Nutrient management in Dill Seed (*Anethum graveolens* L.) under south Gujarat condition

ABSTRACT

The present investigation was carried out during *rabi* season of 2016-17, 2017-18 and 2018-19 at College Farm, Navsari Agricultural University, Bharuch (Gujarat) to determine the requirement of nitrogen and phosphorus for dill seed for achieving maximum seed yield. Three different levels of nitrogen (20, 40 and 60 kg/ha) and phosphorus (00, 20 and 30 kg P_2O_5/ha) in different combination were distributed in the plots. The results indicated that application of nitrogen @ 60 kg/ha significantly increased plant height, branches/plant, number of umbels/plant, seeds/umbel, seed yield (1451 kg/ha) and straw yield (6008 kg/ha), net returns (Rs. 68299/ha) and B:C ratio (2.4), while, significantly higher grain yield (1407 kg/ha) and straw yield (5977 kg/ha), net returns (Rs. 66289/ha) and B:C ratio (2.3) were recorded with application of 30 kg P_2O_5/ha. It also significantly increased content and uptake of nitrogen and phosphorus at 60 kg N/ha and 30 kg P_2O_5/ha in seed and straw and also improves nutrient status of soil. Interaction effect between 60 kg N/ha and 30 kg P_2O_5/ha were found significant higher for umbels/plant and seed yield.

Keywords: Dill seed, nitrogen, phosphorus, economics

Introduction

Nature has gifted many valuable spices in the human beings. Spices are known to be an integral part of our Indian culture that's why India is known as the, "Home of spices" from very ancient times. There are about 63 cultivated spices but only dozen of them are fully important for commercial or large scale cultivation. Among them cumin, dill seed and fennel etc. are vital *rabi* seed spices, particular for arid and semi-arid regions of the country. India is the largest producer, consumer as well as exporter of the spices. Spices production in the Country grew from 67.64 lakh tonnes in 2014-15 to 106.79 lakh tonnes in 2020-21 with an annual growth rate 7.9%, following an increase in area from 32.24 lakh hectare to 45.28 lakh hectare. Among the major spices, Cumin (14.8%), Garlic (14.7%), Ginger (7.5%), Fennel (6.8%), Coriander (6.2%), fenugreek (5.8%), Red chilli (4.2%) and Turmeric (1.3 %), show significant growth rate in production. The rapid stride in production has made available quality spices for export. This is reflected in the growth of spices export which grew from 8.94 lakh tonnes worth Rs 14900 crores to 16 lakh tonnes valued at Rs 29535 crores (US$ 3.98 billion) during the above period, logging an annual growth rate of 9.8% in terms of

volume and 10.5% in terms of value (Anon., 2021). The name "Dill" is derived from "Norse dilla" which mean "to soothe" indicating its old reputation as a healing herb (Willian and Thomson, 1978). The essential oil content is 2.5 to 3.0 per cent in seed and 0.55 to 0.60 per cent in the whole plant. The Indian dill seed are known to contain more dillapiole (36.0 %) and less carvone (19.5 %) whereas European dill has more carvone (45.9 %) and less dillapiole (7 %) (Malhotra and Vashishtha, 2007). In India it is widely cultivated with the name of sowa in the states of Rajasthan, Gujarat, J & K, Uttar Pradesh, Orissa, Madhya Pradesh and Punjab. The area covered under dill, Celery and Poppy cultivation is 32798 thousand ha with the production of 34,566 thousand tonnes with average productivity of 1053 kg/ha and 32798 thousand ha area with the production of 34,566 thousand tonnes with average productivity of 1053 kg/ha in India and Gujarat, respectively during 2019-20 (Anon., 2021). The adequate supply of nitrogen is associated with the vigorous vegetative growth and dark green colour. Phosphorus influences the vigour of plant, root growth and enhance maturity. Considering these, the field experiment entitled, "Nutrient management in Dill Seed (*Anethum graveolens* L) under south Gujarat condition" has planned at the college farm, College of Agriculture, Navasari Agricultural University, Bharuch, Gujarat during *rabi* season in the year 2016-17, 2017-18 and 2018-19.

