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RESEARCH PAPER

Effect of Major Fertilizers and Organic Manure Levels on Growth, Yield and Economic of Nigella (*Nigella sativa* L.)

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ABSTRACT

The main objective of the integrated nutrient management is to maintain economic yield for a long period with little effect on native soil fertility and environmental pollution, making some changes in farmer's awareness toward the eco-friendly technique for producing healthy food free from contaminants and insuring satisfactory economic returns. Integrated nutrient management (INM) can offer good options and economic choices to supply plants with sufficient amounts of nutrients and also can reduce the dose of chemical fertilizers, create favorable soil physiochemical conditions and healthy environment, eliminate the constraints, safeguard the soil nutrient balance in the long run to an optimum level for sustaining the desired crop productivity, and find safety methods to get rid of agriculture wastes. Therefore, the present study was conducted to assess the impacts of different INM practices namely absolute control (T_1), 25 t/ha FYM (T_2), NPK – 40:20:20 Kg/ha + 5 t/ha FYM (T_3), NPK – 40:25:20 Kg/ha + 10 t/ha FYM (T_4), NPK – 40:30:20 Kg/ha + 15 t/ha FYM (T_5), NPK – 45:20:20 Kg/ha + 5 t/ha FYM (T_6), NPK – 45:25:20 Kg/ha + 10 t/ha FYM (T_7), NPK – 45:30:20 Kg/ha + 15 t/ha FYM (T_8), NPK – 50:20:20 Kg/ha + 5 t/ha FYM (T_9), NPK – 50:25:20 Kg/ha + 10 t/ha FYM (T_{10}) and NPK – 50:30:20 Kg/ha + 15 t/ha FYM (T_{11}) in RBD Design with three replications at Department of Plantation, Spices, Medicinal and Aromatic Crops, College of Horticulture, RVSKVV, Mandsaur, (M.P.) during the Rabi season of 2020-2021. The result indicated that treatment T_8 observed early germination, number of days taken to 50% flowering and minimum days to maturity. Treatment T_8 was recorded highest values of plant height, number of branches plant^{-1}, fresh weight, and dry weight at 45, 90, days after sowing and at harvest. Treatment T_8 was recorded the highest value of number of capsule plant^{-1}, number of seeds capsule^{-1}, seed yield, 1000 seeds weight and harvest index.

HIGHLIGHTS

- INM can offer good options and economic choices to supply plants with sufficient amounts of nutrients.

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- INM reduce the dose of chemical fertilizers, create favorable soil physiochemical conditions and healthy environment.
- Application of chemical fertilizers with organic manures has increased nutrients availability in the soil, followed by efficient absorption and translocation in various growths.
- Supply of optimal level of nutrients by using organic manures and chemical fertilizer's to meet the crop mandate at proper time which in turn lead to high benefit cost ratio.
- INM @ 45:30:20 kg/ha NPK+15 t/ha FYM was found suitable combination for increasing the growth, quality and yield of nigella.

Keywords: Growth, nutrients, organic manures, phenology, *Nigella sativa* and yield

Nigella (*Nigella sativa* L.), often known as Kalaunji, is a biochemically significant seed spice. The plant belongs to the Ranunculaceae family. It is an annual plant that grows in dry and semi-arid environments and is frequently utilized in traditional industrial pharmacology. Thymoquinone is a key component in the volatile oil of *Nigella sativa* seeds. *Nigella sativa* seed is used as a spice for vegetables, lentils, and various baked goods (Atta 2003). Application of the recommended and ideal dose of inorganic and organic fertilizers, which is an important factor for enhancing the crop growth and nutrient uptake as well as a vital component in supporting the crop life cycle and yield potential (Yadav *et al.* 2023). Therefore, superfluous additions of fertilizers does not always mean that an increase in crop production must occur; a part of added fertilizers may be not absorbed by the crop and mostly remain in the soil, and then become dangerous and a source of environmental pollution. Therefore, when managing the agriculture strategy, significant attention must not only be given to fertilization programs only but also to the sources of nutrients which are matching, homogeneous, and mixed in such a combination that they are available for plant absorption and cover all of the crop needs. Success of INM relies on a number of factors, including appropriate right combination, right dose, and right form and application at right time of plant need. The integrated use of organic and chemical fertilizers also has an effective role in improving the soil properties (Chandravanshi *et al.* 2021) enhancing the nutrient-use efficiency, decreasing the nutrient loss, minimizing the crop nutrient requirement, and increasing the cation exchange, water storage capacity, and service in sustaining higher yield (Samreen *et al.* 2017; Chouhan *et al.* 2023). INM plays an essential role in improving the plant growth in terms of plant height, dry weight accumulation, leaf area and crop growth rate, which directly have positive effects in raising the crop productivity Thomas *et al.* (2020), Chundawat *et al.* (2023). Owing to the effect of INM on crop growth parameters, high crop yields can be achieved even without further application of NPK rates above the recommended dose according to Tank *et al.* (2022), Vaktariya *et al.* (2023).

