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Impact of Biofertilizers Fortified Inorganic Nutrients and Vermicompost on Growth and Yield Attributes of *Nigella sativa* L.var Azad Kalonji

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ABSTRACT

A field experiment was conducted at the Horticultural-Research Station, Mondouri, BCKV, West Bengal,India during *rabi* season of 2019-20. The experiment was laid out in RBD with 12 treatments replicated thrice, comprising of four levels of RDF (25, 50, 75 and 100%), four levels of nitrogen equivalent through vermicompost (25, 50, 75 and 100%) with and without biofertilizers (*Azospirillum lipoferum*, *Bacillus megaterium* and *Fraturia aurantia*) soil application. The results showed that application of 75% RDF + 25% N equivalent through vermicompost + Biofertilizers recorded significantly higher seed yield (668.85 kg ha^{-1}) which was attributed by enhanced growth parameters like plant height (85.06 cm) at 100 DAS, number of primary branches (9.35), number of secondary branches (17.33), number of capsules $plant^{-1}$ (24.33), number of seeds $capsule^{-1}$ (97.33). Gross returns (Rs 1,67, 212.50 ha^{-1}), net returns (Rs 1, 34, 361.24 ha^{-1}) and benefit cost ratio (4.08 : 1) were also recorded highest in the same treatment combination. The results also showed that 25% inorganic nutrient requirement can be supplemented through vermicompost and biofertilizers with higher yield with reduced cost of cultivation and more ecologically sustainable.

Keywords *Azospirillum, Bacillus*, Biofertilizers, Economics, *Fraturia.*

INTRODUCTION

Black cumin (*Nigella sativa* L.), is a dicotyledon, an annual flowering plant belonging to the buttercup family (*Ranun culaceae*). It is native to Mediterranean region and it is cultivated from the countries of the southern and eastern areas of the Mediterranean basin to Iran, Pakistan and India for seed yield and oil production (Gharby *et al.* 2015). It has been widely cultivated and used as a condiment in preparations of bread, biscuits, pickles and other foods. Seeds of black cumin have been used for centuries as a spice and food preservative, as well as a traditional medicine for various diseases, including skin infections (Goreja 2003). The studies have shown that nigella seed oil and extracts have diuretic, antihypertensive,

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antidiabetic, anticancer, antihelmintic, analgesic, antimicrobial, anti-inflammatory, spasmolytic, hepatoprotective, gastroprotective, nephronprotective, antihypertensive and antioxidant effects (Ahmad *et al.* 2013).

Current trends in agriculture is focusing on reducing the use of inorganic fertilizers by the use of organic sources such as vermicompost, farm yard manure, oil cakes and biofertilizers or plant growth promoting rhizobacteria (PGPR) such as nitrogen fixers, phosphate and potassium solubilizing bacteria along with chemical fertilizers, which not only improves soil health but also maintains reasonably fair productivity (Bhandari *et al.* 2012). Vermicompost is the final product or earthworm casts of vermicomposting (Bawa *et al.* 2016) with high porosity, aeration and water holding capacity and usually contain most nutrients in the available forms like nitrates, exchangeable calcium, phosphates and soluble potassium (Atiyeh *et al.* 2002, Arancon *et al.* 2004). Biofertilizers are cultures of special fungi and bacteria, which do not supply nutrients directly to the crops but add nutrients through natural processes and stimulates plant growth through the synthesis of growthpromoting substances. Organic manure improves soil structure and water holding capacity, leading to more extensive root development and enhanced soil micro flora and fauna activity, which results in availability of micronutrients available to plants (Zeidan 2007). In West Bengal, black cumin is grown in small scale for local distribution and farmers do not follow a proper nutrient management practices. Although, sole application of inorganic fertilizers give adequate yield, considering the higher cost of cultivation and decreasing net profit and negative impact on soil health. It can be improved by integrated use of vermicompost and biofertilizers along with chemical fertilizers. Therefore, the present experiment was conducted by combining different levels of inorganic fertilizers and vermicompost with and without biofertilizers to optimize the required combination of organic and biofertilizers along with inorganic fertilizers on growth and yield of black cumin under new alluvial plains of West Bengal.

MATERIALS AND METHODS

The field experiment was carried out during November to March of 2019-20 at Horticultural research station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal, India. The geographic coordinates of the experimental location is 23.5° North latitude and 9.75° East longitude with an elevation of 9.75 m above mean sea level having soil pH 6.9.

