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Effect of NPK on plant growth, seed yield and seed quality of Black Cumin (*Nigella sativa* L.) cv. NRCSS (AJMER)

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Abstract
An experiment was conducted in the Vegetable Research Farm, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (Uttar Pradesh) Thirteen treatments having one cultivar were laid out in Randomized Block Design (RBD) with three replications. Find out the effect of nitrogen, phosphorus and Potassium (NPK) on growth, and yield of black cumin. On the basis of present investigation it is concluded that the application of treatment T_6 70:65:65 (Urea=152.17kg/ha, Single Super Phosphate=406.25kg/ha, Murate of Pottash= 108.33kg/ha) was superior in terms of growth and yield *viz.* plant height (60.23), number of primary branches per plant (8.25), number of primary branches per plant (14.96), days to flower bud appearance (63.48), days to 50% flowering (56.46), number of capsule plant^{-1} (37.47), seed yield plant^{-1} (8.59g), seed yield plot^{-1} (103.12g) and seed yield (7.20q ha^{-1}) of Black cumin.

Keywords: NPK, growth, yield, MOP, SSP and black cumin

Introduction
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. The crop is native to the Mediterranean region and it has been used for thousands of years by various cultures and civilizations. Naturally, it grows in Mediterranean region of Turkey and Cyprus (Davis, 1965) [3]. It is one of the most important medicinal plants, because it has multipurpose uses.

Black cumin (*Nigella sativa* L.) is an annual species that have originated from arid and semi - arid zones and is used widely in traditional and industrial pharmacology (Patel *et al.*, 1996) [9]. One of the most important constituents of volatile oil of the Nigella sativa seeds are thymoquinone. Thymoquinone belongs to class of compounds known as terpenoids (Bendahou *et al.*, 2008) [1].

The main producer and consumer of cumin is India. It produces 70% of the world supply and consumes 90% of that (which means that India consumes 63% of the world's cumin). Other producers are Syria (7%), Iran (6%) and Turkey (6%). The remaining 11% comes from other countries. In total, around 300,000 tons of cumin per year are produced worldwide.

Nitrogen has the largest effect on plant physiology and is probably the most important limiting nutrient for crop growth. Agricultural soils are often deficient in N and hence, to ensure adequate N supply to crops and to prevent from nutrient deficiencies, large amounts of inorganic N are applied (Shah, 2004) [10]. Phosphorus in thesoil has developmental activity in the plant's root growth. Depending on phosphorus applications, the contact area of the root expands with the growth of root which, in turn, gives values in the range of 30.7 cm and 35.3 cm in black cumin (Geren *et al.*, 1997) [6]. Potassium fertilizer is another essential component to reduce the severity of disease of black cumin plants. Application of 30 kg K ha-1 along with 30 kg N ha-1 decreased plant death due to disease and also increased yield in Cumin (Champawat and Pathak, 1982) [2]. Very cool temperature and excessive use of fertilizer may cause reduction in growth and yield of black cumin and increase diseases infestation. Black cumin of different genotypes requires good combination of fertilizers for optimum growth and yield.

The present study was undertaken to understand the growth and yield of black cumin genotypes under different levels of N-P-K fertilizer and also to determine the optimum fertilizer doses for black cumin production.

Materials and Methods

The present investigation "Effect of NPK on plant growth, seed yield and seed quality of Black Cumin (*Nigella sativa* L.) cv. NRCSS (AJMER)" during the *Rabi* season of the year, 2020. The details of materials used and methodology adopted during the course of study are mentioned below.

Experimental Site

The experiment was conducted in the Vegetable Research Farm, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad (Uttar Pradesh) during 2019-2020. All the facilities necessary for cultivation, including labor were made available in the department. The details of the materials used and the methods adopted for this study are presented in this chapter.

Climate

Allahabad is situated at an elevation of 78 meters above sea level at 25.87 degree North latitude and 81.15 degree E longitude. This region has a sub-tropical climate prevailing in the south-east part of U.P. with both the extremes in temperature, i.e. the winter and the summer. In cold winters, the temperature sometimes is as low as 32°F in December – January and very hot summer with temperature reaching up to 115°F in the months of May and June. During winter, frosts and during summer, hot scorching winds are also not uncommon. The average rainfall is around 1013.4 (cm) with maximum concentration during July to September months with occasional showers in winters. The average monthly rainfall, relative humidity, minimum and maximum temperature recorded during experimental period is shown

Results and Discussion

Growth parameters

Plant height at 120 DAS

The maximum plant height (60.23) was recorded in treatment $T_6$70:65:65(urea=152.17kg/ha,ssp=406.25kg/ha,mop=108.33kg/ha) followed by T_{10} (55.54), T_7 (54.74), T_9 (53.71), T_8 (51.72), T_{11} (49.27), T_{12} (45.60) and T_5 (44.86) and the minimum plant height (26.23) was recorded in treatment T_0 control.