MATERIALS AND METHODS

The experiment was carried out with eleven treatments in simple Randomized Block Design and replicated three times at department of Plantation, Spices, Medicinal and Aromatic Crops, College of Horticulture, Mandsaur, (M.P.) during the Rabi season of 2020-2021. The treatments accompanied with absolute control (T_1), 25 t/ha FYM (T_2), NPK – 40:20:20 Kg/ha + 5 t/ha FYM (T_3), NPK – 40:25:20 Kg/ha + 10 t/ha FYM (T_4), NPK – 40:30:20 Kg/ha + 15 t/ha FYM (T_5), NPK – 45:20:20 Kg/ha + 5 t/ha FYM (T_6), NPK – 45:25:20 Kg/ha + 10 t/ha FYM (T_7), NPK – 45:30:20 Kg/ha + 15 t/ha FYM (T_8), NPK – 50:20:20 Kg/ha + 5 t/ha FYM (T_9), NPK – 50:25:20 Kg/ha + 10 t/ha FYM (T_{10}) and NPK – 50:30:20 Kg/ha + 15 t/ha FYM (T_{11}). Under inorganic fertilizer treatments (50% and 100% recommended dose of fertilizers) nitrogen, phosphorus and potassium nutrients were applied in the form of urea, single super phosphate and murate of potash, respectively. Nitrogen was applied in two equal split doses *i.e.* 50% basal and remaining 50% N dose at 30 days after sowing and flowering stage. The entire phosphorus and potassium were applied as basal. Organic manure, *viz.*, Farm yard manure (FYM) was applied at the time of field preparation and applied to the nigella seed (7 kg ha^{-1}) by line method. The phenological parameters were recorded at 50% germination, 50% flowering and at maturity. The morphological parameters were noted at 45, 90 days after sowing (DAS) and at harvest. Site of the experiment is located in the Malwa plateau in the western part of

Madhya Pradesh and belongs to sub-tropical and semi-arid climatic conditions. The experimental data recorded were subjected to statistical analysis using analysis of variance technique suggested by Panse and Sukhatme (1984). The F-test was measured at the P<0.05 level of significance.

RESULTS AND DISCUSSION

Phenological attributes

Data pertaining to phenology are presented in Table 1. The number of days taken to 50% germination of nigella crop was significantly influenced by different doses of NPK and organic manure application. The early germination was found in treatment T_8 (10.32 DAS) and which was at par with treatments T_{11} (10.42 DAS), T_5 (10.73 DAS) and T_3 (10.92 DAS) but significantly early then rest of the treatments. The late germination was recorded in treatment T_1 (12.52 DAS). The data on days to 50% flowering revealed the early flowering in treatment T_8 (56.46 DAS) followed by treatment T_5 (57.80 DAS). The late flowering was recorded in treatment T_1 (78.39 DAS). The treatment T_8 was recorded minimum days to maturity (138.00 DAS). The assumption seems to be justify that nitrogen, phosphorus and potassium application from organic and inorganic manure enhances the fertility, better aeration and porosity of the soil (Garwal *et al.* 2023) leads to early germination, increased NPK content in the plants from early stage of crop growth results in faster growth of plants evidenced from increased biomass per plant at successive stages of crop growth with NPK subscribe to the views that there was better availability of metabolites and nutrients, which synchronized to the demand for the growth and development of each reproductive structure of the nigella plant results in early flowering and maturity (Nath *et al.* 2008).

