Journal of Spices and Aromatic Crops
Vol. 28 (1) : 61–65 (2019)
doi : 10.25081/josac.2019.v28.i1.5745

Indian Society for Spices

Effect of integrated nutrient management on growth, yield and quality attributes of black cumin (*Nigella sativa* L.) var. Rajendra Shyama grown under terai region of West Bengal

A Sen*, S D Khade, J C Jana & P Choudhury
Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar-736 165, West Bengal.
**E-mail: nini.sen20@gmail.com*

Received 05 February 2019; Revised 29 April 2019; Accepted 24 June 2019

Abstract

A field experiment was conducted during rabi seasons of 2014–15 and 2015–16 to study the effects of various combination of different levels of inorganic, organic and bio-fertilizers (*Azophos*) on the vegetative growth, yield contributing attributes and quality of seeds of black cumin. The results showed that the combination of 100% RDF (Recommended Dose of Fertilizer) + 15 t ha^{-1} FYM (Farm Yard Manure) + 4 kg ha^{-1} *Azophos* significantly improved most of the parameters related to growth of plant, seed yield and net returns. However, for production of seed oil, 75% RDF of chemical fertilizers + FYM + bio-fertilizer was recorded was the best. Most of the soil properties were improved by application of 100% RDF + FYM. Therefore from the results, it could be suggested that inclusion of organic manure and bio-fertilizer along with 100% (RDF) is the best combination for seed production of black cumin whereas for better quality seed oil 25% RDF can be substituted with FYM and bio-fertilizer (*Azophos*) in terai region of West Bengal.

Keywords: *Azophos*, bio-fertilizer, black cumin, fertilizer, farm yard manure.

Black cumin (*Nigella sativa* L.) also known as kalaunji or kala jeera is a seed spice having immense pharmacological potential. The plant belongs to the family Ranunculaceae having chromosome number 2n = 12. It is native of North Africa, Southern Europe and Southwest Asia and is widely grown in areas of Middle Eastern Mediterranean region, Southern Europe, India, Saudi Arabia, Pakistan, Syria and Turkey (Khare 2004). Successful commercial cultivation of black cumin depends upon various factors *viz.*, climate, growing season, soil fertility, fertilizer nutrient management, irrigation, spacing and cultural practices etc.

Developing sustainable agricultural practices along with increase in yield or with non significant reduction in yield is the need of the hour. This can be achieved by integrated use of organic manure and bio-fertilizers along with chemical fertilizers, which not only improves soil health but also maintains reasonably fair productivity (Bhandari *et al*. 2012). The organic manures used are low-cost and renewable sources of plant nutrients which can be a potential supplement for chemical fertilizers. Hence, it can be assumed to be a better, safer and economic alternative source of nutrient for the crops (Hamma *et al*. 2013).

In northern districts of West Bengal *viz*., Cooch Behar, black cumin is grown in small scale for

local markets and for the nearby markets of the neighbouring states. Farmers usually follow the nutrient management practice of 30:40:45 kg ha^{-1} $N:P_2O_5:K_2O$ and use urea, muriate of potash and single super phosphate as sole source. Though this practice gives adequate yield to the farmers substitution of these chemical fertilizers with organic manure like FYM can reduce the cost of cultivation and increase the net profit. Moreover, considering the benefits of organically produced manure and bio-fertilizers, the present experiment was conducted so that not only the black cumin seed yield but the oil yield could also be improved while taking care of the soil health. So far, research work on the integrated nutrient management practices of black cumin in West Bengal is rearce. Therefore, the present experiment was conducted with an aim to study the effect of integrated use of organic and inorganic sources of nutrient on growth, yield and quality attributes of black cumin in terai region of West Bengal.

