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Effect of Different Nitrogen Doses on Yield and Yield Components in Coriander (*Coriandrum sativum* L.) Lines

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Abstract

This study was conducted in the experimental fields of the Department of Field Crops, Faculty of Agriculture, Ankara University, to investigate the effects of varying nitrogen doses on yield and yield components of six coriander (*Coriandrum sativum* L.) lines (lines 11, 22, 26, 41, 54, 58). The experiment was set up in a split-plot design with 3 replications and 72 subplots, where the main plot was the genotype and the subplots were the nitrogen doses, using nitrogen doses of 0 (control), 3, 6, and 9 kg/da. The measured agronomic parameters were plant height, number of branches, number of umbels, number of seed-bearing umbels, seed yield per plant, thousand-seed weight, essential oil content, biological yield, seed yield, and harvest index. The results showed that nitrogen dose and genetic differences between lines had significant effects on all yield parameters. The 3 kg/da nitrogen dose consistently yielded the best results for most variables. Yield remained constant or tended to decrease at the highest nitrogen dose (9 kg/da), indicating a potential threshold for nitrogen efficiency. The findings are consistent with previous studies in the literature, suggesting that 3 kg/da fertilization is ideal for achieving high yield and quality in coriander.

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Kişniş (*Coriandrum sativum* L.) Hatlarında Farklı Azot Dozlarının Verim ve Verim Bileşenleri Üzerindeki Etkisi

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Öz

Bu çalışma, altı kişniş (*Coriandrum sativum L.*) hattının (11, 22, 26, 41, 54, 58 numaralı hatlar) verim ve verim unsurları üzerine değişen azot dozlarının etkilerini araştırmak amacıyla Ankara Üniversitesi Ziraat Fakültesi Tarla Bitkileri Bölümü deneme tarlalarında yürütülmüştür. Denemede 0 (kontrol), 3, 6 ve 9 kg/da azot dozları, tesadüf bloklarında ana parsel genotip, alt parseller ise azot dozları olacak şekilde bölünmüş parseller deneme desenine göre 3 tekrarlamalı ve 72 alt parsel olarak kurulmuştur. Ölçülen agronomik parametreler; bitki boyu, dal sayısı, şemsiye sayısı, tohum taşıyan şemsiye sayısı, bitki başına tohum verimi, bin tohum ağırlığı, uçucu yağ içeriği, biyolojik verim, tohum verimi ve hasat indeksidir. Elde edilen sonuçlar, azot dozunun ve hatlar arasındaki genetik farklılıkların tüm verim parametreleri üzerinde önemli etkilere sahip olduğunu göstermiştir. 3 kg/da azot dozu, çoğu değişkende tutarlı bir şekilde en iyi sonuçları vermiştir. Verim, en yüksek azot dozunda (9 kg/da) sabit kalma veya azalma eğiliminde olmuş, bu da azot verimliliği için potansiyel bir eşik olduğunu göstermektedir. Bulgular, literatürdeki önceki çalışmalarla tutarlıdır ve kışnişte yüksek verim ve kalite elde etmek için 3 kg/da'lık gübrelemenin ideal olduğu görülmektedir.

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Introduction

Since the dawn of humanity, human beings have had essential needs such as eating, drinking, and breathing. These needs initially led them to gather, then to hunt, and eventually to practice cultivation. At first, people consumed what they themselves produced. Later, they began to barter what they cultivated to obtain what they could not produce, which in turn increased their desire to produce more. Over time, the growing world population and the increasing need to feed that population made it necessary to produce much higher crop yields. Therefore, obtaining more yield per unit area has become the primary goal of cultivation. This can only be achieved by improving and developing yield and its components.

Throughout history, humankind has also pursued new and different flavors; eating food in its plain form no longer satisfied them. For this reason, they began using additives such as salt, sugar, and pepper to enhance the taste of food. The same dissatisfaction led them to add different spices to meals in search of new tastes. Today, especially in our country, the most commonly used spices include pepper, garlic, onion, sumac, mint, black cumin, thyme, anise, fennel, cumin, fenugreek, marjoram, henna, salep, bay leaf, licorice root, and coriander.

Coriander is an ancient cultivated plant, and its seeds have been found in Egyptian tombs dating back to 1000 BC. It is also recorded in the ancient Mesopotamian codices and mentioned in the Ebers Papyrus written in 1500 BC in ancient Egypt. In Anatolia, coriander is particularly found mixed with anise (Mutlubaş, 2026).