MATERIALS AND METHODS

The field experiment was carried out at College Farm, Navsari Agricultural University, Bharuch (Gujarat) during *rabi* season of 2016-17, 2017-18 and 2018-19. The soil was clayey in texture and slightly alkaline in reaction. The soil was low in available N (239.65 kg/ha) and low in available P_2O_5 (37.25 kg/ha). The field experiment was laid out in Factorial RBD with 9 treatment combinations consisting of two factors *viz.*, Nitrogen [N_1: 20 kg/ha, N_2:40 kg/ha and N_3:60 kg/ha] and Phosphorus [P_1: 00 kg/ha, P_2: 20 kg/ha and P_3: 30 kg/ha] with three replications. Dill seed variety GD-3 was sown by opening of furrow at distance of 45×10 cm. Application of fertilizers was given before the sowing of seeds in the open furrow. The nitrogen and phosphorus was applied at the time of sowing. The different dose of nitrogen and phosphorus was applied in form of urea and SSP as per the treatment in each plot. For all the growth and development studies during the crop growth period, five plants were selected randomly from net plot and tagged in each plot for recording plant height, days to 50% flowering, number of branches plant^{-1}, number of umbels plant^{-1}, number of umbelates/plant, number of seeds/umbelate at harvest and 1000 seeds were randomly taken from the bulk produce of each net plot and were counted and weighed. The weight was expressed as 1000- seed weight in grams. The data on seed and straw yield were recorded

from net plot and converted on hectare basis. The net realization and B:C ratio were calculated. The nitrogen content in dill seed was estimated by micro Kjeldahl's method as described by Jackson (1973). Chemical studies about nitrogen and phosphorus content and their uptake by seed and straw and available nitrogen and phosphorus status in the soil after harvest of the crop were determined as per different methods viz., Modified Kjeldahl's method (For N) and Wet digestion (Diacid) Vanado molybdo phosphoric acid yellow colour method (for P). The data were analyzed statistically by adopting the standard procedures described by Panse and Sukhatme (1985). The purpose of the analysis of variance was to determine the significant effect of treatments on dill seed. Uptake of nutrients by seed and plant was calculated by using following formula:

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient content (\%) x seed / straw yield (kg/ha)}}{100}$$

RESULTS AND DISCUSSION

Effect of Nitrogen

Growth parameters:

The data of table 1 indicated that the plant height at harvest was not significantly influenced due to different dose of nitrogen application, however, the maximum plant height was recorded with the application of nitrogen @ 60 N/ha and the minimum plant height was recorded with application of nitrogen @ 20 N/ha. The branches/plant in dill seed at harvest as influenced significantly due to different nitrogen treatments. Significantly higher number of branches/plant (8.40) was recorded with the application of nitrogen @ 60 kg N/ha which was remained statistically at par with the application of nitrogen @ 40 kg N/ha. Application of nitrogen treatments to dill plants increased plant height and number of branches plant^{-1} due to increased level of N 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. The improvement in morphological parameters under the influence of N application might have resulted in larger canopy development and presumably higher chlorophyll content of leaves as nutrient actively participate in its formation. These findings are in agreement with those of Hussein and Said (2015) in dill and Waskela *et al*. (2017) in fennel, Sultana *et al.* (2019) in black cumin and Choudhary *et al* (2020) in coriander. Choudhary *et al.* (2020) reported that significantly greater plant height, branches/plant of coriander was observed with the application of nitrogen @ 40 kg/ha which was superior to control and 30 kg N/ha. Waskela *et al*. (2017) reported that significantly higher plant height, primary, secondary and tertiary branches/plant at harvest and fresh and dry weight/plant was recorded as a result of higher

levels of NPK (60:40:40 kg/ha) in fennel. Sultana *et al.* (2019) reported that the maximum plant height and number of branches plant^{-1} was recorded with application of 60 kg/ha N in black cumin.

Yield Attributes:

The data of table 1 indicated that the days to 50 % flowering and number of umbels plant^{-1} at harvest significantly influenced due to different dose of nitrogen application. Significantly higher days to 50% flowering and number of umbels/plant recorded under treatment N_3 (60 kg N/ha) being at par with treatment N_2 (40 kg N/ha). Significantly the highest number of umbelates/plant (29.72), number of seeds/umbelate (29.72) and test weight (27.25 g) were recorded under the treatment having application of N @ 60 kg N/ha. These findings are in agreement with those of Singh and Amin (2015) in *rabi* fennel, Choudhary *et al*. (2020) and Saryam *et al*. (2022) in coriander and Waskela *et al*. (2017) in fennel. Saryam *et al*. (2022) reported that application of nitrogen @ 90 kg/ha was recorded the maximum number of umbels/plant (17.71), umbellets/umbel (5.65), seeds/umbel (6.06) and seed yield/plant (5.72 g). Choudhary *et al.* (2020) reported that significantly greater plant height, branches plant^{-1}, dry matter accumulation plant^{-1}, number of umbels plant^{-1} and number of umbellate umbel^{-1} of coriander was observed with the application of phosphorus @ 30 kg/ha which was superior to control and 15 kg phosphorus/ha. Singh and Amin (2015) reported that the maximum umbel/plant and number of umbellate/umbel was reported with application of 120 kg N/ha and it was at par with application of 90 kg N/ha. Waskela *et al*. (2017) reported that increasing level of NPK up to 60:40:40 kg/ha significantly improved days to 50 per cent lowering, number of umbels/plant, number of umbellate/umbel, number of seeds/umbel and test weight in fennel,

***Quality parameters*:**

Oil content did not differ significantly due to different nitrogen levels. These findings are in agreement with those of Muhammad *et al.* (2011) in fennel. They reported that seed oil contents were not influenced significantly by nitrogen application.

***Yield*:**

The data indicated that seed and stover yield of dill seed significantly enhanced due to application of different nitrogen levels and significantly the highest seed yield (1451 kg/ha) and straw yield (6008 kg/ha) was recorded with the application of 60 kg nitrogen/ha over 20 and 40 kg nitrogen/ha. These findings are in agreement with those of Choudhary *et al*. (2020) and Saryam *et al*. (2022) in coriander and Singh and Amin (2015) in rabi fennel. Choudhary *et al*. (2020) reported that application of different nitrogen levels and significantly

the highest seed yield (1143 kg/ha) and stover yield (1787 kg/ha) was recorded under the application of 40 kg N/ha over control and 30 kg N/ha. The corresponding increase in seed yield due to application of 40 kg N/ha over control and 30 kg N/ha was 51.0 and 16.4 per cent, respectively, whereas, corresponding enhancement in stover yield of coriander due to application of 40 kg N/ha was 48.7 and 15.6 per cent over control and 30 kg N/ha, respectively. Saryam *et al*. (2022) reported that the maximum seed yield (16.04 q/ha) with the application of 90 kg N in coriander. Singh and Amin (2015) reported that the maximum seed and stover yield was recorded with application of 120 kg N/ha and it was at par with application of 90 kg N/ha in rabi fennel. Waskela *et al*. (2017) reported that increasing level of NPK up to 60:40:40 kg/ha significantly improved seed yield.

Nutrient content and uptake

The mean data pertaining to nitrogen and phosphorus content by seed and straw and nitrogen and phosphorus uptake in dill seed crop as influenced by different treatments are presented in Table 2. Nitrogen and phosphorus content in seed and straw did not differ significantly due to different nitrogen levels. The nitrogen and phosphorus uptake by dill seed crop was affected significantly due to nitrogen levels. Application of nitrogen 60 kg N/ha recorded significantly the highest nitrogen and phosphorus of 78.71 and 13.46 kg/ha, respectively. Significant improvement in uptake of nitrogen and phosphorus might be attributed to their respective higher concentration in seed and straw and associated with higher seed and straw yield. The added nitrogen and phosphorus resulted in increased availability of available nitrogen and phosphorus under proper environmental condition of plant growth. These findings are in agreement with those of Javiya *et al.* (2017) in coriander. They reported that significantly higher uptake of nitrogen by seed (37.98 kg/ha) and stover (21.05 kg/ha), phosphorus uptake by seed (5.91 kg/ha) and stover (18.50 kg/ha) and potassium uptake by seed (10.78 kg/ha) and stover (13.01 kg/ha).

Soil properties and available nutrient in soil after harvest:

The important soil properties viz. soil pH, EC, available N and P_2O_5 were not affected significantly due to nitrogen levels, however, Soil organic carbon was affected significantly due to different nitrogen levels (Table 2). Application of nitrogen @ 60 kg N/ha recorded significantly higher 0.36 per cent soil organic carbon after harvest of dill seed crop. The available N and P_2O_5 in the soil after harvest of crop were found to be significant due to nitrogen and phosphorus levels. Application of nitrogen @ 60 kg N/ha recorded significantly higher available nitrogen (248.9 kg/ha) and available phosphorus (41.3 kg/ha) which was remained statistically at par with treatment N_2 (40 kg N/ha). These findings

corroborate the reports of Sanaval *et al*. (2022). They reported that application of nitrogen @ 40 kg/ha being at par with 80 kg N/ha increased the organic carbon and available nitrogen in soil during 2009-10, 2010-11 and in pooled analysis.