The present trial was performed at the Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Pundbari, in Cooch Behar district of West Bengal, India during November to March of 2014–15 and 2015–16. The climate of this area is characterized by average annual rainfall of 210–330 cm during monsoon, high relative humidity, moderate temperature, prolonged winter with high residual soil moisture. The temperature of this region varies from 7–8 °C to 24–33.2 °C. The weather was cool during the vegetative period with maximum temperature of 25.11 °C and minimum temperature of 18.16 °C, and hot during the harvesting period with maximum temperature of 30.69 °C and minimum of 17.17 °C. The soil is low in pH, sandy loam in nature, coarse in texture, poor in water holding capacity. The soil samples from each individual plots were collected for both the years and analyzed before and after raising of black cumin crop using pH meter (Jackson 1973) for measuring pH of the soil, Rapid titration method (Walkley & Black 1934) for organic carbon estimation, modified macro Kjeldahl method (Jackson 1973), Bray's No. 1 method (Jackson 1973), Flame Photometer method (Jackson 1973) for available nitrogen, phosphorus and potassium, respectively.

The study involved two years of field experimental trials during rabi seasons 2014-15 and 2015-16. The experiment was designed under three factorial RBD design which consisted of twelve treatments with three factors *viz.*, 1st Factor: C– 3 levels of recommended dose of chemical fertilizers (RDF)-No (C_0), 75% RDF (C_1) and 100% RDF (C_2); 2nd Factor: F– 2 levels of Farmyard manure (FYM) – No (F_0) and 100% (F_1) FYM; 3rd Factor: B- 2 levels of bio- fertilizer mixture as *Azophos* - No (B_0) and 100% (B_1). The twelve treatment combinations were *viz.*, $C_0F_0B_0$ (T1), $C_0F_0B_1$ (T2), $C_0F_1B_0$ (T3), $C_0F_1B_1$ (T4), $C_1F_0B_0$ (T5), $C_1F_0B_1$ (T6), $C_1F_1B_0$ (T7), $C_1F_1B_1$ (T8), $C_2F_0B_0$ (T9), $C_2F_0B_1$ (T10), $C_2F_1B_0$ (T11), $C_2F_1B_1$ (T12) and replicated three times;

Black cumin seeds of the variety Rajendra Shyama were used as planting material for this experiment. The seeds were soaked overnight for better germination, treated with *Azophos* according to the treatment and were sown in a plot of 2 × 1.5 m^2 size in a row at 25 cm spacing which were thinned at 5 cm distance at 40 days after germination following the spacing of 25 cm × 5 cm during the 3rd week of November. Chemical form of N, P_2O_5, K_2O as urea (46% N), single super phosphate (16% P_2O_5) and muriate of potash (60% K_2O) were applied respectively @30:40:45 kg ha^{-1}, Farm Yard Manure (FYM) was applied @ 15 t ha^{-1} and bio- fertilizer *i.e.*, *Azophos* was applied @ 2 kg ha^{-1} and 4 kg ha^{-1} as seed treatment as well as soil application respectively as a source of organic nutrients. A basal dose was applied consisting of one third of recommended dose of urea along with full dose of single super phosphate and muriate of potash along with organic manures *i.e.*, FYM and *Azophos* were applied as per the treatment combinations allotted for individual bed during the sowing time, while two third of remaining urea was applied in two split doses during later stage of crops development at 40 DAS and 60 DAS.

The observations on growth and yield were recorded from five randomly selected plants and the data were statistically analyzed (Gomez & Gomez 1984). Fisher and Snedecor's 'F' test with probability at 0.05% was used to test the significance of the different sources of variation and least significance difference was tested at 5%

level of significance (Fisher & Yates 1963). For oil extraction solvent extraction method using *n*-hexane was used in soxhlet distillation unit. The total cost of cultivation was calculated by considering the expenditure starting from land preparation till the harvesting, cleaning, and other operations as fixed price. The cost of the black cumin seeds Rs 200 kg^{-1} at the time of experiment in the local market.

