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Integrated micronutrient spray on yield assessment of black cumin (*Nigella sativa*) in Nadia district of West Bengal

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ABSTRACT

Black cumin (Nigella sativa) is an annual flowering plant, native to Iran and other parts of South West Asia, belonging to the family Ranunculaceae. It is a promising aromatic and medicinal herb found in dry temperate regions and has recently domesticated from its wild habitat. Micronutrients may play an important role, as cofactor, in activation of several enzymes such as those involved in photosynthesis. This would reflect increasing the accumulation of carbohydrates in cells. The present investigation has been carried out at HRS. Mondouri, BCKV, during 2013-2014, to find out the effect of integrated micronutrient spray on yield of black cumin. Four micronutrients namely iron, copper, zinc and boron were included in this investigation. Iron in the form of ferrous sulphate ($FeSO_4$, $7H_2O$) @ 0.5%; copper in the form of copper sulphate ($CuSO_4$,$7H_2O$) @ 0.2%; zinc in the form of zinc sulphate ($ZnSO_4$, $7H_2O$) @ 0.5%; and boron in the form of borax (Na_2 B_4 O_7) @ 0.2%. Combination of four micronutrients also included. They applied as foliar spray either once or twice. There were altogether 11 treatments including control (water spray). First and second spraying were done at 45 and 60 days after sowing. All experimental plots received a uniform dose of FYM @ 20 tonnes ha^{-1}, 40 kg N, 40 kg P_2O_5 and 45 kg K_2Oin the form of urea, single super phosphate and muriate of potash. FYM and full dose of dose of fertilizer were applied as basal. The observations were recorded on five randomly selected plants from each plot on different growth and yield parameters. The observations regarding the plant height was recorded at 75 and 105 days after sowing (DAS). The number of primary and secondary branches was recorded at 75 DAS. Yield per hectare was calculated on plot yield basis after deducting 20% area utilized for channel, ridges etc. Data recorded on different parameters of black cumin were analyzed statistically to express the result. Among different treatments the double spray of borax 0.2% recorded maximum plant height (90.73 cm) at 105 days after sowing, maximum number of secondary branches (27.61) at 75 DAS and 1000 seed weight (3.02 g) as compared to 76.72 cm, 20.86 and 2.36 g under control. Double spray of ferrous sulphate produced maximum number of primary branches (7.20) against 6.45 number of branch under control. The plants under double spray of zinc sulphate 0.5% caused higher nodal length (7.53 cm) as compared to (5.53 cm) nodal length under control. The single spray of zinc sulphate 0.5% recorded maximum plot yield (171.09 g) and projected yield (760.44 kg ha^{-1}) as compared to plot yield (141.93 g and 630.81 kg). The next best treatment in respect of projected yield was double spray of ferrous sulphate 0.5% and double spray of borax 0.2%.From yield maximization point of view the most effective treatment was zinc sulphate @ 0.5% as single spray followed by ferrous sulphate @ 0.5% as compared to double spray and borax @ 0.2% as single spray under alluvial plains of West Bengal for black cumin production.

***Keywords*:** Black cumin, borax, copper sulphate, ferrous sulphate, zinc sulphate

Black cumin (*Nigella sativa* L.) is an annual flowering plant, native to Iran and other parts of South West Asia, belonging to the family Ranunculaceae. It is a promising aromatic and medicinal herb found in dry temperate regions and has recently domesticated from its wild habitat. In India, it is cultivated in Punjab, Himachal Pradesh, Uttar Pradesh, Bihar, West Bengal, Assam and Maharashtra. Apart from India the species is also grown in Syria, Lebanon, Israel, South Europe, Bangladesh, Turkey, Middle-East and the Mediterranean basin. It is successfully cultivated in cool-dry with light snowfall areas to warm humid area. Cool and humid area favor flowering and seed settling. Seed oil of black cumin is commonly known as "Kalonji oil" is used in bronchial dilation, asthma and lowering of blood pressure. The seed oil or powder have anti-inflammatory effect (Bhatnagar, 1996), reducing effect on blood levels of both glucose and cholesterol (Bamosa *et al*., 1997), antibacterial activity (Hussain and Tabji, 1997; Tesaki *et al.,* 1998), antifertility, galactagogue, anticancer and cardiovascular activities (Siddiqui and Sharma, 1996).