Economic:

An examination of data related to economics of coriander was significantly influenced by application of all nitrogen treatment and the significantly highest net returns (Rs. 68299/ha) and B:C ratio (2.4) was obtained with the application of nitrogen @ 60 kg/ha which was superior over 20 and 40 kg N/ha. This may due to higher seed and straw yields obtained with these treatments. This increase in the net return and B:C ratio due to application of nitrogen has also been reported by Pooja *et al*. (2017).

Effect of Phosphorus

Growth Parameters:

Plant height in dill seed did not differ significantly due to different phosphorus levels. Number of branches/plant of dill seed did not differ significantly due to different phosphorus levels. The positive influence of P application on number of branches/plant may be due to the increased availability of nitrogen and potassium which resulted in better plant growth. These findings are in agreement with those of Sultana *et al*., (2019) in black cumin, Meena *et al*. (2015) in Anise and Choudhary *et al*. (2020) in coriander. Meena *et al*. (2015) reported that the highest primary branches and secondary branches at all the growth stages were recorded with application of phosphorus 45 kg/ha being at par with 40 kg/ha phosphorus.

***Yield attributes*:**

Days to 50% flowering did not differ significantly due to different phosphorus levels. Significantly higher number of umbels/plant (27.15) was recorded under the treatment P_3 (30 kg P/ha), which was remained at par with treatment P_2 (20 kg P/ha). The number of umbelates/plant (29.59), number of seeds/umbellate (26.94) and test weight (4.12) were recorded significantly highest under the treatment having application of 30 kg P/ha (P_3). Thus on one hand profuse branching might have led to formation of maximum number of flowers, while on the other hand increased availability of nutrients and photosynthates to these developing structures seems to have resulted in greater retention of flowers and then developed into fertile fruits (umbels/plant) and maintaining high soil fertility, which ultimately exhibited higher yield attributes and yield. These findings are in agreement with those of Meena *et al*. (2015) in Anise and Choudhary *et al*. (2020) in coriander and Waskela *et al*. (2017) in fennel. Meena *et al*. (2015) reported that the highest yield attributes like early 50% flowering, maximum number of umbels/plant (35.83), number of umbellateumbel

(13.78), number of seeds/umbellate (16.60) and test weight (25.46 g) were recorded with the application of 40 kg/ha phosphours, being at par with 30 kg phosphours/ha. Choudhary *et al*. (2020) reported that significantly greater number of umbels/plant and number of umbellate/umbel of coriander was observed with the application of phosphorus @ 30 kg/ha which was superior to control and 15 kg P/ha. Waskela *et al*. (2017) reported that increasing level of NPK up to 60:40:40 kg/ha significantly improved days to 50 per cent flowering, number of umbels/plant, number of umbellate/umbel, number of seeds/umbel and test weight in fennel,

***Quality parameters*:**

Oil content did not differ significantly due to different phosphorus levels, however, the maximum oil content (2.71 %) was recorded with the application of phosphorus @ 30 kg/ha and the minimum oil content (2.56 %) was recorded with control.

Yield:

Among the three levels of phosphorus treatment P_3 (30 kg P/ha) gave significantly higher grain yield (1407 kg/ha) and straw yield (5977 kg/ha) as compared to treatment P_1 and P_2. These findings are in agreement with those of Choudhary *et al.* (2020) in coriander and Meena *et al*. (2015) in anise. Choudhary *et al*. (2020) reported that seed and stover yield of coriander significantly enhanced due to application of different phosphorus levels and significantly highest seed yield (1146 kg/ha) and stover yield (1791 kg/ha) of coriander was recorded with the application of 30 kg phosphorus/ha which was found superior to all other treatments. The increase in seed yield due to application of 30 kg phosphorus/ha was 50.6 and 17.5 per cent over control and 30 kg phosphorus/ha, respectively. The magnitude of increase in stover yields due to application of 30 kg phosphorus/ha as compared to control and 15 kg phosphorus/ha was 48.4 and 16.6 per cent, respectively. Meena *et al*. (2015) reported that the highest seed yield (6.82 q/ha) and straw yield (21.09 q/ha) were recorded with the application of P @40 kg/ha being at par with application of P @ 30 kg/ha.

