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Effect of Foliar Application of Micro nutrients on Growth and Yield of Black cumin (*Nigella sativa* L.)

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Abstract

An field study was conducted at department of Plantation, Spices, Medicinal and Aromatic crops, College of Horticulture, RVSKVV, Mandsaur, (M.P.) during the *Rabi* season 2020-21 in simple Randomized Block Design with replicated three times. Result revealed that the treatment T_8- ($FeSO_4$ + $MnSO_4$ + ZnO @2g each) showed early flowering (69.17), maturity (122.67), plant height (12.07, 35.57, 54.43 and 54.50 cm), number of branches (3.93, 7.53, 8.73 and 8.73plant^{-1}), fresh weight (3.62, 31.67, 48.77 and 42.43 g plant^{-1}), dry weight (0.41, 6.20, 12.96 and 15.13 g plant^{-1}) at 40, 80, 120 days after sowing and at harvest respectively but at same weather condition and other edaphic factor the minimum data were recorded in T_1 -(control). Moreover, the highest number of capsule (26.01) number of seeds (71.01), seed yield (7.81 q ha^{-1}), biological yield (21.27), test weight (2.24), harvest index (36.95) were observed under the same treatment as compared to untreated control. The highest net returns (₹ 99600) and benefit: cost ratio (2.43:1) was also recorded in T_8- ($FeSO_4$ + $MnSO_4$ + ZnO @2g each) over T_1-(control).

Introduction

Nigella also known as Kalaunji is a seed spice having immense pharmacological potential. It belongs to the family Ranunculaceae.It is used by numerous cultures and civilizations for thousands of years in both traditional and industrial pharmacology. Thymoquinone is one of the most important components in the volatile oil of nigella seeds (Bendahou *et al*., 2000). *Nigella sativa* is a hermaphrodite annual herb with a more or less branching stem and pinnately divided leaves. Plant height is 35-45 cm, and flowering patterns are predictable (Dubey *et al*., 2016).

In India, it is commercially cultivated in Punjab, Himachal Pradesh, Madhya Pradesh, Rajasthan, Jharkhand, Assam, West Bengal and Andhra Pradesh and covering an area of 9.53 thousand ha, production of 7.86 thousand metric tonnes (Hapis, 2018-19). It is mostly cultivated in Mandsaur, Neemuch and Shajapur districts of Madhya Pradesh.

Micronutrients are only used in trace amounts, yet their effects are significant. These components function as limiting factors in the intake of other nutritional elements when they are insufficient, demanding greater attention to their application (Bagheri and Salamati, 2012).Zinc has an involvement in all metabolic processes and progressive impact on agricultural productivity (Mousavi *et al*., 2013). Iron is a necessary component of the enzymatic system in plants (Rout and Sahoo, 2015). Manganese (Mn) is a component of photosynthesis and is an enzyme activator (Sahu *et al*., 2020).

Fertilization methods are important in achieving optimal nutrition absorption and reduce the amount of chemical fertilizers. To achieve the highest economic production, foliar spraying is the best strategy for maximizing the use of important plant nutrients.

Materials and Methods

An field experiment was conducted at department of Plantation, Spices, Medicinal and Aromatic crops, Research Farm, College of Horticulture, RVSKVV, Mandsaur, (M.P.) during the *Rabi* season 2020-21in simple Randomized Block Design with replicated three times. The experiment was comprised with eight treatments as foliar application of Iron, zinc and manganese in different combination @2 g each along with one untreated control at pre elongation and pre flowering stages of nigella crop. All the parameters were recorded at 40, 80, 120 days after sowing and at harvest and later on their mean was calculated. The experimental data were subjected to statistical analysis using analysis of variance technique suggested by Panse and Sukhatme (1984). Where the "F" test was found significant at 5 % level of significance, the critical

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differences for the treatment's comparison were worked out.

Results and Discussion

Phenology of Nigella

On perusal of data revealed that the phenology of nigella was significantly influenced with the foliar application of different micronutrients (Table 1).The number of days taken to 50% flowering of nigella ranged from 69.17 to 73.33 days. T_8- ($FeSO_4$ + $MnSO_4$ + ZnO @2g each) showed early flowering (69.17) and maturity (122.67).Micronutrients significantly influenced the flowering of nigella. This may be due to beneficial effect is the increase in the activity of growth hormone or activity of phosynthetic system and also due to the active role of these micronutrients in metabolic processes of plants and photosynthesis and thus, tended to increase flowering, and grain formation which ultimately increased the yield attributes according to Drostkar *et al*., (2016) in chickpea. Almost identical results have also been reported by Kumar *et al*., (2009) in chickpea and Meena *et al*., (2010) in moth bean.