The experiment was laid out in Randomized Block Design (RBD) with three replications consisted of 12 treatments consisting of 4 levels of inorganic fertilizers (25, 50, 75 and 100%) of recommended NPK, 4 levels of vermicompost (25, 50, 75 and 100%) equivalent of N requirement and 3 biofertilizers viz., Nitrogen fixing bacteria (*Azospirillum lipoferum*), phosphate solubilizing bacteria (*Bacillus megaterium*) and potassium solubilizer (*Fraturia aurantia*) with a concentration of 2 × 107 cfu/g. The treatment combinations were T_1-100 % RDF ($N_{40}P_{40}K_{45}$), T_2 100 % N equivalent through vermicompost (VC), T_3- 100 % RDF + Biofertilizers, T_4- 100 % N equivalent through vermicompost + Biofertilizers, T_5- 75 % RDF + 25 % N equivalent through VC, T_6- 50 % RDF + 50 % N equivalent through VC, T_7- 25 % RDF + 75 % N equivalent through VC, T_8- 75 % RDF + 25 % N equivalent through VC + Biofertilizers, T_9- 50 % RDF + 50 % N equivalent through VC + Biofertilizers, T_{10}- 25 % RDF + 75 % N equivalent through VC + Biofertilizers,T_{11}- Biofertilizers and T_{12}-Control.

Prior to sowing, the experimental land was brought to fine tilth by two deep ploughing with tractor and raised beds were laid out during first fort night of October . The seeds of black cumin variety Azad kalonji were soaked in water for 24 h before sowing to facilitate germination and treated with *Trichoderma viride* @ 2 g seed kg^{-1} before sowing. The treated seeds were sown in a plot of 2.1 × 1.5 m size in a row at 30 cm spacing during first week of November and the seedlings were thinned out at 15 cm distance at 30 days of sowing. Half dose of N and full dose of P and K were applied as basal and remaining half dose of N was applied in two split doses during later stage at 40 and 60 days after sowing. The sources of N, P_2O_5 and K_2O were Urea (46% N), single super phosphate (16% P) and muriate of potash (60% K) respectively. Vermicompost was incorporated in to

Table 1. Growth and yield attributes of black cumin as influenced by different level combinations of inorganic and vermicompost with and without biofertilizers. T_1-100 % RDF ($N_{40}P_{40}K_{45}$), T_2- 100 % N equivalent through vermicompost (VC), T_3- 100 % RDF + Biofertilizers, T_4- 100 % N equivalent through vermicompost + Biofertilizers, T_5- 75 % RDF + 25 % N equivalent through VC, T_6- 50 % RDF + 50 % N equivalent through VC, T_7- 25 % RDF + 75 % N equivalent through VC, T_8- 75 % RDF + 25 % N equivalent through VC + Biofertilizers, T_9- 50 % RDF + 50 % N equivalent through VC + Biofertilizers, T_{10}- 25 % RDF + 75 % N equivalent through VC + Biofertilizers, T_{11}- Biofertilizers and T_{12}- Control.

Treatments	Plant height (cm) 60 DAS	80 DAS	100 DAS	Number of branches Primary	Secondary	No. of capsule plant^{-1}	No. of seeds capsule^{-1}	1000, seed wt (g)	Projected yield (kg ha^{-1})
T_1	32.83	59.43	81.73	8.50	14.00	22.11	95.33	3.01	486.47
T_2	27.90	51.46	71.93	7.43	8.33	18.66	91.00	2.68	450.71
T_3	34.16	60.93	82.56	8.77	14.00	23.00	96.00	3.05	505.41
T_4	28.42	53.70	75.73	7.66	9.00	19.00	92.66	2.74	463.91
T_5	33.06	58.83	82.73	9.00	14.66	23.77	96.66	3.10	602.50
T_6	30.33	54.83	78.16	8.33	10.66	19.00	94.33	2.87	467.86
T_7	28.43	49.83	66.73	6.20	6.77	15.00	89.00	2.60	376.18
T_8	33.06	59.83	85.06	9.35	17.33	24.33	97.33	3.24	668.85
T_9	31.16	56.83	78.83	8.50	12.33	20.66	95.00	2.92	476.42
T_{10}	28.83	55.50	67.26	6.66	7.00	15.66	89.77	2.63	390.85
T_{11}	25.43	48.50	62.86	6.00	5.33	11.00	88.00	2.55	195.41
T_{12} (Control)	20.50	42.76	55.83	5.40	4.66	10.00	85.00	2.42	165.94
SEm (±)	0.045	0.818	1.135	0.119	0.183	0.299	1.376	0.043	7.485
CD at 5%	1.315	2.416	3.352	0.352	0.539	0.883	4.061	0.127	22.096

soil, 15 days prior before sowing of black cumin. Biofertilizers were applied together @ 2.5 kg ha^{-1} each as sole and with different level combinations of inorganic fertilizers and vermicompost as soil application. Schedule agronomical package of practices were followed .

During the cropping period, observations on different growth and yield parameters like plant height (cm), number of branches, number of capsules plant^{-1}, number of seeds^{-1} and test weight (g) were recorded from five randomly selected plants per plot and the data were statistically analyzed by employing Fisher's method of Analysis of Variance (Gomez and Gomez 1984). Critical difference (CD) values were calculated at 5% level of significance.The data were analyzed with the help of a window based computer package OPSTAT (Sheoran 2004).