The average yield of black cumin is very low, mainly because of the susceptibility of the local genotypes to diseases and insects, poor soil types and lack of knowledge of suitable package of production (Banafar and Nair, 1999). Plant nutrition is one of the key factors influencing the yield and quality of crop plants (Sharma, 2003). Besides the major nutrients, micronutrients also play a vital role as essential elements in deciding the

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growth and development of plants (Sindhu and Tiwari, 1993). Foliar fertilization is a mean of increasing agricultural production due to the rapid absorption of nutrients by plant. Micro-nutrients are needed in small quantities for normal plant growth and development (Abunyewa and Mercer-Quarshie, 2004; Ali *et al*., 2001) and to proceed biological processes such as photosynthesis, respiration, synthesis of chlorophyll and stimulation of many enzymes (Whitehead, 2000 and Pariari *et al.,* 2003). Micronutrients may play an important role, as cofactor, in activation of several enzymes such as those involved in photosynthesis. This would reflect increasing the accumulation of carbohydrates in cells (Mostafa, 1996).

Black cumin requires good nutrient status of soil and proper nutrient management of high yield and better quality. The crop being cultivated without proper nutrient management may be one of the reasons for the lower production. Both macro-and micro-nutrients are equally important in plant nutrition though micronutrients occur in plant and soils in much lower concentration but plant grown in micronutrient deficient soil also exhibit reduction in productivity. Most of the Indian soils are deficient in micronutrients specially boron, zinc, copper and iron. West Bengal is not an exception for this. The present experiment was undertaken to assess the efficiency of various micronutrients on growth and yield of black cumin under new alluvial plains of West Bengal.

The present investigation was undertaken during the *rabi* (winter) season of the year 2013-14 for studying the effect of micronutrients on the growth and yield of black cumin at HRS, Mondouri, BCKV, Nadia, West Bengal. The soil of the experimental filed was Gangetic alluvial (Entisol) with sandy clay loam texture, good water holding capacity, well drained with moderate soil fertility status. The experiment was laid out in Radomised Block Design and Local variety was used as a test crop. The unit plot size was 1.5 x 1.5m, with row to row spacing of 15cm and plant to plant spacing of 10cm. The number of plant in each unit was 150 and the seeds were sown in middle of November. There were 11 treatments comprising, *viz.* T_1- ($FeSO_4$, $7H_2O$) – 0.5%; double spray, T_2- ($CuSO_4$ $7H_2O$) – 0.2%; double spray, T_3- ($ZnSO_4$, $7H_2O$) – 0.5%; double spray, T_4- Borax ($Na_2B_4O_7$) – 0.2%; double spray, T_5- Combination of T_1 to T_4 ; double spray, T_6- ($FeSO_4$, $7H_2O$) – 0.5% ; single spray, T_7- ($CuSO_4$ $7H_2O$) – 0.2% ; single spray, T_8- ($ZnSO_4$, $7H_2O$) – 0.5%; single spray, T_9- Borax (Na_2 B_4 O_7) – 0.2%; single spray, T_{10}- Combination of T_6 to T_9 ; single spray, T_{11}- Control (water spray).

Each treatment was replicated 3 times, so 33 plots were prepared thoroughly by repeated ploughing to get a fine tilth. The time for application of micronutrients was carried out twice at 45 DAS and 60 DAS (T_1, T_2, T_3, T_4 and T_5), while once at 45 DAS (T_7, T_8, T_9, T_{10}) and T_{11} was kept as control. The micronutrient was applied as a foliar spray using knapsack sprayer. Well rotten Farm Yard Manure (FYM) @ 20 t ha^{-1} was applied at the time of field preparation as basal dressing (10 days before planting) and mixed well with the soil. The recommended fertilizer dose was 40 kg N ha^{-1}, 40 kg P_2O_5 ha^{-1} and 45 kg K_2O ha^{-1}. The full dose of nitrogen, phosphorus and potash applied as basal dressing. First irrigation was given immediately after planting. Then subsequent irrigations were given at an interval of 10-15 days depending upon the soil moisture and weather conditions. The experimental plots were kept clean by hand weeding as and when required. Plant protection measures were taken as per requirement. Five plants from each plot were randomly selected and tagged for assessing the parameters of each treatment. Growth parameters such as plant height from each plot were taken at 75 and 90 days after sowing. The nodal length was measured at 75 days after sowing. The number of primary branches was counted at 90 days after sowing. The numbers of secondary branch was counted at 90 days after sowing. Yield parameters such as the number fruits per plant were counted at harvesting stage from five randomly selected plants of each replication. 1000 seeds were counted after drying and weighed were recorded. The total weight of dried seeds per plot was recorded to obtain the yield per plot. The projected yield per hectare was calculated on the basis of yield per plot considering 80% area occupied by black cumin, as 20% area generally occupied by ridges, channels etc. The crop was considered ready for harvesting when the umbels turn brown and showing the sign of drying up tops from neck region. The harvesting was done during the middle of April. The harvested plants properly stacked and dried. The fully dried plants are then threshed with the help of beating sticks. The grains were then separated through repeated winnowing and sieving operations.