***Nutrient content and uptake*:**

The mean data pertaining to nitrogen and phosphorus content and uptake by seed and straw in dill seed crop as influenced by different treatments are presented in Table 2. Nitrogen and phosphorus content in seed and straw did not differ significantly due to different phosphorus levels. The nitrogen and phosphorus uptake by dill seed plant was affected significantly due to phosphorus levels. Application of Phosphorus @ 30 kg/ha recorded significantly the highest nitrogen uptake (77.08 kg/ha) and phosphorus uptake (13.35 kg/ha). These findings are in agreement with those of Javiya *et al.* (2017) in coriander.

They reported that application of 60 kg P_2O_5/ha recorded significantly higher nitrogen uptake by seed (34.72 kg/ha) and stover (18.50 kg/ha), phosphorus uptake by seed (5.64 kg/ha) and stover (1.28 kg/ha), but it was all remained at par with 40 kg P_2O_5/ha.

Soil properties and available nutrient in soil after harvest:

The important soil properties viz. soil pH and EC were not affected significantly due to phosphorus levels, however, soil organic carbon, available nitrogen and available phosphorus was affected significantly due to different phosphorus levels (Table 2). Application of phosphorus @ 30 kg/ha recorded significantly higher soil organic carbon (0.36 %) and available P_2O_5 (41.0 kg/ha). Significantly higher available nitrogen (246.2 kg/ha) was recorded in treatment P_3 (30 kg P/ha) which statistically remained at par with treatment P_2 (20 kg P/ha). These findings are in agreement with those of Sanval *et al.* (2012) in coriander.

***Economics*:**

The maximum net returns (Rs. 66289/ha) and B:C ratio (2.3) of dill seed was obtained with the application of 30 kg phosphorus ha^{-1} which was found superior as compared to control and 20 kg P/ha. These results also substantiated by Mehta *et al.* (2013) and Javiya *et al.* (2017) in coriander. Javiya *et al.* (2017) reported that application of 60 kg P_2O_5/ha gave the highest net returns of Rs. 61008/ha and BCR of 3.26 by 40 kg P_2O_5/ha.

Interaction Effect

The interaction effect due to nitrogen and phosphorus were not found significant in all observations except number of umbels/plant, grain and straw yield. The maximum number of umbels/plant was obtained with treatment N_3P_3 (60 kg N/ha + 30 kg P/ha) but it was at par with all treatments except N_1P_1. More number of seeds/umbel depends on number of umbels/plant and number of umbellate/umbel that is why maximum seeds were recorded with the dose which gave highest number of umbels/plant. Similar results were observed by Mehta *et al*. (2014) in cumin and Hossain and Pariari (2018) in coriander. Mehta *et al.* (2014) reported that application of 30 + 20 kg/ha N and P_2O_5 produced 7 per cent more umbels/plant over 20 + 10 kg N and P_2O_5 kg/ha. Hossain and Pariari (2018) reported that the maximum number of umbels/plant (66.30) due to application with 60 kg N/ha + 40 kg P_2O_5/ha (N_2P_2) which was followed by N_2P_3 (60 kg N/ha + 50 kg P_2O_5/ha). Whereas the minimum umbels/plant (54.00) due to application with 40 kg N/ha + 30 kg P_2O_5/ha (N_1P_1) which was followed by N_1P_2 (40 kg N/ha + 60 kg P_2O_5/ha) treatment.

Significantly the highest seed (1752 kg/ha) and straw yield (6921 kg/ha) under treatment combination of N_3P_3 (60 kg N/ha + 30 kg P_2O_5/ha), while, significantly the lowest seed and straw yield was recorded under treatment N_1P_1 (20 kg N/ha + 00 kg P_2O_5/ha). Application of

