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Influence of nitrogen and phosphorus levels on the yield attributes and yield of coriander in *Inceptisol* of Raigarh District, Chhattisgarh

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Abstract
The present study was conducted during the Rabi seasons of 2021-22 and 2022-23 to evaluate the influence of varying nitrogen and phosphorus levels on the yield attributes and yield of coriander (*Coriandrum sativum* L.) grown in the *Inceptisols* of Raigarh district, Chhattisgarh. The experiment was laid out in a factorial randomized block design with sixteen treatment combinations comprising four nitrogen levels (0, 30, 60, and 90 kg N ha^{-1}) and four phosphorus levels (0, 30, 60, and 90 kg P_2O_5 ha^{-1}), replicated thrice. Results revealed that both nitrogen and phosphorus exerted significant effects on key yield-attributing traits, including number of umbels per plant, umbel length, umbel weight, and number of umbellets per umbel. The highest values for all these parameters were consistently recorded under the application of 90 kg N ha^{-1} and 90 kg P_2O_5 ha^{-1}. Seed and stover yields also increased significantly with increasing nutrient levels, with maximum yields obtained under the highest nitrogen and phosphorus treatments. However, the interaction between nitrogen and phosphorus was found to be non-significant for all measured parameters. The study concludes that the combined application of 90 kg N ha^{-1} and 90 kg P_2O_5 ha^{-1} is optimal for maximizing coriander productivity under the nutrient-deficient *Inceptisols* of Raigarh district. These findings highlight the importance of balanced nutrient management for enhancing yield, soil fertility, and economic returns for coriander growers in the region.

Keywords: Coriander, nitrogen fertilization, phosphorus fertilization, *Inceptisol* soil, nutrient management, crop yield, growth performance, soil fertility

1. Introduction
Coriander (*Coriandrum sativum* L.), popularly known as “Dhania,” is an important seed spice and leafy herb of the family Apiaceae. Cultivated widely across diverse Agro-climatic regions of India, it serves multiple purposes due to its aromatic leaves and essential oil-rich seeds, making it valuable for culinary, medicinal, and industrial uses. India is the world’s largest producer, consumer, and exporter of coriander, with 6.64 lakh hectares under cultivation and 8.61 lakh metric tonnes of annual production. Major producing states include Madhya Pradesh, Rajasthan, Gujarat, Andhra Pradesh, Tamil Nadu, and Uttar Pradesh.

In Chhattisgarh, coriander is grown mainly during the rabi season by small and marginal farmers under rainfed or low-input conditions. The state has 14,988 hectares under coriander with a production of 66,299 metric tonnes, and Raigarh district contributes significantly with over 6,272 hectares under spice crops. However, productivity remains low due to poor soil fertility, traditional varieties, and inadequate nutrient management practices. The region is dominated by Inceptisols-moderately weathered, coarse-textured soils deficient in nitrogen (N) and phosphorus (P), two essential nutrients for coriander growth.

Soil fertility decline due to nutrient mining and imbalanced fertilizer use has emerged as a major concern across Indian Agro-ecosystems. Nitrogen plays a critical role in chlorophyll formation, photosynthesis, vegetative growth, and seed development, while phosphorus is essential for root proliferation, energy transfer, flowering, and seed setting. Deficiencies of these nutrients severely limit coriander yield, whereas balanced application improves biomass, seed yield, essential oil content, and nutrient use efficiency (Pawar *et al.* 2007; Gour *et al.* 2009) [23, 10].

Despite coriander's economic importance, region-specific nutrient management studies are limited, particularly in Chhattisgarh. Therefore, optimizing nitrogen and phosphorus levels for Inceptisol-based coriander cultivation is essential to enhance productivity, profitability, and soil health in Raigarh district.

