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Response of nitrogen and potassium levels on growth and yield of coriander (*Coriandrum sativum* L.)

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Abstract
The study was conducted during the *Rabi* season of 2019–20 at the Vegetable Research Farm, Department of Horticulture, JNKVV, Jabalpur (MP). The treatment combinations consist of three levels of nitrogen (70, 80, and 90 kg ha^{-1}) and four levels of potassium (0, 30, 40, and 50 kg ha^{-1}). The highest growth was observed in treatment combinations of nitrogen 90 kg ha^{-1} and potassium 40 kg ha-1, *viz.*, number of leaves plant^{-1} at 30 DAS (13.97) and at 60 DAS (89.24), length of longest basal leaf (8.91 cm), plant height at 30, 60, and 90 DAS (12.66, 73.68, and 141.40 cm, respectively), and number of branches plant^{-1} at 60 DAS (5.42) and at 90 DAS (8.70). Days taken to 50 percent flowering (59.88 days) and days taken to maturity (44.33 days) (from the date of flowering) were significantly decreased with higher doses of nitrogen. Seed yield (16.04 q/ha) was obtained in coriander.

Keywords: Nitrogen, potassium, growth, yield, coriander

Introduction
Coriander (*Coriandrum sativum* L.) is an aromatic annual herb belonging to the family Apiaceae, a native of the Mediterranean region. Coriander also called "*Dhania"* in *Hindi*, is one of the most important vegetables, spices, and medicinal plants. It is a diploid species with 2n = 22 chromosomes that is cross-pollinated. It is used as a common flavouring substance. The stem, leaves, and fruits have a pleasant aroma. The inflorescence is a compound umbel and usually comprises about five smaller umbellets. Its leaves, as well as fruits, are commonly used raw or dried for culinary applications. Its seed is used in medicine as a carminative, refrigerant, and diuretic. Coriander leaves are a rich source of vitamin C (135 mg/100 g), vitamin A (6918 g/100 g), and protein. Its leaves are used for flavouring curries, sauces, and soups. Dry seeds contain 0.3-0.4% volatile oil, 19.6% non-volatile oil, 1.3% protein, and 24.6% carbohydrates (Iwatani *et al*. 2003) [6]. The volatile oil is used in cosmetic products and beverages. The coriander plant produces two primary products used for flavouring purposes: fresh green herbs and seeds, i.e., spices used in curry powder, pickling spices, sauces, and seasoning. Nitrogen (N) fertilisation is essential for the production of vegetables to ensure sufficient yields and excellent quality. It is involved in photosynthesis, respiration, carbohydrate synthesis, and protein synthesis. It imparts a dark green colour to the leaves and promotes vigorous vegetative growth; more efficient use of available nitrogen can lead to higher productivity (Zhang *et al.* 2015) [18]. Among the primary nutrients, potassium (K) is the second most important nutrient element next to nitrogen for the growth and development of spice crops. Potassium is known to play a vital role in photosynthesis and carbohydrate formulation in spices. Potassium is necessary for young-growing tissues for cell elongation and possibly for cell division (Sadanandan, 1998) [15]. It is well known that potassium is essential for the formation of carbohydrates in spices and for photosynthesis. Additionally, it has been demonstrated that K is essential for the activation of more than 60 enzyme systems in plants. In developing tissues, potassium is required for cell elongation and possibly for cell division. Since potassium is very mobile in plants, it circulates freely and plays a crucial role in maintaining turgor pressure. Additionally, it supports various physiological functions. It raises the yield and quality of spices (Sadanandan, 1993) [16].

Materials and Methods
The experimental material for the present investigation was sown in a Factorial Randomized Block Design was replicated thrice. It was comprised of thirteen treatments to observe growth and yield characters. The treatment combinations consisted of three levels of nitrogen (70, 80, and 90 kg N ha^{-1}) and four levels of potassium (0, 30, 40, and 50 kg K ha^{-1}).