higher level of nitrogen and phosphorus enhance growth and yield parameters which in turn result in higher seed and straw. Similar results were reported by Mehta *et al*. (2014) in cumin and Yimam *et al*. (2015) in black cumin. Mehta *et al.* (2014) reported that seed yield (3.71 q/ha) and straw yield (7.79 q/ha), net return (Rs. 30,502/ha) and B:C ratio (2.23) were obtained with application of 30 N and 20 kg P_2O_5/ha. The significant improvement in seed and stover yields of coriander due to nitrogen and phosphorus fertilization could be ascribed to overall improvement in vigour and crop growth as reflected by plant height, branches/plant and dry weight. Higher seed yield with increasing rate of nitrogen and phosphorus was also reported. Yimam *et al*. (2015) reported that the maximum total yield (6416.7 kg/ha) obtained from the interaction effect of 60/40 kg NP ha^{-1}. Whereas the minimum value (3854.7 kg/ha) obtained from treatment that received zero NP in black cumin. There was a significant interaction of nitrogen and phosphorus levels on total nitrogen and phosphorus uptake by dill seed crop, was recorded. Significantly higher nutrient uptake (93.32 kg/ha) by dill seed crop was recorded under treatment combination N_3P_3 (60 kg N/ha + 30 kg P_2O_5/ha). There was a non-significant interaction found between the nitrogen and phosphorus levels in soil pH, EC, organic carbon and available P_2O5 after harvest of crop while, available N was found significantly due to interaction effect of nitrogen and phosphorus. Significantly higher soil N (251.7 kg/ha) was obtained under treatment combination N_3P_3 (60 kg N/ha + 30 kg P_2O_5/ha) which was being at par with N_2P_1, N_2P_2, N_2P_3, N_3P_1 and N_3P_2. The maximum gross realization (Rs. 110957/ha), net realization (Rs.82301/ha) and BCR (2.9) was obtained under the treatment N_3P_3 (60 kg N/ha + 30 kg P_2O_5/ha). This can be attributed to higher seed and straw yield recorded with these treatments along with comparably low cost. Similar results were reported by Mehta *et al*. (2014) in cumin. They reported that net return (Rs. 30,502/ha) and B:C ratio (2.23) were obtained with application of 30 N and 20 kg P_2O_5/ha.

REFERENCES

Anonymous 2021. Spices statistics at a Glance 2021, Directorate of Arecanut and Spices development, Ministry of Agriculture & Farmers Welfare, Calicut, Kerala, India, pp.3.

Choudhary V, Sharma P K, Mandeewal R L, Verma B L and Choudhary R. 2020. Effect of nitrogen and phosphorus on growth, yield and quality of coriander (*Coriandrum sativum* L.) *Annals Agricultural Research* 41 (3) : 322-324.

Hossain M M and Pariari A. 2018. Effect of different levels of nitrogen and phosphorus on growth and seed yield of coriander (*Coriandrum Sativum* L.) cv. Ajmer coriander-1, *International Journal of Chemical Studies* **6**(5): 2181-2185.

Hussein and Said A. 2015. Growth and chemical composition of dill affected by nitrogen and bio-fertilizers, *International Journal of Life Science and Engineering* **1** (2) : 75-84.

Jackson M L. 1973. Soil Chemical Analysis, Prentice Hall of India Private Limited, New Delhi.

Javiya P P, Solanki J N, Kaneria S C and Rupareliy V V. 2017. Response of Coriander (*Coriandrum sativum* L.) to Nitrogen and Phosphorus in South Saurashtra Condition Int. *Journal of Pure Applied Bio-Sciences* **5** (4): 860-866.

Malhotra S K and Vashishta B B. 2007. Response of Indian dill (Anethum sowa) and European dill (*Anethum graveolens*) varieties to different agro-techniques. *Indian Journal of Agricultural Sciences* **77** (8): 43-46.

Meena R L, Meena S S, Mehta R S, Meena R D and Saini Y. 2015. Response of varying nitrogen and phosphorus levels on growth and yield of Anise (*Pimpinella anisum* L.) *International Journal of Seed Spices* **5**(1):83-87

Mehta R S, Malhotra S K and Meena S S. 2014. Growth and yield of cumin as influenced by irrigation and nutrient levels with varying crop geometry. *Indian Journal of Horticulture* **71**(3) : 433-436.

Muhammed A, Muhammad N, Muhammad A N, Asif T, Muhammad T and Rehan A. 2011. Effect of nitrogen application on growth, yield and oil contents of Fennel (Foenoculum vulgare Mill.) *Journal of Medicinal Plants Research* **5**(11) : 2274-2277.