Flowering parameters

Days to flower bud appearance

The flower emergence *viz.*, Days to flower bud appearance from days after sowing as influenced by NPK are given below: NPK significantly affected the Days to flower bud appearance for first flower bud emergence from days after sowing transplanting. However, it was seen that minimum days to flower bud appearance (63.48) were taken by treatment T_6 70:65:65 (urea=152.17kg/ha, ssp=406.25kg/ha, mop=108.33kg/ha) which was remarkably better than T_1 control (86.30). The increase in the Days to flower bud appearance was seen between the various treatments. Treatment T_{12} (82.42), T_{11} (81.34), T_8 (80.19), T_{10} (79.58), T_9 (78.65), T_5 (72.51), T_3 (75.71) and T_2 (72.50). The minimum number of days to reach 50% flowering date observed from control of nitrogen and phosphorous. This could be because of excessive nitrogen and phosphorous resulting in prolonged vegetative growth of the plant. This result is in close conformity Ozguven and Sekeroglu (2007) [7].

Days to 50% flowering

The flower emergence *viz.*, Days to 50% flowering from days after sowing as influenced by NPK are given below

NPK significantly affected the Days to 50% flowering for first flower bud emergence from days after sowing transplanting. However, it was seen that minimum days to 50% flowering (56.46) were taken by treatment T6 70:65:65 (urea=152.17kg/ha, ssp=406.25 kg/ha,mop=108.33kg/ha) which was remarkably better than T1 control (78.39).

The increase in the Days to 50% flowering was seen between the various treatments T5 (57.80), T4 (58.73), T2 (61.58), T1 (62.35), T3 (68.83), T9 (69.53) and T7 (56.63). The minimum number of days to reach 50% flowering date observed from control of nitrogen and phosphorous. This could be because of excessive nitrogen and phosphorous resulting in prolonged vegetative growth of the plant. This result is in close conformity Ozguven and Sekeroglu (2007) [8].

Number of capsule plant^{-1}

Data in respect of number of capsule plant^{-1} of plant as influenced by NPK are presented in (Table/fig4.6).

It is evident from the data that number of capsule plant^{-1} was significantly affected by NPK. The highest number of capsule plant^{-1} (37.47) was found in treatment T_6 70:65:65(urea=152.17kg/ha,ssp=406.25kg/ha,mop=108.33kg/ha) followed by T_7 (36.47), T_8 (36.81), T_5 (33.92), T_{12} (29.38) and T_{11} (29.48). Lowest number of capsule plant^{-1} was found in treatment T_0 (15.71) control. These findings are also supported by Shah, (2007) [11] in nigella crop. Combined effect of varieties and fertilizer levels exhibited significant influence on quality attributes of nigella.

Seed yield parameter

Seed yield plant^{-1}

Data given in revealed that significantly highest seed yield plant^{-1} (8.59g) was recorded in treatment T_6- 70:65:65 (urea=152.17kg/ha, ssp=406.25kg/ha, mop=108.33kg/ha) than all other treatment. This treatment was followed by T_7 (7.41), T_8 (6.48), T_{10} (6.20), T_{12} (7.45), T_{11} (6.55), T_9 (5.79), T_4 (6.15), T_3 (5.83), T_2 (5.41) and minimum seed yield plant^{-1} (2.41g) was obtained in treatment T_1 Control. The result was linear increment with the increasing rate of Nitrogen and phosphorus through each levels of interaction. The present study was in contrast with Das *et al.* (1992) [4] whose report 590 kg haG1 found from application of 60/120 NP kg haG1. This could be; the type of cultivar, the cropping season difference or the type of soil and its constituents or else the type of managements that can increase or decrease the availability of fertilizer efficiency. The seed yield obtained from this research result is in line with the yields reported by Datta (2004) [5] and Weiss (2002) [12] who reported highest value 1200 and lowest value 1000 kg haG1.

Seed yield (q ha^{-1})

From the data given below it is observed that significantly highest seed yield (7.20q ha^{-1}) was recorded in treatment T_6 70:65:65 (urea=152.17kg/ha, ssp=406.25kg/ha, mop=108.33kg/ha) as compared to other treatment. This treatment was followed by T_7 75:70:70 (urea=163.04kg/ha, ssp=437.5kg/ha, mop=116.66kg/ha), T_{12} 125:95:95 (urea=271.73 kg/ha, ssp=593.75 kg/ha, mop=158.33kg/ha),T_8

80:75:75 (urea=173.91 kg/ha, ssp=468.75 kg/ha, mop=125kg/ha), T_{10} 100:85:85 (urea=217.39kg/ha, ssp=531.25 kg/ha, mop=141.66kg/ha), T_4 60:55:55 (urea=130.43kg/ha, ssp=343.75 kg/ha, mop=91.66kg/ha), T_3 55:50:50 (urea=119.56kg/ha, ssp=312.5 kg/ha, mop=83.33 kg/ha) and T_{11} 110:90:90 (urea=239.13kg/ha, ssp=562.5kg/ha, mop=150kg/ha) and minimum seed yield (q ha^{-1}) (2.03 q ha^{-1}) was obtained in treatment T_1 Control.