The soil characteristics of the experimental site were Organic Carbon (0.26%), available nitrogen (332.50 kg ha^{-1}), available phosphorus (42.85 kg ha^{-1}), available potash (312.08 kg ha^{-1}), soil pH 7.05, and electrical conductivity (mMhos per cm) 0.16. Coriander seed was sown on 22nd November 2019 and harvested on the last week of March 2020. A basal dose of well-rotten farmyard manure @ 10 tonnes ha^{-1} was incorporated into the soil before one month of sowing. In addition to this, a dose of 50 Kg P_2O_5 ha^{-1} through SSP (Single Super Phosphate), and nitrogen and potassium were applied according to treatments. Potassium was applied as a basal dose through (MOP). Nitrogen was applied in two split doses. Half of the dose of nitrogen was applied as a basal and the remaining half was top-dressed 45 days after sowing. Nitrogen (basal) was applied through Urea and top dressed through Urea. The seeds (fruits) were rubbed to separate the two mericarps (seeds) and were soaked in water for 24 hours to enhance germination. The pure, healthy, disease and insect-free, vigorous, and good-quality coriander seed (Jawahar Dhaniya-10) 9.00 kg ha^{-1} was taken. The seeds were cleaned and broken into two halves and treated with carbendazim 50 WP (2 gm per kg seeds). Seeds were sown in furrows opened at 10 cm, keeping row spacing and covered with soil properly. All necessary intercultural operations were followed as needed by the experiment. Seeds were harvested when half of the fruits on the plant changed from green to brown colour. Then the stalks with seeds were dried in the sun. Seeds were separated by beating with sticks, cleaned by winnowing, and dried properly up to 10% moisture of seed. To avoid the border effect, data on different parameters from five randomly selected plants from each treatment were collected and recorded in time from the inner rows of each plot. The data was collected on plant growth stages at 30, 60, and 90 DAS, number of leaves plant^{-1}, length of longest basal leaf (cm), plant height (cm), number of branches plant^{-1}, days taken to 50% flowering, and days taken to maturity (from date of flowering).

Results and Discussion

Coriander is mainly grown for its leaves and seeds. Due to the increased demand for coriander seed for use in confectionery, perfumery, and medicine, efforts are in progress to improve the seed yield of coriander through breeding programs and fertilizer management, etc. It has been attempted to establish an effect and cause relationship in the light of variable evidence and literature. Optimum fertilization is one of the major factors for improving the seed yield of coriander. Seed yields could be boosted with the application of nitrogen and potassium. It has been attempted to establish an effect and cause relationship in the light of variable evidence and literature. Hence, a need was felt to investigate the response of coriander (Jawahar Dhaniya-10) to the application of different levels of nitrogen and potassium in respect of growth, yield, and yield attributes. Among the studied factors, nitrogen and potassium fertilization had a definite effect on the differentiation of morphometric features of plants included in the evaluation, as well as on the yield-forming abilities of coriander. This might also be attributed to better availability of nutrients in root zone coupled with increased metabolic activity at the cellular levels might have increased the nitrogen and potassium uptake The results of present investigation are in agreements with the findings (Rao *et al.*1983) [14].

Growth Parameters

Effect of Nitrogen

The application of nitrogen had a significant effect on the number of leaves plant^{-1}and it was increased with increasing levels of nitrogen. Because nitrogen promoted apical branching and hence more leaves appeared in the plant. Application of nitrogen significantly increased the number of leaves plant^{-1} (13.97, 89.24) at 30 and 60 DAS, respectively, length of longest basal leaf (8.91 cm), plant height (12.66, 73.68, 141.40 cm) at 30, 60, and 90 DAS, respectively and a number of branches plant^{-1}(5.42, 8.70) at 60 and 90 DAS, and they were more pronounced with and increased level (90 kg ha^{-1}) of nitrogen at all stages of growth, which could be due to higher levels of N may be attributed to the better nutritional environment in the root zone as well as in the plant system. The results of obtained significantly maximum plant height and growth from the application of N (90 kg ha^{-1}) as reported by Bhati (1988) [1]. It is an established fact that nitrogen is one of the essential constituents required for the synthesis of protein, chlorophyll, and other organic compounds of physiological significance in the plant system. Since in the plant system, most of the nitrogen accumulated in the reproductive structure is translocated from vegetative parts, the assumption seems to be justified that nitrogen application leads to increased nitrogen content in the plants right from the stage of crop growth Ghosh *et al.* (1985) [5] was observed that nitrogen increases in growth and yield attributing characters with application of 90 kg ha^{-1} nitrogen. Thus, increased endogenous levels of nitrogen in the plant by virtue of its increased availability in the soil medium and, thereafter, efficient absorption and translocation in growth by way of active cell division and elongation result in greater plant height and a greater number of branches were obtained by Moniruzzaman *et al.* (2014) [13] and Diwan *et al* (2018) [4] in coriander.

