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Effect of different doses of NPK fertilizer on morphological characters of nigella under Mandsaur region of Madhya Pradesh

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Abstract
Nigella is a small herb growing to a height of 45 to 55 cm. The seeds of black cumin are of economic importance, used both as a seed spice and also for medicinal purposes. Leaves are capillary, pinnatisect, 2.5 to 5.0 cm long, cut into numerous fine linear, lanceolate, segments, not involucrating the flower. Effect of Nitrogen, Phosphorus & potassium on morphological characters of Nigella under Mandsaur region of Madhya Pradesh. Among all the morphological parameters on plant height, number of branches plant^{-1}, fresh weight of plant (g), dry weight of plant (g) and days to 50% germination except fresh weight at harvest, days to 50% flowering and days to maturity with the Application of different levels of NPK. However, T_8 - 70:70:55 kg ha^{-1} NPK was recorded with superior values of plant height (11.53, 76.87 and 81.23 cm), number of branches plant^{-1}(7.07, 13.20 and 17.53), fresh weight (11.08, 72.82 and 79.77 g plant^{-1}), dry weight (3.16, 19.92 and 23.75 g plant^{-1}), days to 50% germination (10.00), days to 50% flowering (80.00) and days to maturity (140) as compared to T_1 - 40:20:20 kg ha^{-1} NPK (recommended dose).

Keywords: Nitrogen, phosphorus & potassium, Nigella

Introduction
Nigella (*Nigella sativa* L.) also known as *Kalaunji* is a seed spice having an immense pharmacological potential. It belongs to the family Ranunculaceae having chromosome number 2n = 12. It has many regional names like Kalajira, Nallajilakara, Karunjiragam and called as black cumin, black seed or small fennel in English. The crop is native to the Mediterranean region of Turkey and Cyprus (Davis, 1965) [7] and has been used by various cultures and civilizations for millennia. It is an annual spice that has originated from arid and semi-arid zones and is used widely in traditional and industrial pharmacology. One of the most important constituents of volatile oil of the nigella seeds are thymoquinone. Thymoquinone belongs to class of compounds known as terpenoids (Varun *et al.*, 2020) [39].

Nigella is cited as black cumin in many texts and because of the similarity of common names to other spices of the Apiaceae family, *viz*. Siah Zira (Lit. Black cumin - *Carum carvi* L.), Kala Zira (Lit. Black cumin *Bunicun persicum* Bioss. Fedtsch syn. *Carum Bulbocastanum* Koch.).Botanically and structurally, nigella seeds are completely different from the above spices and belong to a different family. To avoid such confusions it is most appropriate to call the spice as nigella.

In India, it is commercially cultivated in Punjab, Himachal Pradesh, Madhya Pradesh, Rajasthan, Jharkhand, Assam, West Bengal and Andhra Pradesh (Vijay and Malhotra, 2002) [40]. It is mostly cultivated in Mandsaur, Neemuch and Shajapur districts of Madhya Pradesh.

The seeds contain a yellowish volatile oil in the range of 1.5 per cent and fatty oil from 36 to 38 per cent, as well as protein, sugar, mucus, organic acids, toxic glucosides, tannins, resins, proteins, saponins, Arabic acid and others soluble in alcohol organic acids. Free amino acids such as cystine, lysine, aspartic acid, glutamic acid, alanine, tryptophan, valine and leucine are present in dormant seeds (Lindley, 1981) [14].

The dried black seeds of nigella are the commercial product being used in food, flavor and medicines. The essential oil from nigella seed has also demand in the pharmaceutical and perfumery industry. The main alkaloids present in nigellin seeds are nigellidine, nigellicine, nigelline they have anticarcinogenic properties. The carboxylic compound, nigellone, is an important component with medicinal and conservative properties. Nigella seeds have been used since ancient times as a spice in the preparation of pickles, as one of the ingredients.

The seeds are sprinkled as a preservative between the folds of linen and woolen fabric to prevent insect attacks. The oil can be used as a stabilizer for edible fats. Seeds are aromatic, diuretic, diaphoretic, antibilous, stomachic, stimulant and carminative, digestive, anthelmintic, galactagogue and emmenagogue (Nadakarni, 1976) [19].

Plant nutrition is one of the most important factors in increasing plant productivity. Nitrogen (N) is best known in plants due to its presence in the structure of a protein molecule. Accordingly, N plays an important role in the synthesis of plant components by various enzymes (Khalid and Shedeed, 2015) [12]. The availability of nitrogen is of paramount importance for plant cultivation, as it is the main and irreplaceable component of protein and nucleic acid molecules (Troug, 1973) [35]. Adequate nitrogen is associated with vigorous vegetative growth, and more efficient use of available resources ultimately leads to increased productivity.