2. Materials and Methods

The field experiment was conducted during the Rabi seasons of 2021-22 and 2022-23 to evaluate the effect of nitrogen and phosphorus levels on the growth and yield attributes of coriander. The study used the variety *Chhattisgarh Shri Chandrahashini Dhaniya-2* and was laid out in a factorial Randomized Block Design (FRBD). The experiment included four nitrogen levels (0, 30, 60, and 90 kg N ha^{-1}) and four phosphorus levels (0, 30, 60, 90 kg P_2O_5 ha^{-1}), resulting in sixteen treatment combinations replicated three times, giving a total of forty-eight plots. The gross and net plot sizes were 12.0 m^2 (4.0 × 3.0 m) and 7.2 m^2 (3.0 × 2.4 m), respectively. Soil samples were collected before sowing to assess baseline fertility. Sowing was done at a row spacing of 20 cm × 15 cm using a seed rate of 12 kg ha^{-1}. Phosphorus was applied as a basal dose according to treatments, while nitrogen was supplied in split applications to maximize nutrient availability. Standard agronomic practices, including irrigation, weed control, and plant protection measures, were uniformly followed across all treatments. Crop growth and development were closely monitored throughout both seasons to ensure accurate assessment of treatment effects.

Data on key parameters-number of umbels per plant, umbel length, umbel weight, number of umbellets per umbel, test weight, seed yield, and stover yield-were recorded from five randomly selected plants in each plot. Observations were averaged and subjected to statistical analysis using analysis of variance (ANOVA) appropriate for a factorial RBD. Treatment means were compared using the standard error of mean (SEm) and critical difference (CD) at the 5% level of significance to determine the influence of nitrogen and phosphorus levels.

3. Results

The data regarding as influenced by various nitrogen and phosphorus levels has been presented in Table 1 to 7.

3.1 Number of umbels plant^{-1}

Nitrogen levels

The coriander cultivated with nitrogen level of N_4 (90 kg N ha^{-1}) recorded significantly highest number of umbels plant^{-1} (17.83,19.84 and 18.83), while the lowest number of umbels plant^{-1} was recorded under N_1 (0 kg N ha^{-1}) (12.96, 14.06 and 13.51) during the 2021-22, 2022-23 and on mean basis, respectively.

Number of umbels per plant increased significantly with the application of highest nitrogen level of 90 kg N ha^{-1} owing to better vegetative growth and branching. Maximum nitrogen facilitated more nodes bearing higher number of umbels. Minimum umbels were recorded with no nitrogen application signifying the critical role of nitrogen in promoting higher branching and in turn umbel formation. Thus, adequate nitrogen is important for increased umbel production in coriander. The finding of present study is in accordance with those of Diwan *et al.* (2018) [8] and Choudhary *et al.* (2020) [5].

Phosphorus levels

The crop with phosphorus levels of P_4 (90 kg P ha^{-1}) showed significantly highest number of umbels plant^{-1} i.e. 17.35, 19.27 and 18.31, while the lowest number of umbels plant^{-1} was recorded under P_1 (0 kg P ha^{-1}) (13.30, 14.54, 13.92) during both the years and on mean basis, respectively.

The number of umbels per plant increased significantly with the highest phosphorus level of 90 kg P ha^{-1} owing to better vegetative growth and maximum branching. Higher phosphorus application resulted in more nodes producing higher umbels. Minimum phosphorus led to least umbel formation indicating the important role of phosphorus in promoting branching and umbel bearing capacity. Thus, adequate phosphorus is critical for increased umbel production in coriander. The finding of present study is in accordance with those of Mohammad *et al.* (2011) [20] and Dadiga *et al.* (2015) [6].

Interaction (N x P)

Interaction effect of nitrogen and phosphorus levels was found non-significant with respect to number of umbels plant^{-1} during the years 2021-22, 2022-23 and on mean basis.

3.2 Length of umbel (cm)

Nitrogen levels

The significant variations in the length of umbel were observed due to the different nitrogen levels. Coriander subjected to nitrogen level of N_4(90 kg N ha^{-1}) produced significantly maximum length of umbel (10.22,10.72 and 10.47 cm) during 2021-22, 2022-23 and on mean basis, respectively which was however at par with the treatment N_3(60 kg N ha^{-1}) during the year 2021-22. The minimum length of umbel was recorded under N_1 (0 kg N ha^{-1}) (9.20, 9.51 and 9.35 cm) during 2021-22, 2022-23 and on mean basis, respectively.