Days to 50% flowering and days to maturity were significantly decreased with higher doses of nitrogen. Minimum days to 50% flowering were observed with 90 kg N ha^{-1} (59.88 DAS). This might be due to the fact that days taken to flowering are decided by the C: N ratio. The plants tend to flower earlier with a higher C: N ratio and higher levels of nitrogen enhanced the vegetative growth and delayed the reproductive stage. Nitrogen at 90 kg ha^{-1} took significantly less number of days to maturity (44.33 days from the date of flowering), However, Kirici *et al.* (1997) [7] stated that nitrogen application has positive significant effect on flowers per plant. The days to maturity decreased with the increased levels of nitrogen. This might be due to higher levels of nitrogen-enhanced vegetative growth and delaying the reproductive stage. These findings are contrary to the results obtained by Malav and Yadav (1997) [10], Moniruzzaman *et al.* (2005) [12], Lokhande *et al.* (2015) [9] and Diwan *et al.* (2018) [4], in coriander.

Effect of potassium

The effect of potassium doses on the length of the longest basal leaf and the number of branches plant^{-1} was not found to be significant. It was also found non-significant with respect to the number of leaves plant^{-1} at 30 DAS but found significant at 60 DAS and plant height (cm) at 60 DAS but found significant at 30 and 90 DAS. The maximum number of leaves plant^{-1} and plant height was observed at 50 kg K. The increase plant growht owing to potassium application might be attributed to crucial role in meristematic growth through its effect on the synthesis of hormones war reported by Mishra *et al.* (2016) [11]. The maximum parameters of growth may be due to favorable agro-climatic conditions during the crop growth period, which might have resulted due to better availability of moisture and nutrients, which resulted in luxurious growth due to better availability of potassium was observed by Moniruzzaman *et al.* (2014) [13] and Solanki *et al.* (2017) [17] in coriander.

Table 1: Effect of different nitrogen and potassium levels on growth parameters of coriander

Treatments	Number of leaves plant^{-1}		Plant height (cm)			Number of branches plant^{-1}		Length of longest basal leaf(cm)	Days taken to 50% Flowering	Days to maturity (From date of flowering)	Seed Yield ha^{-1} (q)
	30 DAS	60 DAS	30 DAS	60 DAS	90 DAS	60 DAS	90 DAS				
Nitrogen doses (Kg/ha)											
N70	11.60	67.28	10.55	63.97	120.17	5.07	7.66	8.11	61.55	48.66	13.52
N80	12.97	85.33	11.80	70.55	133.84	5.32	8.20	8.75	60.33	47.22	15.33
N90	13.97	89.24	12.66	73.68	141.40	5.42	8.70	8.91	59.88	44.33	16.04
S.Em.±	0.22	1.54	0.09	2.04	1.95	0.13	0.13	0.21	0.38	0.52	0.46
C.D.@ 5%	0.69	4.68	0.30	6.18	5.91	NS	0.41	0.65	1.15	1.57	1.41
Potassium doses (Kg/ha)											
K30	12.46	72.17	11.11	65.68	125.66	5.13	8.00	8.47	60.88	47.44	13.93
K30	13.02	84.40	11.93	71.22	134.46	5.33	8.26	8.60	60.44	46.55	15.38
K30	13.06	85.28	11.97	71.31	135.28	5.35	8.31	8.70	60.44	46.22	15.56
S.Em.±	0.22	1.54	0.09	2.04	1.95	0.13	0.13	0.21	0.38	0.52	0.46
C.D.@ 5%	NS	4.60	0.30	NS	5.91	NS	NS	NS	NS	NS	1.41

Conclusion

Based on the conducted study, it may be concluded that the coriander variety Jawahar Dhaniya-10 responded well in terms of morphological and growth characteristics. The treatment combination $N_{90}K_{40}$ was found significantly superior in morphological and growth characteristics. Thus, from the growth, point of view, it is concluded that for securing higher growth, the coriander crop should be fertilized with a 90 kg N ha^{-1} and 40 kg K ha^{-1} treatment combination.

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