At 75 DAS, the maximum plant height (51.53 cm) was recorded in plants grown under borax 0.2%; single spray treatment followed by ferrous sulphate 0.5%; single spray (50.46 cm) and borax 0.2%; double spray (47.46 cm) as compared 49.43 cm plant height under untreated control. At 90 DAS, the maximum plant (90.73 cm) was noticed in borax 0.2%; double spray treatment followed by zinc sulphate 0.5%; single spray and combined application of T_6 to T_{10} treatments under

single spray (85.06 cm) as compared to control (76.72 cm). In individual application of micronutrient the advantage of double spray over single spray was noticed in case of ferrous sulphate and borax only. In respect of combined application there was no increment in plant height was noticed in double spray (56.81 cm) over single spray (58.13 cm). In case of final increase in plant height, the maximum increase over initial (64.50 cm) was observed under borax 0.2%; double spray followed by zinc sulphate 0.5%; single spray (62.12 cm) and borax 0.2%; single spray (61.04 cm) as compared to untreated control (51.10 cm) which was lowest among all treatment. This result indicated the beneficial effect of micronutrient on plant height of black cumin

The non-significant variations in nodal length were observed among the different treatments the maximum nodal length was noticed with zinc sulphate 0.5%; double spray (7.53 cm) followed by zinc sulphate 0.5%; single spray (7.14 cm and borax 0.2%; double spray (7.06 cm). Maximum number of primary branches was observed in ferrous sulphate 0.5%; double spray (7.26) followed by borax 0.2%; single spray (7.20), and zinc sulphate 0.5%; double spray (7.18) as compared to untreated control (6.45). The maximum number of secondary branches observed in borax 0.2%, double spray (27.61) followed by copper sulphate 0.2%, single spray (26.13) as compared to lowest number of branches in untreated control (24.16). The four micronutrients in its double spray produced seed with higher weight as compared to single spray which clearly indicated the production of seed with higher weight due to micronutrient application. The lowest 1000 seed weight was associated with untreated control.

Maximum yield per plot (171.09) was observed in zinc sulphate 0.5%; single spray followed by ferrous sulphate 0.5%; double spray (165.53 g) and borax 0.2%; double spray (160.63 g). The double spray of combined application (T_1 to T_4) recorded lowest plot yield (128.76 g) as compared to control (141.93 g), indicating a chance of toxicity may be there.

Highest yield was observed under zinc sulphate 0.5%; double spray (760.44 kg ha^{-1}) followed by double spray of ferrous sulphate (731.26 kg ha^{-1}) and double spray of borax 0.2% (713.93 kg ha^{-1}) as compared to 630.81 kg ha^{-1} under control. Significant variations were observed among the different treatments. In respect of frequency of application the non-significant variations noticed in respect of copper and borax. Single spray of zinc sulphate 0.5% and combined treatment produced more yield as compare to double spray. Double spray of ferrous sulphate 0.5% only produced significantly more yield as compared to single application but lower than single application of zinc sulphate. These results clearly indicated that there is no additive or synergistic effect was observed in combined application, further in most of the micro-nutrient there was no benefit was found in double application of micro-nutrient except ferrous sulphate.

The experimental results revealed a number of interesting features of growth and yield parameters of black cumin. It is clear from the results that application of zinc sulphate showed better response on yield of black cumin followed by iron and boron. Zinc has an activator of large number enzymes including dehydrogenase, anhydrase and superoxide mutase. Under zinc application, improved root system helped the plant in better absorption of water and other nutrients. The entire favourable effect was also attributed to the fact that the zinc was essential in nitrogen metabolism. These finding are in good agreement with E1-Itag (1996). He also recorded highest yield in black cumin with zinc @ 2.5 per thousand of zinc sulphate solution. Pariari *et al.* (2003) also reported the yield enhancement with 0.1% boron and 0.2% Zinc. Zinc was also essential in nitrogen metabolism (Asana *et al.*, 1971).