Long umbels were recorded with the application of 90 kg N ha^{-1} because nitrogen is considered to be a vitally important plant nutrient. In addition to its role in the formation of proteins, nitrogen is an integral part of chlorophyll, which is the primary absorber of light energy needed for photosynthesis. Besides these, it is also a constituent of certain organic compounds of physiological importance (Saryam *et al.* 2023) [26]. Thus, adequate nitrogen ensured increased photosynthate translocation resulting in improved umbel dimensions in coriander. Similar results were also observed by Bairwa and Khandelwal (2013) [2].

Phosphorus levels

The significant variations in the length of umbel also were observed as a result of different phosphorus levels. Significantly maximum length of umbel of coriander was recorded under the treatment of P_4 (90 kg P ha^{-1}) (10.13,10.59 and 10.36cm), which was at par with treatment P_3 (60 kg P ha^{-1}) (9.99, 10.47 and 10.23cm) during the year 2021-22, 2022-23 and on mean basis, respectively. However, it was also at par with the treatment P_2 (30 kg P ha^{-1}) during 2022-23. The lowest length of umbel was recorded under P_1 (0 kg P ha^{-1}) (9.29, 9.42 and 9.35cm) during 2021-22, 2022-23 and on mean basis, respectively.

The significant variations in umbel length of coriander observed under different phosphorus levels can be attributed to the essential role of phosphorus in plant growth, particularly in reproductive development. Phosphorus is crucial for energy transfer (ATP), photosynthesis, and the synthesis of nucleic acids, all of which support vigorous root growth and enhanced nutrient uptake. These processes lead to improved carbohydrate translocation and meristematic activity, promoting greater floral organ development, including longer umbels. The maximum umbel length recorded under P_4 (90 kg P ha^{-1}) was due to optimal phosphorus availability, which stimulated better flowering. These findings are supported by Havlin*et al.* (2013) [11], who emphasize phosphorus's critical role in enhancing reproductive growth and yield-related traits. Similar results were reported by Nisarata*et al.* (2020) [21].

Interaction (N x P)

The interaction effect of nitrogen and phosphorus levels were found to be non- significant with respect to length of umbel of coriander during the both the years and on mean basis.

3.3 Average weight of umbel (g)

Nitrogen levels

The data indicated that the average weight of umbel was observed significantly maximum under the treatment N_4 (90 kg N ha^{-1}) i.e. 0.47, 0.53 and 0.50g, while the lowest weight of umbel was observed in treatment N_1 (0 kg N ha^{-1}) i.e. 0.33, 0.37 and 0.35g) during the 2021-22, 2022-23 and on mean basis, respectively.

The significant increase in umbel weight of coriander under the N_4 treatment (90 kg N ha^{-1}) can be scientifically attributed to the vital role of nitrogen in promoting vegetative growth, chlorophyll synthesis and protein formation, which collectively enhance the plant's photosynthetic efficiency and biomass accumulation. Adequate nitrogen availability ensures improved nutrient uptake, leading to greater assimilation of carbohydrates and their translocation to reproductive structures like umbels, thereby increasing their weight. These effects are consistent with findings from Sahu *et al.* (2013) [25] and Marschner (2012) [18], who highlight nitrogen's key role in supporting both vegetative and reproductive growth phases in crop plants.

Phosphorus levels

The data regarding weight of umbel at different phosphorus levels clearly shows that significantly highest weight of umbel (0.46, 0.52 and 0.49g) was observed in treatment P_4(90 kg P ha^{-1}), while the lowest weight of umbel was observed in treatment P_1 (0 kg P ha^{-1}) (0.34, 0.38 and 0.36g) during 2021-22, 2022-23 and on mean basis, respectively.

The significant increase in average umbel weight of coriander with the application of 90 kg P ha^{-1} was due to phosphorus enhancing energy transfer, root development, and nutrient uptake, which support better carbohydrate production and allocation to reproductive parts. This results in fuller, heavier umbels. Also, similar results were reported by Singh (2015) [27]. Similarly, greater yield attributes of coriander under higher dose of phosphorus were also reported by Singh and Singh (2019) [28].