A significant improvement in plant growth attributes *viz*., plant height, secondary branches and dry weight was observed when organic and inorganic nutrients and bio-fertilizers were used in an integrated manner. This positive effect observed might be due to continuous and steady supply of the nutrients throughout the growing period of crop at various stages. The organic manures incorporated improves the soil quality by acting as a feed to the bio- fertilizers which help them to grow and perform their function more efficiently. The same kind of results by combination of fertilizers was obtained by Iman & Pariari (2007) in coriander which was later confirmed by Farooqui *et al.* (2009).

The growth parameters like average number of secondary branches (15.87) and dry weight (14.78 g) of plant were significantly higher under T12, where 100% RDF of chemical fertilizers + FYM + bio-fertilizer were used and maximum plant height (57.20 cm) was obtained in T11 where 75% RDF of chemical fertilizers + FYM were used (Table 1). The results are with the findings of Singh (2011) in coriander. More over other vegetative characters like average number of primary branches and chlorophyll content were increased non- significantly but still it was highest for T12 treatment as compared to others. The bio-fertilizer applied convert nitrogen in available form near the root zone and the synergistic effect of the vermi-compost along with bio-fertilizers enhanced the physiological and metabolic activities of the treated plants. With the increasing nitrogen application and bio-fertilizers, the nutrient available in the soil also increased and thereby resulted in significant improvement on growth attributes of crop.

Yield attributes like average number of capsules $plant^{-1}$ (22.77), yield $plot^{-1}$ (384.79 g) and yield ha^{-1} (961.89 kg ha^{-1}) were recorded highest when 100% RDF of chemical fertilizers + FYM + bio-fertilizer were applied *i.e*., T12. Though average number of seeds per capsules (97.40) and 1000 seed weight (3.604 g) improved, it was non-significant (Table 1). This might be due to better vegetative growth and continuous supply of nutrients during capsule formation and seed development. Similar results were reported by Choudhary & Jat (2004) where they observed higher yield and net return at 100% inorganic N + *Azospirillum* + 5 t FYM in coriander. The control treatment where no manures and fertilizers were applied was the poorest performer amongst all.

The seed oil content improved significantly with the increase in input of nutrients from various sources and it was the highest in T8 where 75% RDF of chemical fertilizers + FYM + bio-fertilizer was applied (Table 1). Similar results were reported by Arancon *et al*. (2006) by application of vermi-compost which increased mineral uptake, biomass and enhanced essential oil content. Hellal *et al*. (2011) in his experiment on dill also confirmed that combination of bio-fertilizer with two third of recommended dose of nitrogen fertilizer had significant positive effect on oil yield.

Combined application of inorganic nutrient, organic nutrient and bio-fertilizer improved the property of the soil than the sole application and their continuous application may result in significant improvements in soil properties and also yield. Among all the treatments, T11 (100% RDF + FYM) was the best for all the soil parameters *viz*., available nitrogen (increased to 208.23 kg ha^{-1} from 174.36 kg ha^{-1}), potassium (increased to 78.96 kg ha^{-1} from 74.99 kg ha^{-1}), organic carbon (increased to 1.03 g kg^{-1} from 0.96 g kg^{-1}) and pH (increased to 5.81 from 5.79) whereas highest available phosphorus (increased to 46.77 kg ha^{-1} from 41.03 kg^{-1} ha) was recorded in T12. Udayasoorian *et al*. (1989) also confirmed that continuous use of FYM over seven years on an Alfisol significantly increased the NH_4-N and NO_3-N contents, whereas addition of green leaf manures did not leave any profound effect. Application of FYM serves as the store house of the nutrients ensures the sustainability at higher level by taking care of the hidden deficiency of micro and secondary nutrients and it also acts as conditioner for optimizing the physical condition of soil.