Table 1: Effect of Nitrogen, Phosphorus and Potassium (NPK) on plant height (cm) of Black cumin cv. NRCSS (AJMER)

Treatments Symbol	Treatment Combinations	Plant height (cm)
		120 DAS
T_0	40:20:30 (urea=(86.8kg/ha,ssp=125kg/ha, mop=49.8kg/ha)	26.23
T_1	40:30:40(urea=86.8kg/ha,ssp187.5kg/ha,mop=66.4kg/ha)	36.51
T_2	50:40:45(urea=108.6kg/ha,ssp=250kg/ha,mop=75kg/ha)	35.32
T_3	55:50:50(urea=119.56kg/ha,ssp=312.5kg/ha,mop=83.33kg/ha)	33.54
T_4	60:55:55(urea=130.43kg/ha,ssp=343.75kg/ha,mop=91.66kg/ha)	38.44
T_5	65:60:60(urea=141.30kg/ha,ssp=375kg/ha,mop=100kg/ha)	44.86
T_6	70:65:65(urea=152.17kg/ha,ssp=406.25kg/ha,mop=108.33kg/ha)	60.23
T_7	75:70:70(urea=163.04kg/ha,ssp=437.5kg/ha,mop=116.66kg/ha)	54.74
T_8	80:75:75(urea=173.91kg/ha,ssp=468.75kg/ha,mop=125kg/ha)	51.72
T_9	90:80:80(urea=195.65kg/ha,ssp=500kg/ha,mop=133.33kg/ha)	53.71
T_{10}	100:85:85(urea=217.39kg/ha,ssp=531.25kg/ha,mop=141.66kg/ha)	55.54
T_{11}	110:90:90(urea=239.13kg/ha,ssp=562.5kg/ha,mop=150kg/ha)	49.27
T_{12}	125:95:95(urea=271.73kg/ha,ssp=593.75kg/ha,mop=158.33kg/ha)	45.60
	F-Test	S
	C.D. at 0.5%	4.46
	S.Ed. (+)	2.16

Table 2: Effect of Nitrogen, Phosphorus and Potassium (NPK) on Days to 50% flowering and Days to flower bud appearance of Black cumin cv. NRCSS (AJMER)

Treatments Symbol	Treatment Combinations	Days to 50% flowering	Days to flower bud appearance
T_0	40:20:30 (urea=(86.8kg/ha,ssp=125kg/ha, mop=49.8kg/ha)	78.39	86.30
T_1	40:30:40(urea=86.8kg/ha,ssp187.5kg/ha,mop=66.4kg/ha)	62.35	71.67
T_2	50:40:45(urea=108.6kg/ha,ssp=250kg/ha,mop=75kg/ha)	61.58	72.50
T_3	55:50:50(urea=119.56kg/ha,ssp=312.5kg/ha,mop=83.33kg/ha)	68.83	75.71
T_4	60:55:55(urea=130.43kg/ha,ssp=343.75kg/ha,mop=91.66kg/ha)	58.73	68.98
T_5	65:60:60(urea=141.30kg/ha,ssp=375kg/ha,mop=100kg/ha)	57.80	72.51
T_6	70:65:65(urea=152.17kg/ha,ssp=406.25kg/ha,mop=108.33kg/ha)	56.46	63.48
T_7	75:70:70(urea=163.04kg/ha,ssp=437.5kg/ha,mop=116.66kg/ha)	56.63	65.90
T_8	80:75:75(urea=173.91kg/ha,ssp=468.75kg/ha,mop=125kg/ha)	72.47	80.19
T_9	90:80:80(urea=195.65kg/ha,ssp=500kg/ha,mop=133.33kg/ha)	69.53	78.65
T_{10}	100:85:85(urea=217.39kg/ha,ssp=531.25kg/ha,mop=141.66kg/ha)	72.25	79.58
T_{11}	110:90:90(urea=239.13kg/ha,ssp=562.5kg/ha,mop=150kg/ha)	71.89	81.34
T_{12}	125:95:95(urea=271.73kg/ha,ssp=593.75kg/ha,mop=158.33kg/ha)	73.93	82.42
	F-Test	S	S
	C.D. at 0.5%	0.74	0.156
	S.Ed. (+)	0.362	0.076