Interaction (N x P)

The weight of umbel of coriander was found to be non-significant due to the interaction effect of nitrogen and phosphorus levels during both the years and their pooled mean.

3.4 Number of umbellets umble^{-1}

Nitrogen levels

Among the nitrogen levels significantly highest number of umbellets umble^{-1} (4.52, 5.07 and 4.79) was observed in treatment N_4 (90 kg N ha^{-1}), which was found to be at par with the treatment N_3 (60 kg N ha^{-1}) (4.32, 4.89 and 4.60). While the least number of umbellets umble^{-1}of (3.94, 4.32 and 4.13) was observed in treatment N_1 (0 kg N ha^{-1}) during 2021-22, 2022-23 and on mean basis, respectively.

The number of umbellets and umbels per plant increased significantly with the application of the highest nitrogen level (90 kg N ha^{-1}), primarily due to nitrogen's role in promoting vigorous vegetative growth, enhanced branching, and improved plant architecture. Sufficient nitrogen availability supports greater nodal development and lateral shoot formation, thereby facilitating a higher number of umbels per plant. In contrast, the minimum number of umbels observed under zero nitrogen application highlights nitrogen's essential function in regulating morphological traits associated with reproductive capacity in coriander. These outcomes are consistent with findings of Lal *et al.* (2020) [16] and Manvi *et al.* (2023) [17].

Phosphorus levels

Amongst phosphorus levels, the significantly highest number of umbellets umble^{-1}(4.46, 5.02 and 4.74) was observed in treatment P_4 (90 kg P ha^{-1}), which was at par with the treatment P_3 (60 kg P ha^{-1}) (4.33, 4.88 and 4.60). While the least number of umbellets umble^{-1}of 3.97, 4.37 and 4.17) was observed in treatment P_1 (0 kg P ha^{-1}) during 2021-22, 2022-23 and on mean basis, respectively.

The number of umbellets and umbels per plant increased significantly with the application of the highest phosphorus level (90 kg P ha^{-1}), attributed to enhanced vegetative growth, improved root development, and increased nodal proliferation. Adequate phosphorus availability promotes efficient energy transfer and carbohydrate metabolism, which support optimal branching and biomass partitioning toward reproductive structures, thereby increasing umbel formation per plant. Conversely, the lowest number of umbels under zero phosphorus application underscores its crucial role in regulating plant architecture and reproductive efficiency in coriander. Similar study was also observed by Meena *et al.* (2006) [19] and Pooja *et al.* (2017) [24].

Interaction (N x P)

The interaction effect of nitrogen and phosphorus levels found to be non- significant with respect to number of umbellets umbel^{-1}, during both the years as well as on mean basis.

3.5 Test weight (g)

Nitrogen levels

Test weight of coriander was not significantly affected by nitrogen application during both years and in the pooled analysis. However, the highest test weight was recorded under N_2 (30 kg N ha^{-1}) in 2021-22 and in the mean (11.75 g), while in 2022-23 it was highest under N_4 (90 kg N ha^{-1}) at 11.79 g. Although statistically non-significant, nitrogen application at 30-90 kg ha^{-1} tended to maintain higher test weights compared to the control. These findings suggest that nitrogen had a marginal influence on seed development in coriander, corroborating the results reported by Chaudhary *et al.* (2011) and Deshmukh *et al.* (2020) [7].

Phosphorus levels

Phosphorus application did not exert a statistically significant effect on the test weight of coriander during either year or in the pooled data. In 2021-22, the highest test weight (11.73 g) was observed with 90 kg P ha^{-1} (P_4), whereas in 2022-23 and in the pooled mean, the highest values were noted under 30 kg P ha^{-1} (P_2), at 11.74 g and 11.65 g, respectively. Despite the lack of significance, phosphorus application between 30-90 kg ha^{-1} was associated with relatively higher test weights compared to the untreated control, suggesting a subtle positive influence on seed filling and maturation.