The seeds have the highest phosphorus concentration in the mature plant and are required in large quantities in young cells such as shoots and root tips, where metabolism is high and cell division is rapid. P aidsin root development, flower initiation, seed and fruit development (Khalid and Shedeed, 2015) [12]. Phosphorus is the most important nutrient element in the production of essential oil yielding crops. Phosphorus application has been found to increase plant height, branch count, fresh and dry weight, and black seed oil content (Sushama and Jose, 1994) [34].

Potassium (K) is an essential macronutrient and the most abundant cation in higher plants.K has been the target of some researchers mainly because it is required for enzyme activation (Khalid and Shedeed, 2015) [12]. Potash fertilizers are an indispensable component for reducing the severity of diseases in nigella plants. Application of 30 kg K / ha together with 30 kg N / ha reduced plant death due to disease and also increased caraway yields (Champawat and Pathak, 1982) [6].

Material and Methods

The field experiment entitled "Effect of NPK on growth, yield and quality of nigella (*Nigella sativa* L.)" was conducted during the *rabi* season of 2020-2021. The field experiment was carried out at the "Horticulture Research Farm", department of Plantation, Spices, Medicinal and Aromatic crops, College of Horticulture, Mandsaur, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.) during *rabi* season of 2020-2021. The College of Horticulture, Mandsaur is situated in Malwa plateau in Western part of Madhya Pradesh. This region falls under agro climatic zone No.10 of the State. The research experiment was enclosing in a randomized block design with three replications and nine treatments.

Table 1: Treatment details

S. No	Treatment details
T_1	NPK – 40:20:20 Kg/ha
T_2	NPK – 40:30:25 Kg/ha
T_3	NPK – 50:40:30 Kg/ha
T_4	NPK – 50:50:35 Kg/ha
T_5	NPK – 60:55:40 Kg/ha
T_6	NPK – 60:60:45 Kg/ha
T_7	NPK – 70:65:50 Kg/ha
T_8	NPK – 70:70:55 Kg/ha
T_9	NPK – 80:75:60 Kg/ha

Fig 1: View of experiment field of Nigella

Result and Discussion

The present investigation entitled "Effect of NPK on growth and yield and quality of nigella (*Nigella sativa* L.)."was conducted at Horticulture Research Farm, department of Plantation, Spices, Medicinal and Aromatic crops, College of Horticulture, Mandsaur (M.P.). The study highlighted the effect of applying different levels of NPK on nigella on all the growth stages at 45, 90 DAS and at harvest.

Morphological parameters

The experimental data exhibited the significant variation of all the morphological parameters *viz*., plant height (cm), number of branches plant^{-1}, fresh weight of plant^{-1} (g), dry weight of plant^{-1} (g) during all the growth intervals, except fresh weight of plant^{-1} (g) at harvest. Among the phonological parameters days to 50% germination was shown significant variation while, days to 50% flowering and days to maturity shown non-significant variation.

Result revealed that treatment T_8 – 70:70:55 kg/ha NPK recorded the highest plant height (11.53, 76.87 and 81.23 cm) while, lowest under T_1 – 40:20:20 kg/ha NPK (8.49, 57.83 and 64.34 cm) during all the growth stages. Plant height can be controlled genetically and / or by environmental factors. The reason may be associated with the introduction of higher doses of nitrogen, which in itself increases plant growth, stimulating processes such as cell division, cell enlargement, metabolic processes by Ali *et al*., 2015 [1].

The treatment T_8 – 70:70:55 kg/ha NPK had more number of branches plant^{-1} (7.07, 13.20 and 17.53) while, lowest no. of branchesplant^{-1} (5.13, 9.93 and 15.20) under T_1 – 40:20:20 kg/ha NPK during all the growth stages. The increase in the number of branches with increasing nitrogen application can be explained by the regular supply of nitrogen, which may have increased branching and the formation of vegetative buds. The positive effect of phosphorus application on the number of branches may be due to the increased availability of nitrogen and potassium, which led to better plant growth by Sultana *et al*., 2019 [33].

The result pertaining that the maximum fresh weight of plant was recorded under T_8 – 70:70:55 kg/ha NPK (11.08, 72.82 and 79.77 g plant^{-1}) while, lowest (5.62, 54.60 and 60.34 gplant^{-1}) was recorded under T_1 – 40:20:20 kg/ha NPK during all the growth stages. A very high fertilizer level results in a significant increase in fresh weight. The reason may be due to the sufficient amount of nitrogen, which promotes aerial vegetative growth, increasing the ratio of top to root nitrogen by Hammo 2008 [9]. Similar results were obtained by Mohamed *et al*., 2000 [17] and Özgüven and Sekeroglu 2007 [22].