Panse V G and Sukhatme P V. 1973. Statistical Methods for Agricultural Workers. ICAR Publication, Ministry of Agriculture, New Delhi.

Pooja, Nagre P K and Yadav H. 2017. Influence of different levels of nitrogen and phosphorus on seed yield and economics of coriander (*Coriandrum sativum* L.). *Journal of Pharmacognosy and Phytochemistry* **6**(5): 157-160.

Sanwal R C, Sharma Y, Reager M L, Dayanand and Rakesh. 2022. Effect of vermicompost, nitrogen and phosphorus on economics of coriander and soil health. *The Pharma Innovation Journal* **11**(1): 1429-1433.

Saryam N, Bisen B P, Singh R and Dahayat A. 2022. Effect of different Nitrogen and Potassium Levels on Yield and yield attributes of Coriander (*Coriandrum sativum* L.) *Biological Forum – An International Journal* **15**(6): 367-370.

Singh A and Amin A U. 2015. Response of drilled rabi fennel (*Foeniculum vulgare* Mill) to spacing under varying levels of nitrogen. *International Journal of Seed Spices* **5**(1):102-104

Sultana S, Mondal A, Das S , Rudra B C, Alam B and Roy S. 2019. Effect of Nitrogen and Phosphorous Fertilizer Application on Growth and Yield of Black Cumin Cultivation in

Malda District (WB) *International Journal of Current Microbiological Applied Sciences* **8**(4): 2813-2817.

Waskela P, Naruka I S and Shaktawat R P S. 2017. Effect of Row Spacing and Level of NPK on Growth and Yield of Fennel (*Foeniculum vulgare*). *Journal of Krishi Vigyan* **6**(1) : 78-82.

William A R and Thomson M D. 1978. *Anethum graveolens* L. Healing plants. A Modern herbal., Mc Graw Hill book Co., UK, pp.42.

Yimam E, Nebiyu A, Mohammed A and Getachew M. 2015. Effect of Nitrogen and Phosphorus Fertilizers on Growth, Yield and Yield Components of Black Cumin (*Nigella sativa* L.) at Konta District, South West. *Ethiopia Journal of Agronomy* **14** (3): 112-120.

Table 1 Growth, yield economics of dill seed as influenced by nitrogen and phosphorus levels (Pooled)

Treatment	Plant height (cm)	No. of branches / plant	Days to 50% flowering	Number of umbels /plant	Number of umbelates/ plant	Number of seeds/ umbelate	Test weight (g)	Oil content (%)	Seed yield (kg/ha)	Straw yield (kg/ha)	Gross realization (Rs./ha)	Net Return (Rs./ha)	B:C ratio
Nitrogen levels N kg/ha													
N_1 : 20	133.42	7.54	81.45	24.04	26.94	24.84	3.73	2.59	951	4472	72586	45031	1.6
N_2 : 40	137.79	8.01	82.83	26.16	27.84	25.79	3.88	2.67	1243	5456	86436	58648	2.1
N_3 : 60	142.10	8.40	86.70	27.28	29.72	27.25	4.22	2.72	1451	6008	96320	68299	2.4
SEm±	2.56	0.18	1.36	0.51	0.45	0.35	0.08	0.06	29	175			
CD (P=0.05)	NS	0.53	4.08	1.53	1.36	1.06	0.25	NS	86	525			
Phosphorus levels P kg/ha													
P_1 : 0	134.50	7.84	81.87	24.27	26.76	25.09	3.76	2.56	1018	4540	75060	48065	1.8
P_2 : 20	136.97	7.94	83.60	26.05	28.15	25.85	3.94	2.70	1220	5418	85569	57624	2.1
P_3 : 30	141.83	8.17	85.51	27.15	29.59	26.94	4.12	2.71	1407	5977	94712	66289	2.3
SEm±	2.56	0.18	1.36	0.51	0.45	0.35	0.08	0.06	29	175			
CD (P=0.05)	NS	NS	NS	1.53	1.36	1.06	0.25	NS	86	525			
Interaction													
SEm±	2.69	0.18	2.35	0.88	0.77	0.49	0.15	0.10	49.0	303.0			
CD (P=0.05)	NS	NS	NS	NxP	NS	NS	NS	NS	N x P	N x P			

Seed Price : Rs. 45 /kg, Straw price : Rs.0.50 /kg

Table 2 Nutrient content, uptake by plant, soil properties and available nutrient in soil after harvest of dill seed as influenced by nitrogen and phosphorus levels (Pooled)