Interaction (N x P)

Interaction effect of both the factors i.e. nitrogen and phosphorus levels were found to be non-significant with respect to test weight of coriander during both the years and pooled mean.

3.6 Seed yield (q ha^{-1})

Nitrogen levels

The coriander sown under nitrogen levels of N_4 (90 kg N/ha) produced significantly more seed yield (q ha^{-1}) with mean values of (16.58 q ha^{-1}, 17.29 q ha^{-1}, 16.93 q ha^{-1}) during the year 2021-22, 2022-23 and pooled mean Respectively data. Which was at par with the treatment N_3 (60 kg N/ha) value of (14.85 q ha^{-1}, 15.21 q ha^{-1}, 15.03 q ha^{-1}). Conversely, the lowest seed yield (q ha^{-1}) was recorded under N_1 (0 kg N/ha) at nitrogen levels values of (7.77 q ha^{-1}, 8.54 q ha^{-1}, 8.15 q ha^{-1}) during the 2021-22, 2022-23 and pooled mean. Respectively.

The seed yield increased significantly with the highest nitrogen level of 90 kg N/ha owing to its influence in improving yield attributes. Maximum nitrogen facilitated optimal partitioning of photosynthates towards seed yield. Minimum seed yield was recorded with no nitrogen application signifying its crucial role in dry matter translocation and yield. Adequate nitrogen ensured higher photosynthate production and harvest index for greater seed yield in coriander. The finding of present study is in accordance with those of Pooja *et al.* (2017) [24] and Javiya *et al.* (2017) [14].

Phosphorus levels

The coriander sown under phosphorus levels of P_4 (90 kg P/ha) produced significantly more seed yield (q ha^{-1}) with mean values of (15.31 q ha^{-1}, 15.96 q ha^{-1}, 15.64 q ha^{-1}) during the year 2021-22, 2022-23 and pooled mean Respectively data. Which was at par with the treatment P_3 (60 kg P/ha) value of (14.38 q ha^{-1}, 14.76 q ha^{-1}, 14.57 q ha^{-1}). Conversely, the lowest seed yield (q ha^{-1}) was recorded under P_1(0 kg P/ha) at phosphorus levels values of (9.00 q ha^{-1}, 9.51 q ha^{-1}, 9.25 q ha^{-1}) during the 2021-22, 2022-23 and pooled mean. Respectively.

The seed yield increased significantly with the highest phosphorus level of 90 kg P/ha owing to its role in influencing yield contributing components. Maximum phosphorus facilitated optimum partitioning of photosynthates to seeds resulting in higher yield. Minimum yield was recorded with no phosphorus application indicating its key role in translocation and productivity. Adequate phosphorus ensured higher photosynthate production and harvest index for greater seed yield in coriander. Similar results were reported by Pooja *et al.* (2017) [24] and Choudhary *et al.* (2020) [5].

Interaction (N x P)

Interaction effect of both the factors found non- significant for seed yield (q ha^{-1}) at all the stages, during the 2021-22, 2022-23 and Pooled mean respectively.

3.7 Stover yield (q ha^{-1})

Nitrogen levels

The data on stover yield (q ha^{-1}) of N_4 (90 kg N/ha) value ranges from (29.68 q ha^{-1}, 32.04 q ha^{-1}, 30.86 q ha^{-1}) during the year 2021-22, 2022-23 and pooled mean Respectively data. Which was at par with the treatment N_3 (60 kg N/ha) value of (26.51 q ha^{-1}, 28.13 q ha^{-1}, 27.32 q ha^{-1}). Conversely, the lowest stover yield (q ha^{-1}) was recorded under N_1(0 kg N/ha) at nitrogen levels values of (14.05 q ha^{-1}, 16.03 q ha^{-1}, 15.04 q ha^{-1}) during the 2021-22, 2022-23 and pooled mean. Respectively.