Morphological attributes

The data on morphological parameters are presented in Table 2 and 3. The varied amounts of NPK and FYM had perceived significant changes in plant height during the different intervals of plant growth. The treatment T_8 was recorded significantly maximum plant height (20.95 cm) at 45 days after sowing. The minimum plant height was recorded in treatment T_1 (16.27 cm). The treatment T_8 was registered highest plant height (46.89 cm) and was at par with treatments T_{11} (45.86 cm), T_5 (45.72 cm), T_3 (45.12 cm), T_{10} (44.88 cm) and T_9 (44.82 cm) at 90 DAS. The lowest plant height was noted in treatment T_1 (40.05 cm).The maximum plant height was observed in treatment T_8 (57.59 cm) at harvest as compared to other treatments. In this treatment, increased growth was related to suitable combination of organic and inorganic nitrogenous fertilizer maintained the sustainable soil fertility in soil and enhances high level of productivity (Shakywa *et al.* 2022). Nitrogen and Phosphorus, which have positive effect on the growth and

Table 1: Effect of different levels of major nutrients and organic manure on phenology of nigella

Treatments		Phenological stages		
		Days to 50% germination	Days to 50% flowering	Days to maturity
T_1	Absolute control	12.52	78.39	142
T_2	25t/ha FYM	12.33	72.25	141
T_3	40:20:20 kg/ha NPK+5 t/ha FYM	10.92	58.73	139
T_4	40:25:20 kg/ha NPK+10 t/ha FYM	12.28	71.89	140
T_5	40:30:20 kg/ha NPK+15 t/ha FYM	10.73	57.80	139
T_6	45:20:20 kg/ha NPK+5 t/ha FYM	12.05	69.53	140
T_7	45:25:20 kg/ha NPK+10 t/ha FYM	11.93	68.83	140
T_8	45:30:20 kg/ha NPK+15 t/ha FYM	10.32	56.46	138
T_9	50:20:20 kg/ha NPK+5 t/ha FYM	11.52	62.35	139
T_{10}	50:25:20 kg/ha NPK+10 t/ha FYM	11.05	61.58	139
T_{11}	50:30:20 kg/ha NPK+15 t/ha FYM	10.42	56.63	138
S. Em. ±		**0.21**	**1.16**	**1.75**
C.D. at 5%		**0.63**	**3.42**	**5.17**

Table 2: Effect of different levels of major nutrients and organic manure on plant height and number of primary branches of nigella

Treatments		Plant height (cm)			Number of primary branches plant^{-1}		
		45 DAS	90 DAS	At harvest	45 DAS	90 DAS	At harvest
T_1	Absolute control	16.27	40.05	44.57	3.21	5.25	5.75
T_2	25t/ha FYM	16.87	40.42	46.53	3.29	5.77	5.86
T_3	40:20:20 kg/ha NPK+5 t/ha FYM	18.79	45.12	53.45	4.53	6.54	7.13
T_4	40:25:20 kg/ha NPK+10 t/ha FYM	17.22	42.12	46.60	3.53	5.93	6.53
T_5	40:30:20 kg/ha NPK+15 t/ha FYM	18.85	45.72	54.27	5.33	6.77	7.18
T_6	45:20:20 kg/ha NPK+5 t/ha FYM	17.27	42.61	47.03	3.67	6.15	6.64
T_7	45:25:20 kg/ha NPK+10 t/ha FYM	17.55	42.90	47.73	3.73	6.28	6.74
T_8	45:30:20 kg/ha NPK+15 t/ha FYM	20.95	46.89	57.59	5.67	7.23	7.26
T_9	50:20:20 kg/ha NPK+5 t/ha FYM	17.72	44.82	51.57	3.87	6.35	6.78
T_{10}	50:25:20 kg/ha NPK+10 t/ha FYM	17.78	44.88	52.47	4.33	6.45	6.93
T_{11}	50:30:20 kg/ha NPK+15 t/ha FYM	19.78	45.86	54.28	5.42	6.97	7.20
S.Em. ±		**0.50**	**0.89**	**0.73**	**0.58**	**0.22**	**0.24**
C.D. at 5%		1.47	2.63	2.16	1.72	0.66	0.71

Table 3: Effect of different levels of major nutrients and organic manure on fresh and dry weight of nigella