Morphology of Nigella

All the morphological traits were significantly influenced with the foliar application of different micro nutrients during the different intervals of plant growth. This dissimilarity in morphological characteristics was arising due to different micro nutrients combinations. Result

Table1 : Effect of micro nutrients on plant height and number of branches of Black cumin

Treatments	Plant height (cm)				No. of branches (plant^{-1})			
	40 DAS	80 DAS	120 DAS	At harvest	40 DAS	80 DAS	120 DAS	At harvest
T_1 -Control	9.57	28.37	40.33	40.33	3.07	5.63	6.80	6.80
T_2 -$FeSO_4$ (2 g L^{-1})	11.43	33.27	49.03	49.00	3.63	6.83	7.97	7.97
T_3 -ZnO (2 ml L^{-1})	10.57	32.87	47.07	47.13	3.57	6.20	7.33	7.33
T_4 -$MnSO_4$ (2 g L^{-1})	11.47	33.23	46.90	46.97	3.50	6.47	7.37	7.37
T_5 -T_2+ T_3(2 g+ 2 ml L^{-1})	11.53	34.40	50.80	50.70	3.80	7.17	8.20	8.20
T_6 -T_2 +T_4 (2 g+2 g L^{-1})	11.40	33.43	49.73	49.80	3.70	7.07	8.00	8.00
T_7 -T_3+ T_4 (2 ml+2 g L^{-1})	11.37	30.30	48.77	48.77	3.57	6.73	7.67	7.67
T_8 -T_2+ T_3+T_4 (2 g+2 g+2 ml L^{-1})	12.07	35.57	54.43	54.50	3.93	7.53	8.73	8.73
S.Em(±)	0.28	0.72	1.22	1.58	0.07	0.12	0.19	0.19
CD (5%)	0.85	2.19	3.71	4.80	0.22	0.37	0.57	0.57

* DAS - Days after sowing

Table 2: Effect of micro nutrients on fresh and dry weight of Black cumin

Treatments	Fresh weight (g plant^{-1})				Dry weight (g plant^{-1})			
	40 DAS	80 DAS	120 DAS	At harvest	40 DAS	80 DAS	120 DAS	At harvest
T_1 -Control	2.56	23.47	37.30	34.07	0.29	4.84	10.98	13.64
T_2 -$FeSO_4$ (2 g L^{-1})	2.73	27.97	43.93	36.60	0.35	5.56	11.91	14.16
T_3 -ZnO (2 ml L^{-1})	2.74	26.20	41.83	36.63	0.33	5.42	11.79	13.46
T_4 -$MnSO_4$ (2 g L^{-1})	2.72	26.47	42.60	39.17	0.34	5.57	11.83	13.98
T_5 -T_2+ T_3 (2 g+ 2 ml L^{-1})	3.17	29.57	45.93	39.83	0.40	5.85	12.87	14.49
T_6 -T_2 +T_4 (2 g+2 g L^{-1})	3.10	28.77	45.07	39.70	0.37	5.82	12.75	14.41
T_7 -T_3+ T_4 (2 ml+2 g L^{-1})	2.81	27.40	43.53	38.47	0.34	5.18	12.11	14.04
T_8 -T_2+ T_3+T_4 (2 g+2 g+2 ml L^{-1})	3.62	31.67	48.77	45.63	0.41	6.20	12.96	15.13
S.Em(±)	0.20	0.73	1.00	1.94	0.02	0.15	0.18	0.25
CD (5%)	0.61	2.20	3.04	5.88	0.06	0.44	0.53	0.75

* DAS - Days after sowing

confirmed from the Table 2 that, T_8- ($FeSO_4$ + $MnSO_4$ + ZnO @2g each) had maximum plant height (12.07, 35.57, 54.43 and 54.50 cm), number of branches (3.93, 7.53, 8.73 and 8.73plant^{-1}), fresh weight (3.62, 31.67, 48.77 and 42.43 g plant^{-1}), dry weight (0.41, 6.20, 12.96 and 15.13 g plant^{-1}) at 40, 80, 120 days after sowing and at harvest respectively but at same weather condition and other edaphic factor the minimum data were recorded in T_1 -control. These incremental patterns in weight of plants may be due to the foliar application of micronutrients. Micronutrients, especially Fe and Zn, act either as metal components of various enzymes or as functional, structural, or regulatory cofactors. Hence, they are directly linked to saccharide metabolism, photosynthesis process and protein synthesis. Iron has important role in plant metabolism, such as activating catalyses enzymes, chlorophyll content, as well as in photorespiration and the glycolate pathway (Hendawy *et al*., 2012). Nano Zn has favorable effects in creation of active Zn phosphate inside the plant (Lv *et al*., 2015). Abdelkader *et al*., (2019) on *Foeniculum vulgare* stated that nano micronutrients improved vegetative growth which is responsible for fresh weight of plant.

The experimental results exhibited that foliar application of micronutrients has a significant role on dry matter production of nigella. Zinc has an energizer of large number of enzymatic activities such as dehydrogenase, anhydrase and superoxide mutase. Zinc application with other micronutrients has improved root system which helped to the plant in higher absorption of water and other nutrients in nigella (Bhutia *et al*., 2015). Misra and Sharma (2006) reported that zinc application significantly enhanced the fresh and dry herb production in Japanese mind.