The stover yield increased significantly with the highest nitrogen level of 90 kg N/ha owing to its role in enhancing vegetative growth. Maximum nitrogen supply facilitated higher dry matter partitioning into stover. Minimum stover yield was observed with no nitrogen application signifying its importance in improving biomass production. Adequate nitrogen ensured increased photosynthate synthesis leading to greater stover yield in coriander. Similar results were reported by Javiya *et al.* (2017) [14].

Phosphorus levels

The data on stover yield (q ha^{-1}) of P_4 (90 kg P/ha) value ranges from (27.37 q ha^{-1}, 29.52 q ha^{-1}, 28.45 q ha^{-1}) during the year 2021-22, 2022-23 and pooled mean Respectively data. Which was at par with the treatment P_3 (60 kg P/ha) value of (25.66 q ha^{-1}, 27.35 q ha^{-1}, 26.51 q ha^{-1}). Conversely, the lowest stover yield (q ha^{-1-}) was recorded under P_1 (0 kg P/ha) at phosphorus values of (16.23 q ha^{-1}, 17.78 q ha^{-1}, 17.00 q ha^{-1}) during the 2021-22, 2022-23 and pooled mean. Respectively.

The stover yield increased significantly with the highest phosphorus level of 90 kg P/ha due to its role in boosting vegetative growth. Maximum phosphorus aided optimum photosynthate partitioning into stover biomass. Minimum stover yield was noted with no phosphorus application highlighting its importance in dry matter production. Adequate phosphorus ensured higher photosynthate production leading to greater stover yield in coriander. Also, similar results were reported by Choudhary *et al.* (2020) [5].

Interaction (N x P)

Interaction effect of both the factors found non- significant for seed yield (q ha^{-1}) at all the stages, during the 2021-22, 2022-23 and pooled mean respectively.

Table 1: Effect of nitrogen and phosphorous levels on number of umbels $plant^{-1}$ of coriander.

Treatment	Number of umbels $plant^{-1}$		
	2021-22	2022-23	Pooled Mean
Nitrogen levels			
N_1- 0 kg N ha^{-1}	12.96d	14.06d	13.51d
N_2- 30 kg N ha^{-1}	15.19c	17.04c	16.12c
N_3- 60 kg N ha^{-1}	16.51b	18.42b	17.46b
N_4- 90 kg N ha^{-1}	17.83a	19.84a	18.83a
S.Em ±	0.21	0.21	0.008
CD (P=0.05)	0.61	0.61	0.024
Phosphorus levels			
P_1- 0 kg P ha^{-1}	13.30d	14.54d	13.92d
P_2- 30 kg P ha^{-1}	15.30c	17.05c	16.17c
P_3- 60 kg P ha^{-1}	16.55b	18.50b	17.52b
P_4- 90 kg P ha^{-1}	17.35a	19.27a	18.31a
S.Em ±	0.21	0.21	0.008
CD (P=0.05)	0.61	0.61	0.024
Interaction (N x P)			
S.Em ±	0.42	0.42	0.017
CD (P=0.05)	NS	NS	NS

Table 2: Effect of nitrogen and phosphorous levels on length of umbel of coriander

Treatment	Length of umbel (cm)		
	2021-22	2022-23	Pooled Mean
Nitrogen levels			
N_1- 0 kg N ha^{-1}	9.20c	9.51c	9.35c
N_2- 30 kg N ha^{-1}	9.678b	10.24b	9.96b
N_3- 60 kg N ha^{-1}	10.01ab	10.25b	10.13b
N_4- 90 kg N ha^{-1}	10.22a	10.72a	10.47a
S.Em ±	0.14	0.12	0.09
CD (P=0.05)	0.41	0.37	0.28
Phosphorus levels			
P_1- 0 kg P ha^{-1}	9.29c	9.42b	9.35c
P_2- 30 kg P ha^{-1}	9.70b	10.24a	9.97b
P_3- 60 kg P ha^{-1}	9.99ab	10.47a	10.23ab
P_4- 90 kg P ha^{-1}	10.13a	10.59a	10.36a
S.Em ±	0.14	0.12	0.09
CD (P=0.05)	0.41	0.37	0.28
N x P			
S.Em ±	0.28	0.25	0.19
CD (P=0.05)	NS	NS	NS

Table 3: Effect of nitrogen and phosphorous levels on weight of umbel of coriander.