Treatments		Fresh weight (g plant^{-1})			Dry weight (g plant^{-1})		
		45 DAS	90 DAS	At harvest	45 DAS	90 DAS	At harvest
T_1	Absolute control	7.29	25.72	36.21	1.78	6.73	9.23
T_2	25t/ha FYM	9.43	30.71	45.42	2.32	7.39	9.75
T_3	40:20:20 kg/ha NPK+5 t/ha FYM	12.82	43.79	61.33	3.22	9.21	13.23
T_4	40:25:20 kg/ha NPK+10 t/ha FYM	10.05	37.32	58.32	2.70	8.15	11.87
T_5	40:30:20 kg/ha NPK+15 t/ha FYM	13.23	44.83	62.72	3.45	9.42	13.83
T_6	45:20:20 kg/ha NPK+5 t/ha FYM	10.27	39.87	58.82	2.72	8.32	12.92
T_7	45:25:20 kg/ha NPK+10 t/ha FYM	10.89	40.92	59.07	2.87	8.87	13.01
T_8	45:30:20 kg/ha NPK+15 t/ha FYM	13.82	45.89	65.72	3.79	9.76	14.73
T_9	50:20:20 kg/ha NPK+5 t/ha FYM	11.55	41.28	59.31	3.09	9.09	13.05
T_{10}	50:25:20 kg/ha NPK+10 t/ha FYM	12.10	41.82	60.32	3.12	9.15	13.15
T_{11}	50:30:20 kg/ha NPK+15 t/ha FYM	13.72	45.72	64.33	3.59	9.52	14.52
S.Em. ±		**0.47**	**0.73**	**1.10**	**0.17**	**0.19**	**0.27**
C.D. at 5%		1.39	2.17	3.26	0.52	0.57	0.82

development of plants by promoting cell division, and elongation (Tank *et al.* 2022). Applied NPK and organic manure were significantly influenced the number of branches plant^{-1} during the different intervals of plant growth and data are presented in Table 1. At 45 days after sowing, the maximum number of primary branches plant^{-1} was found in treatment T_8 (5.67) which was at par with treatments T_{11} (5.42), T_5 (5.33), T_3 (4.53) and T_{10} (4.33) but significantly superior over the remaining treatments. The treatment T_8 was recorded higher number of branches plant^{-1} (7.23) which was at par with treatments T_{11} (6.97) and T_5 (6.77) but was significantly higher over the remaining treatments at 90 DAS. Likewise, treatment T_8 was recorded higher number of branches plant^{-1} (7.26) at harvest. This could be attributed to the application of FYM with chemical fertilizers. Increased levels of NPK in plants as a result of increased nutrients availability in the soil, followed by efficient absorption and translocation in various growths via active cell division and elongation, resulting in increased plant height, number of primary and secondary branches. The findings of this investigation were in close conformity with those of Naruka *et al.* (2012) and Chandravanshi *et al.* (2021).

Dry matter production

The significant differences were exhibited among the different NPK doses and organic manure for fresh and dry weight during the different intervals of plant growth (Table 3). The fresh weight was recorded significantly highest (65.72 g plant^{-1}) under the treatment T_8 at harvest which was at par with treatments T_{11} (64.33 g plant^{-1}) and T_5 (62.72 g plant^{-1}). This may be due to balance application of NPK fertilizers leading to higher vegetative growth than other doses. Similar results were obtained by Chouhan *et al.* (2023). Similarly, the treatment T_8 was accumulated significantly highest dry weight (14.73 g plant^{-1}) at harvest which was at par with treatment T_{11} (14.52 g plant^{-1}). The increased dry matter production in treatment T_8 could be attributed to better vegetative growth and production of more fresh weight. The better absorption and accumulation of nutrients promotes growth and metabolism Chandravanshi *et al.* (2021).

Yield parameters and yield

The significant differences were indicated among the yield and yield attributing traits and data are represented in Table 4. The result revealed that, treatment T_8 had significantly highest number of capsule plant^{-1} (37.47), number of seeds capsule^{-1} (97.45), test weight (3.60 g), harvest index (46.31 %) and seed yield (8.76 g plant^{-1}and 9.11 q ha^{-1}) while they were lowest in treatment T_1. The important reason responsible for better production of yield components and yield could be the supply of nutrients in balanced amount and available form (Yadav *et al.* 2023). The increased growth in term of plant height, branches per plant provided greater sites for photosynthesis and diversion of photosynthates towards sink. The beneficial effect on yield attributes might be also due to increased supply of all the essential nutrients by organic manures which might have resulted in higher synthesis of food and its subsequent partitioning to sink Chandravanshi *et al.* (2021). The increased yield might also be owing to better nutritional status of the soil which might have stimulated the rate of various plant physiological processes which lead to increased yield attributing characteristics and their cumulative effect resulted in enhanced seed yields (Yadav *et al.* 2023). These findings of present investigation are in conformity of the results of Kumar *et al.* (2002).