The maximum dry weight of plant^{-1} (3.16, 19.92 and 23.75 g) was recorded under T_8 – 70:70:55 kg/ha NPK. Whereas, lowest (1.66, 13.83 and 15.93 g) was recorded under T_1 – 40:20:20 kg/ha NPK during all the growth stages. These results may be due to that NPK full dose rich the root zone with sufficient amount of N, P and K which essential nutrients for many processes in plant cells. N plays an important role in the synthesis of plant components through the work of various enzymes. Also, P plays a central and regulatory role in metabolism and relationship between many physiological and biochemical processes in plants, in addition, photosynthesis, energy conservation. Over all K plays an essential role in activating the enzyme and protein synthesis, photosynthesis, osmoregulation, stomatal movement, energy transfer, phloem transport and stress resistance. All the NPK functions are dependent on the amount of them in the root zone and its uptake by plant roots and that effects on the plant growth by El-Mahrouk *et al.*, 2018 [8] on lemongrass. The same kind of result was obtained by Ali *et al.*, 2015 [1] on nigella.

Table 2: Effect of different levels of NPK on plant height (cm plant^{-1}), Number of branches plant^{-1}, Fresh weight of (g plant^{-1})

Treatment details	Plant height (cm plant^{-1})			Number of branches plant^{-1}			Fresh weight of (g plant^{-1})		
	45 DAS	90 DAS	At harvest	45 DAS	90 DAS	At harvest	45 DAS	90 DAS	At harvest
T_1 - NPK – 40:20:20 Kg/ha	8.49	57.83	64.34	5.13	9.93	15.20	5.62	54.60	60.34
T_2 - NPK – 40:30:25 Kg/ha	8.81	62.25	67.96	5.93	10.53	15.53	6.24	56.16	62.96
T_3 - NPK – 50:40:30 Kg/ha	9.11	64.09	69.55	6.13	10.73	15.80	6.88	58.43	64.55
T_4 - NPK – 50:50:35 Kg/ha	9.55	66.02	73.01	6.27	11.07	16.20	8.23	61.87	68.01
T_5 - NPK – 60:55:40 Kg/ha	9.98	67.63	73.73	6.40	11.60	16.33	9.06	63.38	70.73
T_6 - NPK – 60:60:45 Kg/ha	10.01	69.69	76.39	6.53	11.60	16.53	9.51	66.34	73.39
T_7 - NPK – 70:65:50 Kg/ha	11.23	74.02	78.09	6.80	12.73	17.33	10.53	70.73	76.09
T_8 - NPK – 70:70:55 Kg/ha	11.53	76.87	81.23	7.07	13.20	17.53	11.08	72.82	79.77
T_9 - NPK – 80:75:60 Kg/ha	10.59	71.20	76.42	6.60	12.53	16.80	9.97	68.97	75.97
S.Em (±)	0.08	0.98	1.29	0.13	0.19	0.06	0.11	0.54	3.00
CD (5%)	0.24	2.94	3.88	0.38	0.58	0.17	0.33	1.61	8.98

Table 3: Effect of different levels of NPK on Fresh weight of (g plant^{-1}) Dry weight (g plant^{-1}) Days to 50% germination Days to 50% flowering Days to maturity

Treatment details	Fresh weight of (g plant^{-1})			Dry weight (g plant^{-1})			Germination effect		
	45 DAS	90 DAS	at harvest	45 DAS	90 DAS	At harvest	Days to 50% germination	Days to 50% flowering	Days to maturity
T_1 - NPK – 40:20:20 Kg/ha	5.62	54.60	60.34	1.66	13.83	15.93	13.67	87.00	144.00
T_2 - NPK – 40:30:25 Kg/ha	6.24	56.16	62.96	1.76	14.21	16.74	13.33	86.67	144.00
T_3 - NPK – 50:40:30 Kg/ha	6.88	58.43	64.55	1.81	14.70	17.41	12.00	85.67	144.00
T_4 - NPK – 50:50:35 Kg/ha	8.23	61.87	68.01	1.85	15.05	17.82	12.00	84.33	144.00
T_5 - NPK – 60:55:40 Kg/ha	9.06	63.38	70.73	1.92	17.51	19.81	11.67	83.33	142.00
T_6 - NPK – 60:60:45 Kg/ha	9.51	66.34	73.39	1.98	18.41	20.98	11.00	82.33	142.00
T_7 - NPK – 70:65:50 Kg/ha	10.53	70.73	76.09	2.44	18.89	22.62	10.00	80.00	140.00
T_8 - NPK – 70:70:55 Kg/ha	11.08	72.82	79.77	3.16	19.92	23.75	10.00	80.00	140.00
T_9 - NPK – 80:75:60 Kg/ha	9.97	68.97	75.97	2.14	18.71	22.01	10.33	80.33	142.00
S.Em (±)	0.11	0.54	3.00	0.04	0.44	0.24	0.14	0.12	0.66
CD (5%)	0.33	1.61	8.98	0.13	1.32	0.71	0.41	0.37	1.97