Yield and yield attributed of Nigella

The significant variations were observed in yield and yield attributing parameters with thefoliar application of different micro nutrients (Table 3). The highest number of capsule per plant (26.01) was observed under the treatment T8- (FeSO4 + MnSO4 + ZnO @2g each), number of seeds per capsule (71.01), seed yield (7.81 q ha^{-1}), biological yield (21.27), test weight (2.24), harvest index (36.95) while, the lowest in T_1-control. 37.5% seed yield was increased with the application of FeSO4 + MnSO4 + ZnO @2g each as compared to untreated control from the Table number 3. The foliar application of micronutrients have positive role on crop growth and development may be due to the improved capacity of the crop to absorb nutrients, higher photosynthesis and better sink-source association as these play vital role in various biochemical processes which are responsible for more yield. Zn participates in the creation of carbohydrates, proteins, and their translocation, along with contributing to the metabolism of various substances. It also contributes in the division of meristem cells. The amount of photosynthetic pigmentation and photosynthesis per unit leaf area improves in the presence of iron. Finally, the grain weight and yield are enhanced by the formation of starches and sugars in the leaves and their storage in the seed according to Malakouti, 2008. These findings are supported by Naga Sivaiah *et al*., (2013) who studied that, application of boron, zinc, molybdenum, copper, iron, manganese, and a mixed treatment of them was significant effect on 1000-seed weight, seed yield plant^{-1} and seed yield hectare^{-1} in tomato cultivars. These results are in close conformity with the findings of Chiyaneh *et al*., (2018) in Nigella and Kalidasu *et al*., (2008) in coriander.

Table 3 : Effect of micro nutrients on yield and yield attributes of Black cumin

Treatments	Number of capsules plant^{-1}	Number of seed capsule^{-1}	Test weight (g)	Seed yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)
T_1 -Control	19.50	56.00	1.54	4.88	14.60	33.59
T_2 -$FeSO_4$ (2 g L^{-1})	23.30	63.70	1.86	6.75	18.48	36.54
T_3 -ZnO (2 ml L^{-1})	21.80	60.30	1.73	6.23	17.21	36.19
T_4 -$MnSO_4$ (2 g L^{-1})	21.10	59.90	1.68	6.09	17.18	35.46
T_5 -T_2+ T_3 (2 g+ 2 ml L^{-1})	24.00	66.90	2.01	7.25	19.60	36.95
T_6 -T_2 +T_4 (2 g+2 g L^{-1})	23.70	64.50	1.93	6.90	18.99	36.33
T_7 -T_3+ T_4 (2 ml+2 g L^{-1})	21.90	61.30	1.77	6.46	18.36	35.20
T_8 -T_2+ T_3+T_4(2 g+2 g+2 ml L^{-1})	26.00	71.00	2.24	7.81	21.28	36.71
S.Em(±)	0.69	1.53	0.08	0.19	0.62	0.32
CD (5%)	2.09	4.63	0.24	0.58	1.87	0.96

Table 4: Effect of micro nutrients on economics of the treatments in Black cumin

Treatments	Treatment cost (₹)	Gross return (₹)	Net return (₹)	B:C ratio
T_1 -Control	29900	87840	57940	1.93
T_2 -$FeSO_4$ (2 g L^{-1})	35900	121500	85600	2.38
T_3 -ZnO (2 ml L^{-1})	34900	112320	77420	2.21
T_4 -$MnSO_4$ (2 g L^{-1})	34900	109620	74720	2.14
T_5 -T_2+ T_3 (2 g+ 2 ml L^{-1})	39900	130320	90420	2.26
T_6 -T_2 +T_4 (2 g+2 g L^{-1})	38900	124200	85300	2.19
T_7 -T_3+ T_4 (2 ml+2 g L^{-1})	38900	116280	77380	1.98
T_8 -T_2+ T_3+T_4(2 g+2 g+2 ml L^{-1})	40900	140500	99600	2.43

Economics analysis of the study

In the present investigation the data of benefit cost ratio were affected with the application of different micronutrients as shown in Table 4.The highest net returns (₹99600) and benefit: cost ratio (2.43:1) was recorded in treatment in T_8- ($FeSO_4$ + $MnSO_4$ + ZnO @2g each) as compared to other treatments and the lowest in T_1-(control) (₹57940) net returns and (1.93:1) B: C ratio. It might be due to significant increase in yield with increased supply of available zinc in the soil and correction in hidden deficiency of zinc and iron in plants or better nutrition of the crop with foliar application of these micronutrients (Choudhary *et al*., 2015) in fennel. These findings corroborate the results with zinc application by Gupta (2012) in fennel and with iron application by Sharma (2006) in fenugreek.

Conclusion

On the basis of present investigation could be concluded that, the effect of using triple combination of micronutrients such as (Fe+Zn+Mn @2g each) at pre elongation and pre flowering stages on all measured traits was higher than separate application of Fe, Zn, and Mn and double combinations of micronutrient (including Fe+Mn, Fe+Zn, and Zn+Mn).

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