Treatment	N content (%)		P content (%)		N uptake (kg/ha)	P uptake (kg/ha)	Soil properties			Available nutrient	
	Seed	Straw	Seed	Straw			pH	EC	OC (%)	N (kg/ha)	P_2O_5 (kg/ha)
Nitrogen levels (N)											
N_1 : 20	1.85	0.81	0.284	0.149	54.38	9.32	7.60	0.43	0.31	230.3	33.1
N_2 : 40	1.86	0.82	0.292	0.150	68.51	11.82	7.39	0.44	0.33	245.1	37.8
N_3 : 60	1.86	0.83	0.292	0.154	78.71	13.46	7.53	0.42	0.36	248.9	41.3
SEm±	0.007	0.006	0.004	0.001	1.91	0.34	0.09	0.01	0.01	2.00	0.54
CD (P=0.05)	NS	NS	NS	NS	5.72	1.01	NS	NS	0.02	6.01	1.61
Phosphorus levels (P)											
P_1 : 0	1.85	0.82	0.288	0.148	56.27	9.65	7.58	0.44	0.31	236.3	33.2
P_2 : 20	1.85	0.82	0.281	0.151	68.25	11.60	7.46	0.43	0.33	241.9	38.0
P_3 : 30	1.86	0.83	0.299	0.153	77.08	13.35	7.48	0.42	0.36	246.2	41.0
SEm±	0.007	0.006	0.004	0.001	1.91	0.34	0.09	0.01	0.01	2.00	0.54
CD (P=0.05)	NS	NS	0.013	NS	5.72	1.01	NS	NS	0.02	6.01	1.61
Interaction											
SEm±	0.006	0.007	0.001	0.001	3.30	0.58	3.42	4.22	6.96	2.49	4.30
CD (P=0.05)	NS	NS	NS	NS	N×P	N×P	NS	NS	NS	NxP	NS

Table 3 Interaction effect of nitrogen and phosphorus on number of umbels/plant, seed yield and straw yield of dill seed (Pooled)

Treatment	Number of umbels/plant				Seed yield (kg/ha)				Straw yield (kg/ha)			
	P levels (P)				P levels (P)				P levels (P)			
N levels (N)	**P_1 : 0**	**P_2 : 20**	**P_3 : 30**	**Mean (N)**	**P_1 : 0**	**P_2 : 20**	**P_3 : 30**	**Mean (N)**	**P_1 : 0**	**P_2 : 20**	**P_3 : 30**	**Mean (N)**
N_1 : 20	20.06	25.53	26.54	24.04	822	1051	980	951	4059	4924	4433	4472
N_2 : 40	25.99	25.25	27.32	26.19	1024	1216	1488	1243	4467	5323	6578	5456
N_3 : 60	26.76	27.63	27.69	27.36	1207	1394	1752	1451	5095	6008	6921	6008
Mean (P)	24.27	26.14	27.18		1018	1220	1407		4540	5418	5977	
SEm±		0.88				49				303		
CD (P=0.05)		2.64				148				910		

Table 4 Interaction effect between N and P levels on nutrient uptake by plant and available N in soil after harvest of dill seed (Pooled)

Treatment	N Uptake by plant				P uptake by plant				Available N (kg/ha)			
	P levels (P)				P levels (P)				P levels (P)			
N levels (N)	**P_1 : 0**	**P_2 : 20**	**P_3 : 30**	**Mean (N)**	**P_1 : 0**	**P_2 : 20**	**P_3 : 30**	**Mean (N)**	**P_1 : 0**	**P_2 : 20**	**P_3 : 30**	**Mean (N)**
N_1 : 20	47.10	60.53	55.52	54.38	8.17	10.21	9.58	9.32	217.0	233.5	240.5	230.3
N_2 : 40	55.76	67.35	82.41	68.51	9.54	11.38	14.55	11.82	246.1	242.9	246.4	245.1
N_3 : 60	65.96	76.87	93.32	78.71	11.25	13.19	15.93	13.46	245.7	249.2	251.7	248.9
Mean (P)	56.27	68.25	77.08		9.65	11.60	13.35		236.3	241.9	246.2	
	SEm±	3.30				0.58				3.47		
	CD (P=0.05)	9.90				1.75				10.40		