Discussion

Revealed that treatment T_8 – 70:70:55 kg/ha NPK showed early germination (10.00), flowering (80.00) and maturity (140) while, late under T_1 – 40:20:20 kg/ha NPK (13.67), (87.00) and (144) respectively. This result was obtained by Latye *et al.*, 2016 [13] and Jhajhra *et al.*, 2017 [10] in fenugreek. Similar finding was obtained by Ozguven and Sekeroglu 2007 [22] and Yimam *et al.*, 2015 [42].

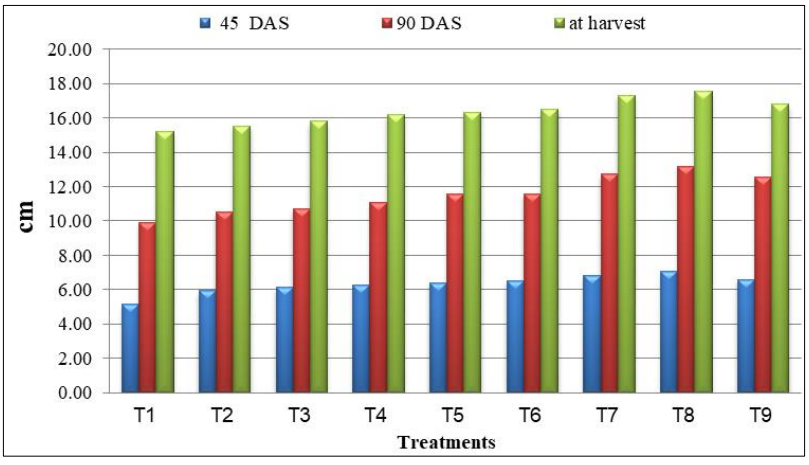

Fig 2: Effect of different levels of NPK on plant height (cm plant^{-1})