The favorable effects of boron might be attributed to its involvement in cell division and cell expansion. The beneficial effect of boron on growth and bulb yield of onion was also reported by Singh and Tewari (1995). Iron is a part of the catalytic group of many redox enzymes. It is also required for synthesis of chlorophyll. The favour effect of iron for increasing yield of black cumin was also reported by Khonlenjani and Salamati (2011). They obtained highest yield though application of ferrous sulphate @ 2.5 per thousand. In general plant responses to micronutrient in the order zinc>boron>iron>copper.

Among different treatments the double spray of borax 0.2% recorded maximum plant height (90.73 cm) at 1.5 days after sowing, maximum number of secondary branches (27.61) at 75 DAS and 1000 seed weight (3.02 g) as compared to 76.72 cm, 20.86 and 2.36 g under control. Double spray of ferrous sulphate produced maximum number of primary branches (7.20) against 6.45 number of branch under control. The plants under double spray of zinc sulphate 0.5% caused higher nodal length (7.53 cm) as compared to (5.53 cm) nodal length under control. The single spray of zinc sulpahte 0.5% recorded maximum plot yield (171.09 g) and projected yield (760.44 kg ha^{-1}) as compared to plot yield (141.93 g and 630.81kg). The next best treatment in

Table 1: Effect of micronutrients on growth and yield attributes of black cumin

Treatments	Plant height (cm)			Increase in plant height (cm)	Nodal length (cm)	Number of branches plant^{-1}		Weight of 1000 seed (g)	Plot yield (g 2.25 m^{-2})	Projected yield (kg ha^{-1})
	Initial (40 DAS)	After 1st spray (75 DAS)	After 2nd spray (90 DAS)			Primary	Secondary			
T_1	25.67	44.93	80.50	54.83	6.56	7.26	22.3	2.41	165.53	731.26
T_2	25.90	45.45	79.82	53.92	6.82	6.64	21.46	2.36	139.06	618.07
T_3	25.30	43.86	80.58	55.28	7.53	7.18	22.73	2.43	153.20	680.90
T_4	26.23	47.46	90.73	64.50	7.06	6.93	27.61	3.02	160.63	713.93
T_5	23.64	40.53	80.45	56.81	5.43	5.86	25.06	2.23	128.76	572.30
T_6	25.37	50.46	77.67	52.30	6.73	7.13	23.07	2.34	126.06	560.30
T_7	24.35	47.33	84.23	59.88	6.40	6.74	26.13	1.86	144.45	642.03
T_8	24.71	48.46	86.83	62.12	7.14	6.78	24.73	2.03	171.09	760.44
T_9	24.72	51.53	85.76	61.04	6.32	6.53	21.34	2.62	156.18	694.13
T_{10}	26.93	47.53	85.06	58.13	5.66	7.20	24.36	2.35	147.16	654.07
T_{11}	25.62	49.43	76.72	51.10	5.53	6.45	20.86	2.36	141.93	630.81
SEm (±)	**1.05**	**1.03**	**1.75**	**2.15**	**0.79**	**0.34**	**2.72**	**0.28**	**2.21**	**10.51**
LSD(0.05)	**NS**	**3.03**	**5.16**	**4.26**	**NS**	**1.02**	**8.01**	**0.84**	**6.51**	**31.02**

T_1-Ferrous sulphate 0.5%; double spray
T_2-Copper sulphate 0.2%; double spray
T_3-Zinc sulphate 0.5%; double spray
T_4-Borax 0.2%; double spray
T_5-Combination of T_1 to T_4 ; double spray
T_6-Ferrous sulphate 0.5% ; single spray
T_7-Copper sulphate 0.2% ; single spray
T_8-Zinc sulphate 0.5%; single spray
T_9-Borax 0.2%; single spray
T_{10}-Combination of T_6 to T_{10} ; single spray
T_{11}-Control (water spray)

respect of projected yield was double spray of ferrous sulphate 0.5% and double spray of borax 0.2%.

From yield maximization point of view the most effective treatment was zinc sulphate @ 0.5% as single spray followed by ferrous sulphate @ 0.5% as compared to double spray and borax @ 0.2% as single spray under alluvial plains of West Bengal for black cumin production.

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