RESULTS AND DISCUSSION

Growth parameters

As recorded from the present study (Table 1), the growth parameters like plant height (85.06 cm) at 100 DAS, average number of primary branches (9.35) and secondary branches (17.33) were significantly higher with the application of T_8 (75% RDF + 25% N equivalent through VC + biofertilizers). The results are in conformity with Kusum *et al.* (2019) in fennel, where the maximum plant height, primary and secondary branches were recorded by application of FYM + 75% RDF + biofertilizers. The lowest (55.83) was recorded in the control plot (T_{12}). The increase in plant height, primary and secondary branches might be due to the sufficient supply of inorganic nutrients at the initial stage and slow pace long term availability of nutrients through vermicompost, which also has a beneficial effect in improving the soil environment which in turn encourages activities of Azospirillum, *Bacillus* and *Fraturia* and better root growth resulting in better absorption of moisture and nutrients. Increase in growth parameters are often attributed to the positive effect of biofertilizers on nutrient uptake by plants (Gad 2001).

Yield parameters

Yield attributing characters like average number of capsules plant^{-1} (24.33), number of seeds capsule^{-1} (97.33), 1000 seed weight (3.24 g) and projected yield (668.85 kg ha^{-1}) were also recorded highest in the

Table 2. Economics of black cumin as influenced by different level combinations of inorganic and vermicompost with and without biofertilizers.

Treatments	Total cost of cultivation	Gross return	Net return	B:C ratio
T_1-100 % RDF ($N_{40}P_{40}K_{45}$)	26,812	1,21,617.50	94,805.50	3.53
T_2- 100 % N equivalent through vermicompost (VC)	48,390	1,12,677.50	64,287.50	1.32
T_3- 100 % RDF + Biofertilizers (BF)	27,232	1,26,352.50	99,120.50	3.63
T_4- 100 % N equivalent through vermicompost + BF	48,810	1,15,977.50	67,167.50	1.37
T_5- 75 % RDF + 25 % N equivalent through VC	32,431.26	1,50,625	1,18,193.74	3.64
T_6- 50 % RDF + 50 % N equivalent through VC	38,050.88	1,16,965	78,914.12	2.07
T_7- 25 % RDF + 75 % N equivalent through VC	43,220.5	94,045	50,824.50	1.17
T_8- 75 % RDF + 25 % N equivalent through VC + BF	32,851.26	1,67,212.50	1,34,361.24	4.08
T_9- 50 % RDF + 50 % N equivalent through VC + BF	38,470.88	1,19,105.50	80,634.62	2.09
T_{10}- 25 % RDF + 75 % N equivalent through VC + BF	43,640.5	97,712.50	54,072	1.23
T_{11}- Biofertilizers	22,710	48,852.50	26,142.50	1.15
T_{12} (Control)	22,290	41,485	19,195	0.86

treatment T_8 (75% RDF + 25%N equivalent through VC + biofertilizers) followed by T_5 (75 % RDF + 25 % N equivalent through VC) which was at par with T_3 (100 % RDF + Biofertilizers) as shown in Table 1. The results are in accordance with the observation of integrated nutrient management in black cumin (Nuthana 2017). Faravani *et al.* (2012) also found that application of biofertilizers significantly improved growth, quality and yield attributes of black cumin. Better production of yield attributing characters and yield could be due to the steady supply of nutrients in balanced amounts. Higher plant height, number of branches plant^{-1} and leaf area provide greater sites for photosynthesis and diversion of photosynthates towards higher capsules and seeds formation (Roy and Singh 2006). The increased photosynthesis might be due to increased biological activities of soil and mineral absorption (Jat and Ahlawat 2006). Application of biofertilizer has increased the weight of 1000 seeds by enhancing the rate of photosynthesis and the biomass production improvement (Valadabadi and Farahani 2011) on black cumin.

Economics

Economics of cultivation was studied with respect to net return, gross return and B:C ratio under different treatments. Table 2, indicated that the maximum gross return (Rs ha^{-1}) (1,67,212.50) and B:C ratio (4.08 : 1) was recorded under T_8 (75% RDF + 25% N equivalent through VC + biofertilizers), where highest yield was also recorded. Benefit cost ratio of T_5 (3.64 : 1) and T_3 (3.63 : 1) were at par. Highest B:C ratio (7.75 : 1) was also reported by (Nuthana 2017) in black cumin with the application of 75% RDF + 25% N through FYM + biofertilizers. The lowest gross return (Rs 41,485) and B:C ratio (0.86 : 1) was recorded in T_{12} (Control) plot. From this, it can be concluded that application of inorganic fertilizers and vermicompost along with biofertilizers can increase the output by many folds.

CONCLUSION

From the study, it can be concluded that the combined effect of inorganic fertilizers and vermicompost along with biofertilizers played a very important role due to their synergistic effect for better growth and development and production of yield attributing characters and yield than the sole application. Thus, under alluvial zone of West Bengal, the combination of 75% RDF + 25% N equivalent through VC + biofertilizers would be an effective treatment for black cumin seed production with higher yield, gross return and benefit cost ratio. This indicates that 25% NPK requirement can be supplemented through vermicompost with higher yield with reduced cost of cultivation, reduces environmental pollution to some extent and more ecologically sustainable. However, the experiment should be carried out for atleast 2-3 years to confirm the results.

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