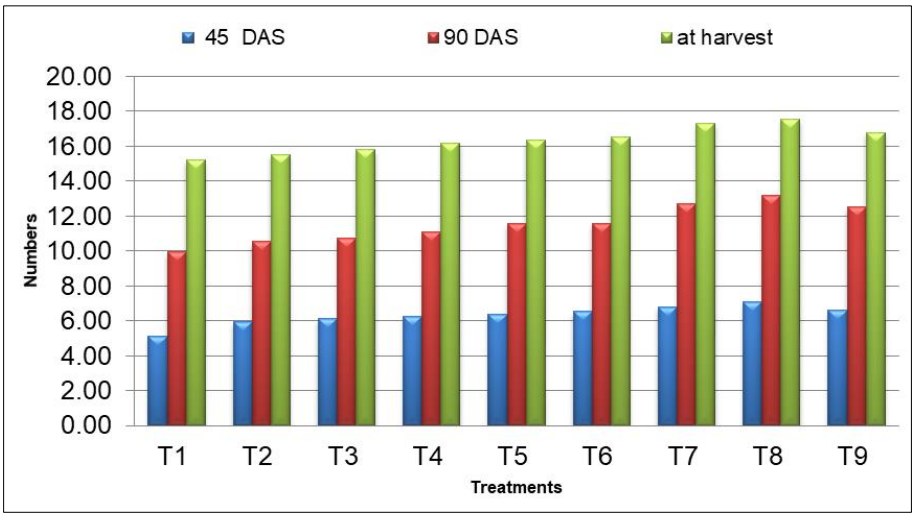

Fig 3: Effect of different levels of NPK on number of branches plant^{-1}

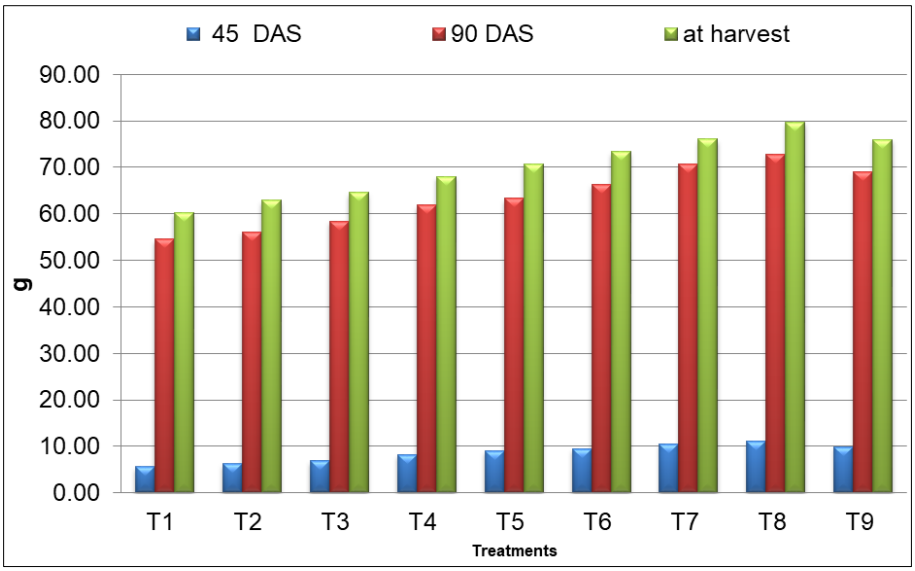

Fig 4: Effect of different levels of NPK on fresh weight of (g plant^{-1}).

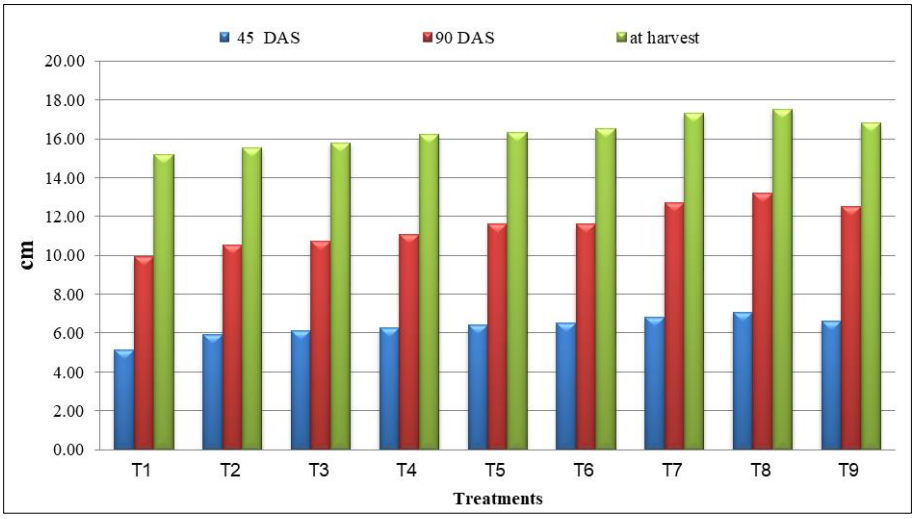

Fig 5: Effect of different levels of NPK on plant height (cm plant^{-1})

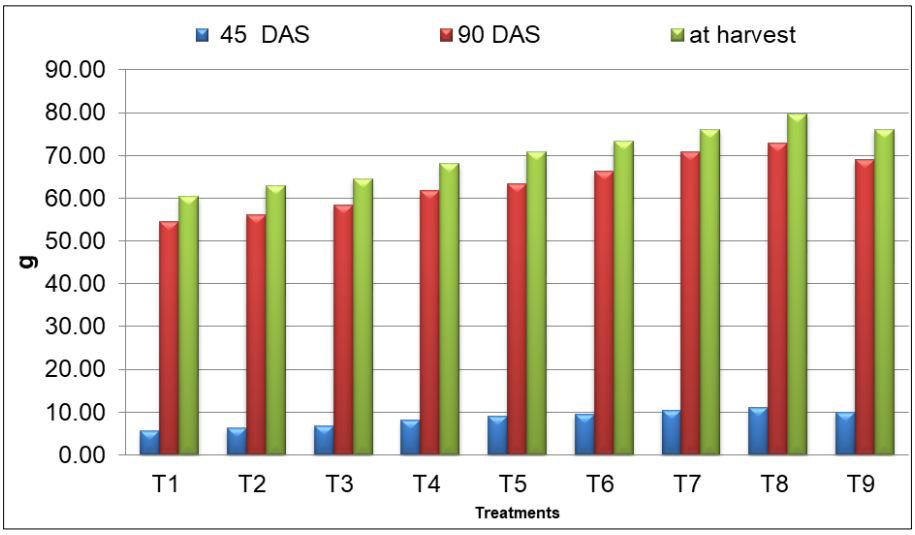

Fig 6: Effect of different levels of NPK on fresh weight of (g plant^{-1})

