and Spices Journal. 1985; 8(1):2.
4. Anonymous,. Horticulture Statistics at a Glance, 2017.
5. Singhania DL, Singh D, Raje RS. Coriander. In: Ravindran PR, KN Shiva and Kallu JA- purackal (eds.). Advances in Spices and Achievements of Spices Research in India since Independence, 2006, 678-695.
6. Anonymous. Guidelines for the conduct of tests for distinctiveness, uniformity and stability on coriander (*Coriandrum sativum* L.) Protection of plant varieties & farmers' rights authority (PPV & FRA) government of India, 2015.
7. Randhawa GS, Gill SS, Saini BS and Singh J. Effect of plant spacing and nitrogen levels on the seed yield of dill seed (*Anethum graveolens* L.). Acta Hort. 1978; 42(6):623-628.
8. Baboo R, Rana SN. Effect of cutting management, nitrogen and phosphorous on growth and yield of coriander (*Coriandrum sativum* L.). Indian Journal of Agronomy. 1995; 40(2):253-255.
9. Moniruzzaman M, Islam MR, Mozumder SN. Effect of nitrogen levels and foliage cuttings on the yield of

coriander. Journal of Agriculture & Rural Development (Gazipur). 2005; 3 (1/2):99-102.

10. Ughreja PP, Chundawat BS. Nutritional studies in coriander (*Coriandrum sativum* L.) II: Effect on growth and production. GAU Res. J. 1992; 17(2):87-93.
11. Ghosh DK. Performance of coriander at different doses of nitrogen fertilizer under coconut based cropping system. Indian Coconut Journal. 2009; 51 (9):6-10.
12. Javiya PP, Solanki JN, Kaneria SC, Rupareliya VV. Response of Coriander (*Coriandrum sativum* L.) to nitrogen and phosphorus in south saurashtra condition. Int. J. Pure App. Biosci. 2017; 5(4):860-866.
13. Malav NB and Yadav SN. Effect of row spacing and levels of nitrogen on growth and seed yield of coriander. Indian Cocoa Arecanut and Spices Journal. 1997; 21(2):37-41.
14. Amin AU, Singh A, Patel BS and Patel JK. Effect of various row spacing and nitrogen levels on drilled rabi fennel (*Foeniculum vulgare* Mill). Agric. Sci. Digest. 2005; 25(1):44-46.
15. Sukhadia HL, Sinha MP, Malavia DD, Kaneria BB and Patel JC. Response of coriander to planting patterns and seed rates. Indian J Agron. 1986; 31(3): 96-297.
16. Bhati DS, Shaktawat MS. Effect of sowing date, row spacing and nitrogen on quality parameters of coriander (*Coriandrum sativum* L.). Prog. Hort. 1994; 26(1-2):14-18**.**
17. Jat SC, Jat NC, Singh U. Response of coriander to row spacing and seed rates under semi-arid conditions. Annals of Agri-Bio Research. 1996; 1(1-2):105-106.
18. Mehta RS, Anwer MM and Sharma YK. Effect of irrigation, nutrient levels and crop geometry on growth and yield of dill (*Anethum sowa* L.). J Spices Arom. Crops. 2012; 21(1):20-24.
19. Meena SS, Mehta RS, Meena RD, Meena NK and Singh B. Effect of sowing time and crop geometry on growth and seed yield of dill (*Anethum sowa* L.) Int. J. Seed Spices. 2013; 3(2):81-84.
20. Krishnamoorthy V, Madalageri MB. Effect of interaction of nitrogen and phosphorus on seed and essential oil yield of ajowan (*Trachyspermum ammi* L.) genotypes. J. Spices Arom. Crops. 2000; 9 (2):137-139.
21. Naruka IS, Singh PP, Barde M, Rathore SS. Effect of spacing and nitrogen levels on growth, yield and quality of ajwain (*Trachyspermum ammi* L. Sprague). Int. J. Seed Spices. 2012; 2 (1):12-17.
22. Hans R and Thakral KK. Effect of chemical fertilizers on growth, yield and quality of fennel (*Foeniculum vulgare* Mill.) J. Spices Arom. Crops. 2008; 17 (2):134-139.
23. Gujar SM, Warade AD and Paithankar DH. Effect of dates of sowing and nitrogen levels on growth, seed yield and quality of coriander. Crop Research (Hissar). 2005; 29 (2):288-291.
24. Nayak BR, Saini SS, Sahu GS. Effect of farm yard manure, nitrogen and plant spacings on yield and attributing character of coriander (*Coriandrum sativum* L.). Environment and ecology. 2009; 27(3A):1374-1377.
25. Bali AS. Response of dill (*Anethum graveolens* L.) to row spacing and nitrogen. Indian J of Agron. 1988; 33 (3):337-338.
26. Sharma RN and Prasad R. Effect of seed rates and row spacing on fennel cultivars. Indian J Agron. 1990; 35(4):455-456.
27. Meena SS, Sen NL, Malhotra SK. Influence of sowing date, nitrogen and plant growth regulators on growth and yield of coriander (*Coriandrum sativum* L.). Journal of Spices and Aromatic Crops. 2006; 15(2):88-92.