Table 1. Effect of integrated nutrient application on attributes of growth, yield and quality of black cumin (mean data of 2 years)

Treatment	Avg. plant height (cm)	Avg. no. of primary branches	Avg. no. of secondary branches	Leaf chloro-phyll content (SPAD)	Plant dry weight (g)	Avg. no. of capsules plant^{-1}	Avg. no. of seeds capsule^{-1}	Yield plot^{-1} (g)	Yield ha^{-1} (kg ha^{-1})	Seed oil content (mg g^{-1})	1000 seed weight (g)	Benefit cost ratio
T1	44.57	5.70	10.40	11.01	09.25	12.92	80.50	138.19	345.47	0.22	2.747	1.62
T2	46.07	5.93	11.07	11.43	09.40	14.12	86.22	183.31	458.27	0.29	3.043	2.42
T3	46.53	5.80	11.00	09.70	09.31	13.20	81.90	142.39	355.97	0.28	2.709	1.36
T4	47.73	6.30	12.93	11.78	09.93	13.35	84.90	162.61	404.87	0.30	2.739	1.65
T5	46.60	6.47	13.93	12.56	10.15	13.19	83.37	133.41	333.555	0.30	2.803	1.21
T6	51.57	6.97	14.87	13.27	12.73	22.09	91.10	288.22	720.55	0.32	2.996	3.71
T7	52.47	6.15	12.27	10.28	11.72	13.79	79.00	161.82	404.54	0.31	3.053	1.38
T8	53.40	6.77	14.87	12.50	12.63	17.63	86.07	230.05	575.13	0.35	3.238	2.35
T9	47.03	5.74	10.20	10.71	11.61	12.99	84.60	141.54	353.84	0.25	2.642	2.72
T10	54.27	6.75	14.93	11.56	12.55	15.70	86.60	205.53	466.99	0.31	3.146	1.97
T11	57.20	6.77	15.27	12.41	13.76	19.25	89.89	236.44	591.1	0.32	2.796	2.39
T12	54.28	7.23	15.87	14.80	14.78	22.77	97.40	384.79	961.98	0.34	3.604	4.45
CD (P<0.05)	03.33	NS	02.32	NS	00.85	01.46	NS	025.21	64.82	0.01	NS	0.015
S. Em±	1.07	0.35	0.79	0.368	0.27	0.47	2.75	8.10	20.83	0.003	0.177	0.005

Note: $C_0F_0B_0$ (T1); $C_0F_0B_1$ (T2); $C_0F_1B_0$ (T3); $C_0F_1B_1$ (T4); $C_1F_0B_0$ (T5); $C_1F_0B_1$ (T6); $C_1F_1B_0$ (T7); $C_1F_1B_1$ (T8); $C_2F_0B_0$ (T9); $C_2F_0B_1$ (T10); $C_2F_1B_0$ (T11); $C_2F_1B_1$ (T12); where, no RDF (C0); 75% RDF (C1) and 100% RDF (C2); no FYM (F0) and 100% FYM (F1); no Azophos (B0) and 100% Azophos (B1); NS- Non Significant

Economics of cultivation of black cumin under different treatments was studied with respect to net return, gross return and B: C ratio. The data presented in Table 1, indicates that different levels of fertilizers, organic manure and bio-fertilizers has an influence on the gross return (Rs ha^{-1}). The maximum and almost double gross return (Rs 2,56,200/-) was recorded in T12 where 100% RDF + FYM + bio-fertilizer was applied. This was due to maximum yield recorded for the same treatment. Gross return of T6 (Rs 1,92,200/-) where 75% RDA + bio fertilizer was applied was almost double than T5 (Rs 89,000/-). From this it can be concluded that application of chemical fertilizer along with bio fertilizer can increase the output by many folds. Similar effects were observed for the benefit cost ratio of the treatments where T12 showed the highest benefit cost ratio (4.45 : 1) followed by T6 (3.71 : 1) and T11 (2.39 : 1). Similar results were obtained by Singh (2018) for dill where it was reported that application of 100% NPK + 5 tons vermi-compost ha^{-1} + PSB 5 kg ha^{-1} and *Azotobacter* 5 kg ha^{-1} recorded highest B:C ratio of 3.78 : 1.