Treatment	Average weight of umbel (g)		
	2021-22	2022-23	Pooled Mean
Nitrogen levels			
N_1- 0 kg N ha^{-1}	0.33d	0.37d	0.35d
N_2- 30 kg N ha^{-1}	0.40c	0.46c	0.43c
N_3- 60 kg N ha^{-1}	0.44b	0.50b	0.47b
N_4- 90 kg N ha^{-1}	0.47a	0.53a	0.50a
S.Em ±	0.008	0.006	0.005
CD (P=0.05)	0.024	0.017	0.014
Phosphorus levels			
P_1- 0 kg P ha^{-1}	0.34d	0.38d	0.36d
P_2- 30 kg P ha^{-1}	0.40c	0.46c	0.43c
P_3- 60 kg P ha^{-1}	0.43b	0.49b	0.46b
P_4- 90 kg P ha^{-1}	0.46a	0.52a	0.49a
S.Em ±	0.008	0.006	0.005
CD (P=0.05)	0.024	0.017	0.014
Interaction (N x P)			
S.Em ±	0.017	0.012	0.010
CD (P=0.05)	NS	NS	NS

Table 4: Effect of nitrogen and phosphorous levels on number of umbellets umble^{-1}of coriander.

Treatment	Number of umbellets umble^{-1}		
	2021-22	2022-23	Pooled Mean
Nitrogen levels			
N_1- 0 kg N ha^{-1}	3.94c	4.32c	4.13c
N_2- 30 kg N ha^{-1}	4.14bc	4.62b	4.38b
N_3- 60 kg N ha^{-1}	4.32ab	4.89a	4.60a
N_4- 90 kg N ha^{-1}	4.52a	5.07a	4.79a
S.Em ±	0.07	0.07	0.07
CD (P=0.05)	0.21	0.20	0.20
Phosphorus levels			
P_1- 0 kg P ha^{-1}	3.97c	4.37c	4.17c
P_2- 30 kg P ha^{-1}	4.16bc	4.62b	4.39b
P_3- 60 kg P ha^{-1}	4.33ab	4.88a	4.60a
P_4- 90 kg P ha^{-1}	4.46a	5.02a	4.74a
S.Em ±	0.07	0.07	0.07
CD (P=0.05)	0.21	0.20	0.20
N x P			
S.Em ±	0.14	0.14	0.14
CD (P=0.05)	NS	NS	NS

Table 5: Effect of nitrogen and phosphorous levels on test weight of coriander.

Treatment	Test weight (g)		
	2021-22	2022-23	Pooled Mean
Nitrogen levels			
N_1- 0 kg N ha^{-1}	11.55	11.35	11.45
N_2- 30 kg N ha^{-1}	11.75	11.76	11.75
N_3- 60 kg N ha^{-1}	11.62	11.41	11.51
N_4- 90 kg N ha^{-1}	11.50	11.79	11.64
S.Em ±	0.10	0.19	0.10
CD (P=0.05)	NS	NS	NS
Phosphorus levels			
P_1- 0 kg P ha^{-1}	11.59	11.44	11.51
P_2- 30 kg P ha^{-1}	11.57	11.74	11.65
P_3- 60 kg P ha^{-1}	11.53	11.71	11.62
P_4- 90 kg P ha^{-1}	11.73	11.41	11.57
S.Em ±	0.10	0.19	0.10
CD (P=0.05)	NS	NS	NS
N x P			
S.Em ±	0.20	0.39	0.20
CD (P=0.05)	NS	NS	NS

Table 6: Effect of nitrogen and phosphorous levels on seed yield (q ha^{-1})