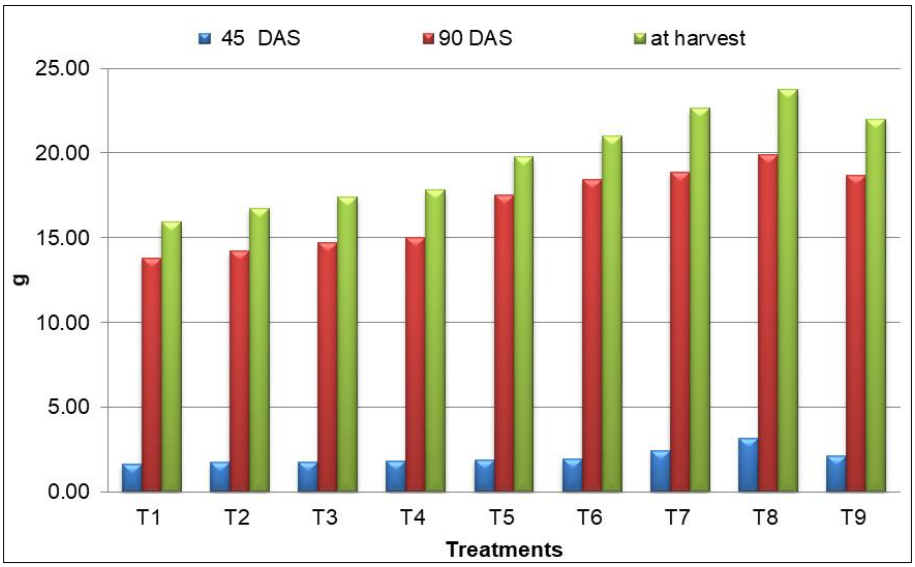

Fig 7: Effect of different levels of NPK on dry weight (g plant-1)

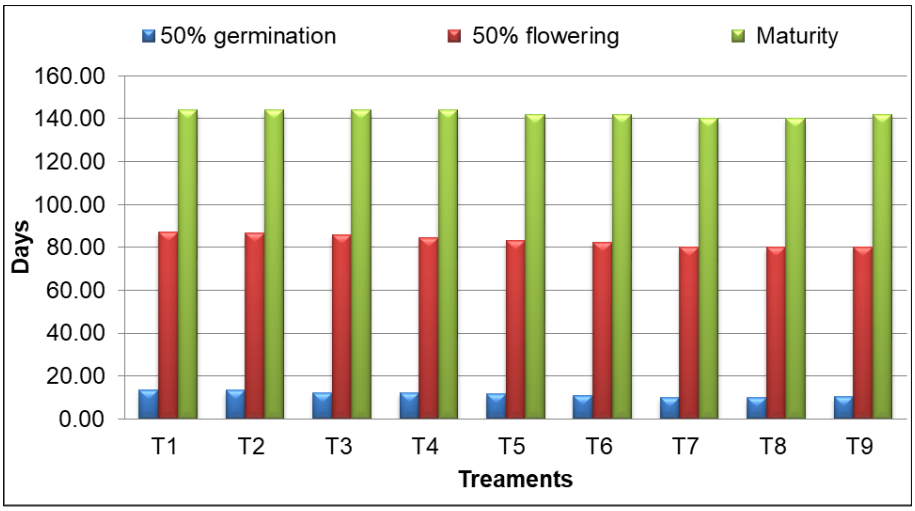

Fig 8: Effect of different levels of NPK on days to 50% germination, days to 50% flowering and days to maturity

Conclusion

Effect of N, P, & K among all the morphological parameters on plant height, number of branches plant^{-1}, fresh weight of plant (g), dry weight of plant (g) and days to 50% germination except fresh weight at harvest, days to 50% flowering and days to maturity with the application of different levels of NPK. However, T_8 - 70:70:55 kg ha^{-1} NPK was recorded with superior values of plant height (11.53, 76.87 and 81.23 cm),

number of branches plant^{-1}(7.07, 13.20 and 17.53), fresh weight (11.08, 72.82 and 79.77 g plant^{-1}), dry weight (3.16, 19.92 and 23.75 g plant^{-1}), days to 50% germination (10.00), days to 50% flowering (80.00) and days to maturity (140) as compared to T_1 - 40:20:20 kg ha^{-1} NPK (recommended dose).

On the basis of one year research and the results reported above it could be concluded that the different levels of NPK significantly and non-significantly influenced the growth attributes of nigella. Hence, out of nine treatments T_8 - 70:70:55 kg ha^{-1} NPK was best comprises for enhanced different morphological parameter of nigella.