From the study it can be concluded that in terai region of West Bengal, integrated nutrient management practice involving 100% RDF + FYM + bio-ferttilizer (*Azophos*) would be effective in increasing the yield and gross return with the highest benefit cost ratio in terms of the cumin seed production but if the crop is grown for production of black cumin oil purpose which is also having a greater demand and value in market (Rs 500 250 ml^{-1}) then 75% RDF of chemical fertilizers + FYM + bio-fertilizer is the best as this not only partially replaces the chemical fertilizer with organic manure and bio-fertilizer which reduces the cost of cultivation but also is ecologically sustainable.

Acknowledgement

The Authors are grateful to the personnel of Central Instrumentation Laboratory, Uttar Banga Krishi Viswavidyalaya, Pundibari, West Bengal for encouragement and help during the entire research work.

References

Arancon N Q, Edwards C A, Lee S & Byrne R 2006 Effects of humic acids from vermi-composts on plant growth. European J. Soil Biol. 42: 65–69.

Bhandari S A, Patel K S & Nehete D S 2012 Effect of integrated nutrient management on growth, yield and quality of garlic (*Allium sativum* L.) cv. GUJRAT GARLIC-3. The Asian J. Hort. 7: 48–51.

Chaudhary G R & Jat N L 2004 In: National seminar on new perspectives in commercial cultivation, processing and marketing of seed spices and medicinal plants, 25-26 March 2004, Jobner, Rajasthan (pp.44–45).

Farooqui M A, Naruka I S, Rathore S S, Singh P P & Shaktawat R P S 2009 Effect of nitrogen and sulphur levels on growth and yield of garlic (*Allium sativum* L.). As. J. Food Ag-Ind. S: 18–23.

Fisher S R A & Yates F 1963 Statistical Tables for Biological, Agricultural and Medical Research. (6th Edn.) Oliver & Boyd, Edinburgh Tweedale Court, London.

Gomez K A & Gomez A A 1984 Statistical Procedures for Agricultural Research. (2nd Edn.), John Wiley and sons Inc., Hoboken, p.680.

Hamma I L, Ibrahim U & Mohammed A B 2013 Growth, yield and economic performance of garlic (*Allium sativum* L.) as influenced by farm yard manure and spacing in Zaria, Nigeria. J. Agril. Econ. Develop. 2: 1–5.

Hellal F A, Mahfouz S A & Hassan F A S 2011 Partial substitution of mineral nitrogen fertilizer by bio-fertilizer on (*Anethum graveolens* L.) plant. Agri. Biol. J. North America. 2: 2151–7517.

Iman M N & Pariari A 2007 Response of different nitrogen sources on growth and yield of coriander (*Coriandrum sativum* L.). Seed Res. 12: 75–76.

Jackson M L 1973 Soil chemical analysis. Pretice Hall of India Pvt. Ltd. Publisher, New Delhi, p.497–503.

Khare C P 2004 Encyclopedia of Indian medicinal plants. New York: Springes-Verlag Berlin Heidelberg.

Singh P 2018 Effect of integrated nutrient management on growth, yield and quality of dill (*Anethum sowa* Roxb). M.Sc. (Hort.) Thesis, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, India.

Singh M 2011 Effect of vermicompost and chemical fetilizers on growth, yield and quality of coriander (*Coriandrum sativum* L.) in semi arid tropical climate. J. Spices Arom. Crops. 20: 30–33.

Udayasoorian C, Ramula U S & Paramasirand P 1989 Effect of continuous manuring and fertilization on the fractions of soil nitrogen. Madras Agri. J. 76: 257–261.

Walkley A & Black J A 1934 An experimentation of the Degtjareff method for determining soil organic matter and proposed modification of chronic acid titration method. Soil Sci. 37: 27–28.