Treatment Details	Seed yield (q ha^{-1})		
	2021-22	2022-23	Pooled Mean
Nitrogen levels			
N_1- 0 kg N/ha	7.77	8.54	8.15
N_2- 30 kg N/ha	11.91	12.23	12.07
N_3- 60 kg N/ha	14.85	15.21	15.03
N_4- 90 kg N/ha	16.58	17.29	16.93
S.Em ±	0.26	0.22	0.18
CD = (P=0.05)	0.75	0.64	0.52
Phosphorus levels			
P_1- 0 kg P/ha	9.00	9.51	9.25
P_2- 30 kg P/ha	12.42	13.04	12.73
P_3- 60 kg P/ha	14.38	14.76	14.57
P_4- 90 kg P/ha	15.31	15.96	15.64
S.Em ±	0.26	0.22	0.18
CD = (P=0.05)	0.75	0.64	0.52
Interaction (N x P)			
S.Em ±	0.52	0.43	0.36
CD = (P=0.05)	NS	NS	NS

Table 7: Effect of nitrogen and phosphorous levels on stover yield (q ha^{-1})

Treatment Details	Stover yield (q ha^{-1})		
	2021-22	2022-23	Pooled Mean
Nitrogen levels			
N_1- 0 kg N/ha	14.05	16.03	15.04
N_2- 30 kg N/ha	21.26	22.60	21.93
N_3- 60 kg N/ha	26.51	28.13	27.32
N_4- 90 kg N/ha	29.68	32.04	30.86
S.Em ±	0.34	0.36	0.26
CD = (P=0.05)	1.00	1.05	0.76
Phosphorus levels			
P_1- 0 kg P/ha	16.23	17.78	17.00
P_2- 30 kg P/ha	22.24	24.13	23.18
P_3- 60 kg P/ha	25.66	27.35	26.51
P_4- 90 kg P/ha	27.37	29.52	28.45
S.Em ±	0.34	0.36	0.26
CD = (P=0.05)	1.00	1.05	0.76
Interaction (N x P)			
S.Em ±	0.69	0.72	0.53
CD = (P=0.05)	NS	NS	NS

4. Conclusion

The study demonstrated that nitrogen and phosphorus levels had a significant and positive influence on the growth and yield attributes of coriander grown under Inceptisol conditions of Raigarh district. Application of the highest nutrient levels-90 kg N ha^{-1} and 90 kg P_2O_5 ha^{-1}-consistently produced the maximum number of umbels per plant, greater umbel length and weight, higher number of umbellets per umbel, and significantly superior seed and stover yields across both years. Improved nutrient supply enhanced vegetative growth, branching, nutrient uptake, and photosynthate translocation, all contributing to better reproductive performance and yield. In contrast, nutrient-deficient control plots recorded the lowest values for all parameters, underscoring the essential role of nitrogen and phosphorus in coriander productivity. Although both nutrients independently influenced most traits significantly, their interaction remained non-significant. Overall, the results indicate that applying 90 kg N ha^{-1} and 90 kg P_2O_5 ha^{-1} is optimal for maximizing coriander yield and ensuring efficient nutrient use in the *Inceptisols* of Raigarh district, Chhattisgarh.

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6. Conflict of Interest

The authors declare that there is no conflict of interest associated with this study. The research was conducted independently, without any financial or commercial influence that could bias the findings.

7. Future scope

- Further experiments can be conducted to determine the optimum combination of nitrogen and phosphorus for maximizing coriander yield and umbel production under different soil and climatic conditions.
- Long-term studies should assess the residual effects of nitrogen and phosphorus fertilization on soil fertility, microbial activity, and subsequent crops in crop rotation systems.
- Research can focus on the integration of organic manures and biofertilizers with nitrogen and phosphorus to improve nutrient use efficiency and promote sustainable coriander cultivation.
- Studies on nutrient uptake dynamics and their correlation with umbel formation and essential oil yield could provide deeper physiological insights.
- Field trials using site-specific nutrient management (SSNM) and precision farming tools can optimize fertilizer doses while reducing input costs and environmental impact.
- Experiments evaluating split application or foliar feeding of nitrogen and phosphorus may enhance umbel weight, length, and number per plant.
- Genetic studies can identify varieties with higher nutrient use efficiency under varied nitrogen and phosphorus regimes.

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