References

1. Ali MMK, Hasan MA, Islam MR. Influence of fertilizer levels on the growth and yield of black cumin (*Nigella sativa* L.). The Agriculturist. 2015;13(2):97-104.
2. Ashraf M, Ali Q, Iqbal Z. Effect of nitrogen application rate on the content andcomposition of oil, essential oil and minerals in black cumin (*Nigellasativa* L.) seeds. Journal of the Science of Food and Agriculture. 2006;86(6):871-876.
3. Ayub M, Naeem M, Nadeem MA, Tanveer A, Tahir M, Alam R. Effect of nitrogen application on growth, yield and oil contents of Fennel (*Foenoculum vulgare* Mill.). Journal of Medicinal Plants Research. 2011;5(11):2274-2277.
4. Bommi PV, Jinturkar SP, Barkule SR, Bhosale AM, Syed N. Effect of graded levels of nitrogen and seed rate on growth and flowering of fenugreek (*Trigonella foenum-graecum* Linn) cv. RMT-1. Asian Journal of Horticulture. 2010a;5(2):491-494.
5. Bommi PV, Jinturkar SP, Barkule SR, Bhosale AM, Syed N. Effect of graded levels of nitrogen and seed rate on yield and yield parameters of fenugreek (*Trigonella foenum-gracum* Linn) cv. RMT-1. Asian Journal of Horticulture. 2010b;5(2):469-471.
6. Champawat RS, Pathak VN. Role of nitrogen, Phosphorus and potassium fertilizers and organic amendments in cumin (*Cuminum cyminum* L.) with incites by *Fusarium oxysporum* f. sp. cumin. Indian Journal of Agricultural Science. 1982;58(9):728-730.
7. Davis PH. Nigella L. In: Davis, P.H. (ed.). The Flora of Turkey and East AegeanIslands, 1:98–105. Edinburgh University Press, Edinburgh, 1965.
8. El-Mahrouk EM, Abido AI, Radwan FI, Hamed ES, El-Nagar EE. Vegetative growth and essential oil productivity of lemongrass (*Cymbopogon citratus*) as affected by NPK and some growth stimulators. International Journal of Botany Studies. 2018;3(6):48-55.
9. Hammo YH. Effect of high levels of nitrogen and phospours fertilizer, pinching, and seed rate on growth and yield components of *Nigella sativa* L. 1-vegetative growth and seed yield. Mesopotamia Journal of Agriculture. 2008;36(1):1815-316X.
10. Jhajhra MR, Rana DK, Ola AL. Evaluation of fenugreek (*Trigonella foenum-graecum* L.) varieties under sub-tropical condition of garhwal Himalayas. Chemical Science Review and Letters. 2017;6(22):684-689.
11. Kaheni A, Ramazani SHR, Ganjali HR, Mobaser HR. Effect of nitrogen fertilizer and plant density on yield and its components in Cumin (*Cuminum cyminum* L.) in South Khorasan Province. International Journal of Agriculture and Crop Sciences. 2013;6(5):248-251.
12. Khalid KA, Shedeed MR. Effect of NPK and foliar nutrition on growth, yield and chemical constituents in *Nigella sativa* L. Journal Materials and Environmental Science. 2015;6(6):1709-1714.
13. Latye PT, Bharad SG, Kale VS, Nandeshwar VN, Kholia A. Varietal performance of fenugreek under akola conditions. International Journal of Minor Fruits, Medicinal and Aromatics Plants. 2016;2(1):32-34.
14. Lindley J. Flora Medica, Ajay Book Service, New Delhi, 1981, 1-13.
15. Mehta RS, Patel BS, Meena SS, Meena RS. Influence of nitrogen, phosphorus and bio-fertilizers on growth characters and yield of fenugreek (*Trigonella foenum-graecum* L.). Journal of Spices and Aromatic Crops. 2010;19:1/2:23-28.
16. Metson AJ. Methods of chemical analysis for soil survey samples Bull.No.2, Deptt. Sci. Md. Res. Soil Bur, 1956, 12.
17. Mohamed SA, Medani RA, Khafaga ER. Effect of nitrogen and phosphorus applications with or without micronutrients on black cumin (*Nigella sativ*a L.) plants. Annuals of Agricultural Science (Cairo). 2000;3:1323-1338.
18. Mollafilabi A, Moodi H, Rashed MH, Kafi M. Effect of plant density and nitrogen on yield and yield components of Black cumin (*Nigella sativa* L.). Acta Horticulturae. 2010;853:115-126.
19. Nadakarni KM. Indian Materia Medica, Popular Prakashan Pvt. Ltd., Mumbai. 1976;4:854-856.
20. Nataraj A, Farooqi AA, Sreeramu BS, Srinivasappa KN. Influence of nitrogen, phosphorus and potassium on growth and yield of black cumin (*Nigella sativa* L.) Journal of Spices and Aromatic Crops. 2003;12(1):51-54.
21. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium bicarbonate USDA Circular No. 959. Washington DC, USA, 1954.
22. Ozguven M, Sekeroglu N. Agricultural practices for high yield and quality of black cumin (*Nigella sativa* L.) cultivated in Turkey. Acta Horticulturae. 2007;756:329-337.
23. Piper CS. Soil and plant analysis. Inter Science Publishers Inc. New York, USA, 1950.
24. Rana S, Singh PP, Naruka IS, Rathore SS. Effect of nitrogen and phosphorus on growth, yield and quality of black cumin (*Nigella sativa* L.). International Journal of Seed Spices. 2012;2(2):5-8.
25. Richards LA. Diagnosis and Improvement of Saline and Alkali Soils. USDA Hand book No. 60, 1956.
26. Sammauria R, Yadav RS. Performance of fenugreek (*Trigonella foenum-graecum*)-pearlmillet (*Pennisetum glaucum*) system as influenced by phosphorus and zinc application to fenugreek. Indian Journal of Agronomy. 2010;55(3):197-202.
27. Sathyanarayana E, Hadole SS, Ghawade SM. Effect of nutrient levels on nutrient uptake by Ajwain crop (*Trachyspermum ammi* L. Sprague). International journal of chemical studies. 2017;5(4):1987-1990.
28. Sathyanarayana E, Hadole SS, Laharia GS, Ghawade SM. Effect of nutrient levels on fertility status of soil and quality of ajwain. International Journal of Therapeutic Applications. 2015, 33(4).
29. Shah SH. Influence of nitrogen and phytohormone spray