Economics of the treatment

In the present investigation economics of various treatments with benefit cost ratio were affected with the application of different doses of inorganic and organic fertilizers (Table 5). The highest net returns (₹ 137480) and benefit: cost ratio (5.18:1) was recorded in treatment T_8 as compared to other treatments and the lowest in treatment T_1 (₹ 59680) net returns and (2.46:1) B: C ratio. The intensification in the net return may be attributed to supply of

Table 4: Effect of different levels of major nutrients and organic manure on yield and yield attributes of nigella

Treatments		Number of capsules (plant^{-1})	Number of seeds (capsule^{-1})	Test weight (g)	Harvest index (%)	Seed yield plant^{-1} (g)	Seed yield (q ha^{-1})
T_1	Absolute control	16.93	79.23	2.64	38.67	3.21	4.66
T_2	25 t/ha FYM	20.74	81.62	2.70	46.61	4.06	6.20
T_3	40:20:20 kg/ha NPK+5 t/ha FYM	33.92	86.65	3.05	41.17	7.05	7.30
T_4	40:25:20 kg/ha NPK+10 t/ha FYM	20.84	83.37	2.74	41.59	4.16	6.31
T_5	40:30:20 kg/ha NPK+15 t/ha FYM	36.47	89.81	3.15	43.22	7.86	7.94
T_6	45:20:20 kg/ha NPK+5 t/ha FYM	25.18	84.65	2.73	40.19	5.11	6.31
T_7	45:25:20 kg/ha NPK+10 t/ha FYM	26.63	84.91	2.76	40.81	5.42	6.51
T_8	45:30:20 kg/ha NPK+15 t/ha FYM	37.47	97.45	3.60	46.31	8.76	9.11
T_9	50:20:20 kg/ha NPK+5 t/ha FYM	29.38	86.07	2.99	38.94	6.06	6.66
T_{10}	50:25:20 kg/ha NPK+10 t/ha FYM	29.48	86.22	3.04	38.13	6.10	6.67
T_{11}	50:30:20 kg/ha NPK+15 t/ha FYM	36.81	91.15	3.24	46.29	8.05	8.57
S.Em. ±		**0.73**	**1.63**	**0.16**	**0.88**	**0.19**	**0.21**
C.D. at 5%		**2.18**	**4.82**	**0.49**	**2.59**	**0.57**	**0.64**

Table 5: Effect of different levels of major nutrients and organic manure on economics of nigella

Treatments		Total cost (₹)	Gross return (₹)	Net profit (₹)	B:C ratio
T_1	Absolute control	24200	83880	59680	2.46:1
T_2	25 t/ha FYM	24500	111600	87100	3.55:1
T_3	40:20:20 kg/ha NPK+5 t/ha FYM	25100	131400	106300	4.23:1
T_4	40:25:20 kg/ha NPK+10 t/ha FYM	25800	113580	87780	3.40:1
T_5	40:30:20 kg/ha NPK+15 t/ha FYM	26100	142920	116820	4.47:1
T_6	45:20:20 kg/ha NPK+5 t/ha FYM	26050	113580	87480	3.35:1
T_7	45:25:20 kg/ha NPK+10 t/ha FYM	26100	117180	91080	3.48:1
T_8	45:30:20 kg/ha NPK+15 t/ha FYM	26500	163980	137480	5.18:1
T_9	50:20:20 kg/ha NPK+5 t/ha FYM	26800	119880	93080	3.47:1
T_{10}	50:25:20 kg/ha NPK+10 t/ha FYM	27000	120060	93060	3.44:1
T_{11}	50:30:20 kg/ha NPK+15 t/ha FYM	27200	154260	127060	4.67:1

optimal level of nutrients by using organic manures and chemical fertilizer's to meet the crop mandate at proper time which in turn lead to higher yield Chouhan *et al.* (2023).

CONCLUSION

On the basis of research and the results reported, it could be concluded that out of 11 treatment combinations treatment T_8 - 45:30:20 kg/ha NPK+15 t/ha FYM was found better for increasing the growth, quality and yield of nigella.

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