Table 3: Effect of Nitrogen, Phosphorus and Potassium (NPK) on Number of capsule $plant^{-1}$ of Black cumin cv. NRCSS (AJMER)

Treatments Symbol	Treatment Combinations	Number of capsule $plant^{-1}$
T_0	40:20:30 (urea=(86.8kg/ha,ssp=125kg/ha, mop=49.8kg/ha)	15.71
T_1	40:30:40(urea=86.8kg/ha,ssp187.5kg/ha,mop=66.4kg/ha)	17.97
T_2	50:40:45(urea=108.6kg/ha,ssp=250kg/ha,mop=75kg/ha)	25.18
T_3	55:50:50(urea=119.56kg/ha,ssp=312.5kg/ha,mop=83.33kg/ha)	20.58
T_4	60:55:55(urea=130.43kg/ha,ssp=343.75kg/ha,mop=91.66kg/ha)	20.74
T_5	65:60:60(urea=141.30kg/ha,ssp=375kg/ha,mop=100kg/ha)	33.92
T_6	70:65:65(urea=152.17kg/ha,ssp=406.25kg/ha,mop=108.33kg/ha)	37.47
T_7	75:70:70(urea=163.04kg/ha,ssp=437.5kg/ha,mop=116.66kg/ha)	36.47
T_8	80:75:75(urea=173.91kg/ha,ssp=468.75kg/ha,mop=125kg/ha)	36.81
T_9	90:80:80(urea=195.65kg/ha,ssp=500kg/ha,mop=133.33kg/ha)	20.84
T_{10}	100:85:85(urea=217.39kg/ha,ssp=531.25kg/ha,mop=141.66kg/ha)	26.63
T_{11}	110:90:90(urea=239.13kg/ha,ssp=562.5kg/ha,mop=150kg/ha)	29.48
T_{12}	125:95:95(urea=271.73kg/ha,ssp=593.75kg/ha,mop=158.33kg/ha)	29.38
	F-Test	S
	C.D. at 0.5%	2.02
	S.Ed. (+)	0.982

Table 4: Effect of Nitrogen, Phosphorus and Potassium (NPK) on Seed yield plant^{-1} (g) and Seed yield (q ha^{-1}) of Black cumin cv. NRCSS (AJMER)

Treatments Symbol	Treatment Combinations	Seed yield plant^{-1} (g)	Seed yield (q ha^{-1})
T_0	40:20:30 (urea=(86.8kg/ha,ssp=125kg/ha, mop=49.8kg/ha)	2.41	2.03
T_1	40:30:40(urea=86.8kg/ha,ssp187.5kg/ha,mop=66.4kg/ha)	4.79	4.03
T_2	50:40:45(urea=108.6kg/ha,ssp=250kg/ha,mop=75kg/ha)	5.41	4.55
T_3	55:50:50(urea=119.56kg/ha,ssp=312.5kg/ha,mop=83.33kg/ha)	5.83	4.90
T_4	60:55:55(urea=130.43kg/ha,ssp=343.75kg/ha,mop=91.66kg/ha)	6.15	5.16
T_5	65:60:60(urea=141.30kg/ha,ssp=375kg/ha,mop=100kg/ha)	4.62	3.88
T_6	70:65:65(urea=152.17kg/ha,ssp=406.25kg/ha,mop=108.33kg/ha)	8.59	7.20
T_7	75:70:70(urea=163.04kg/ha,ssp=437.5kg/ha,mop=116.66kg/ha)	7.41	6.20
T_8	80:75:75(urea=173.91kg/ha,ssp=468.75kg/ha,mop=125kg/ha)	6.48	5.42
T_9	90:80:80(urea=195.65kg/ha,ssp=500kg/ha,mop=133.33kg/ha)	5.79	4.84
T_{10}	100:85:85(urea=217.39kg/ha,ssp=531.25kg/ha,mop=141.66kg/ha)	6.20	5.18
T_{11}	110:90:90(urea=239.13kg/ha,ssp=562.5kg/ha,mop=150kg/ha)	6.55	5.46
T_{12}	125:95:95(urea=271.73kg/ha,ssp=593.75kg/ha,mop=158.33kg/ha)	7.45	6.21
	F-Test	S	S
	C.D. at 0.5%	0.386	0.323
	S.Ed. (+)	0.187	0.156

Conclusion

On the basis of present investigation it is concluded that the application of treatment T_6 70:65:65 (urea=152.17kg/ha, ssp=406.25kg/ha, mop=108.33kg/ha) was superior in terms of growth and flower yield of Black cumin.

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