on seed, inorganic protein and oil yields and oil properties of *Nigella sativa*. Asian Journal of Plant Sciences. 2007a;6(2):364-368.
30. Shah SH. Effects of nitrogen fertilisation on nitrate reductase activity, protein, and oil yields of *Nigella sativa* L. as affected by foliar GA_3 application. Turkish Journal of Botany. 2008;32(2):165-170.
31. Subbiah BV, Asija GL. A rapid procedure for the estimation of available nitrogen in soils. Current Science. 1956;25:259-260.
32. Sultan MT, Butt MS, Anjum FM, Jamil A, Akhtar S, Nasir M. Nutritional profile of indigenous cultivar of black cumin seeds and antioxidant potential of its fixed and essential oil. Pak. J Bot. 2009;41(3):1321-1330.
33. Sultana S, Mondal A, Das S, Rudra BC, Alam B, Roy S. Effect of Nitrogen and Phosphorus fertilizer application on growth and yield of black cumin cultivation in malda district (WB). International Journal of Current Microbiology and Applied Sciences. 2019;8(4):2813-2817.
34. Sushama PK, Jose AL. Nutrition of Ginger. In: Advances in Horticulture Vol.9, Plantation and Spices Crops Part 1 (eds. Chadha, K.L. and Rethinam, P). Malhotra publishing House, New Delhi, 1994, 490-497.
35. Troug E. Mineral nutrition in relation to autogency of plants. In: Nutrition of plants. Oxford and IBH publishers, New Delhi, 1973, 345.
36. Tuncturk M, Tuncturk R, Yildirim B. The effects of varying Phosphorus dose on yield and some yield components of black cumin (*Nigella sativa* L.). Advances in Environmental Biology. 2011;5(2):371-374.
37. Tuncturk R, Tuncturk M, Ciftci V. The Effects of Varying Nitrogen Doses on Yield And Some Yield Components of Black Cumin (*Nigella Sativa* L.). Advances in Environmental Biology. 2012;6(2):855-858.
38. Valiki SRH, Sobhanallah Ghanbari S, Golmohammadzadeh S, Tat OF. The Effect of Vermicompost and NPK Fertilizer on Yield, Growth Parameters and Essential Oil of Fennel (*Foeniculum vulgare*). International Journal of Life Sciences. 2015;9(4):38-43.
39. Varun V, Saravanan SS, Bahadur V. Effect of NPK on growth, seed yield and seed quality of black cumin (*Nigella sativa* L.) cv. Nrcss (Ajmer). International Journal of Chemical Studies. 2020;8(5):897-900.
40. Vijay OP, Malhotra SK. Seed spices in India and world. Seed spices Newsletter. 2002;2(1):1-4.
41. Waskela P, Naruka IS, Shaktawat RPS. Effect of Row Spacing and Level of NPK on Growth and Yield of Fennel (*Foeniculum vulgare*), Journal Krishi Vigyan. 2017;6(1):78-82.
42. Yimam E, Nebiyu A, Mohammed A, Getachew M. Effect of Nitrogen and Phosphorus fertilizers on growth, yield and yield components of black cumin (*Nigella sativa* L.) at konta district, South West Ethiopia. Journal of Agronomy. 2015;14(3):112-120.