Coriander (Coriandrum sativum L.) is an annual herbaceous plant belonging to the Apiaceae (Umbeliferae) family. It has a thin, spindle-shaped root system. The upright stem is rounded and branched, especially at the top. Stem height can reach 60-120 cm. The lower leaves, which do not persist for long, have long petioles and are unsegmented. However, they are simply lobed with trimmed edges or are usually three-lobed (Naeem et al.).

In coriander, the central leaves are usually stemless. The flower cluster has a long stalk and the protective leaf is often absent or largely atrophied. The flower cluster has 3-5 rays, with a cluster of small flowers at the tip of each ray. Individual flowers have five small, elongated sepals of unequal length and five smaller petals ranging in color from white to red. There are also five stamens and two pistils (Naeem et al.).

Unlike other Apiaceae, the coriander fruit is a single, rather than two-part, rounded shape. While the dried fruit has a pleasant odor, the unripe fruit and the green plant have an offensive odor. The fruit is firm and ranges in color from yellowish brown to yellowish red. The fruit has a conical protrusion at its apex, which is studded with pointed tips extending to either side. Two main varieties are distinguished according to fruit size.

1. Coriandrum sativum var. vulgare; its fruit is 3-5 mm in diameter. It is the most common form. Indian coriander is also included in this group.

2. Coriandrum sativum var. microcarpum; fruit diameter varies between 1.5 and 3 mm. Originally from Mexico, this group also includes Russian coriander. Both varieties were used in this study.

The most important ingredient in coriander fruit is its essential oil. Depending on the origin, the essential oil content varies between 0.2% and 1.5%. There is a certain correlation between the essential oil content and fruit size. Smaller fruits have higher essential oil content than larger ones. 40% of the essential oil

is found in the fruit peel, and 60% in the seed. The primary ingredient in the essential oil is D-Linalool, which makes up 60-70% of the essential oil. In addition to the essential oil, the fruit also contains fixed oils, starch, tannins, and sugars (Naeem et al.).

Coriander is especially common in the Mediterranean region. However, it is also cultivated today in Central Europe, the Netherlands, Romania, Russia, India, East Asia, Japan, North and South America, Egypt, and particularly Morocco. Coriander prefers light, sandy, lime-rich soils. Likewise, it favors neutral to slightly alkaline soils (pH = 6.0–7.5). It is known to grow well in hot and dry regions. The fruit yield of the coriander plant varies between 100-200 kg/da and the stem yield varies between 180-300 kg/da (Diederichsen, 1996).

Although the development of coriander is slow, it does not pose significant challenges in terms of care. However, it should be sown in fields that are as weed-free as possible. Coriander cultivation is not suitable under fruit trees. Cereals are considered good preceding crops for coriander. The plant requires a significant amount of water, especially in its early growth stages. Seeds at a rate of 1.5–2 kg per decare should be sown with 30 cm row spacing, at a depth of about 1 cm, and the soil should be compacted with a roller. Plants emerge within 2–3 weeks. During the vegetation period, the field should be weeded several times manually or with machinery (Beyzi and Gürbüz, 2010).

In terms of fertilization, phosphorus and potassium are applied at the same rates as for cereal crops. In particular, phosphorus fertilization has a positive effect on the essential oil content. Nitrogen fertilization should be managed carefully. Excess nitrogen can lead to lodging and disease. A nitrogen dose of 8–4 kg/da is considered sufficient. When the field takes on a yellowish-brown color, it indicates that harvest time has arrived. Proper nitrogen dosing can increase coriander yield, although studies in this area remain limited (Kızıl end İpek, 2004).

This study aims to investigate the effects of different nitrogen doses applied to various coriander lines on yield components such as plant height, number of branches, number of umbels, seed yield, thousand seed weight, and essential oil content.

Material and Method

In this study, coriander (Coriandrum sativum L.) lines numbered 11, 22, 26, 41, 54, and 58 developed through single plant selection at the Department of Field Crops, Faculty of Agriculture, Ankara University were used. Among these lines, Line 11, Line 41, and Line 54 have large seeds, while Line 22, Line 26, and Line 58 have small seeds.

Ammonium nitrate fertilizer was used in the experiment, which was established on a total area of 728 m². Four different nitrogen doses were applied to each of the six coriander lines with three replications. The nitrogen doses applied were: 0 kg/da (Control), 3 kg/da (41.4 g N), 6 kg/da (82.8 g N), 9 kg/da (124.2 g N).

In the experimental design, the main plot represents the genotype, and the subplots represent the N doses, and these plots are arranged in split-plot configurations in randomized blocks. Since four nitrogen doses were tested for six different lines, each block consisted of 24 sub-plots (Figure 1). With three replications, the total number of sub-plots was 72.

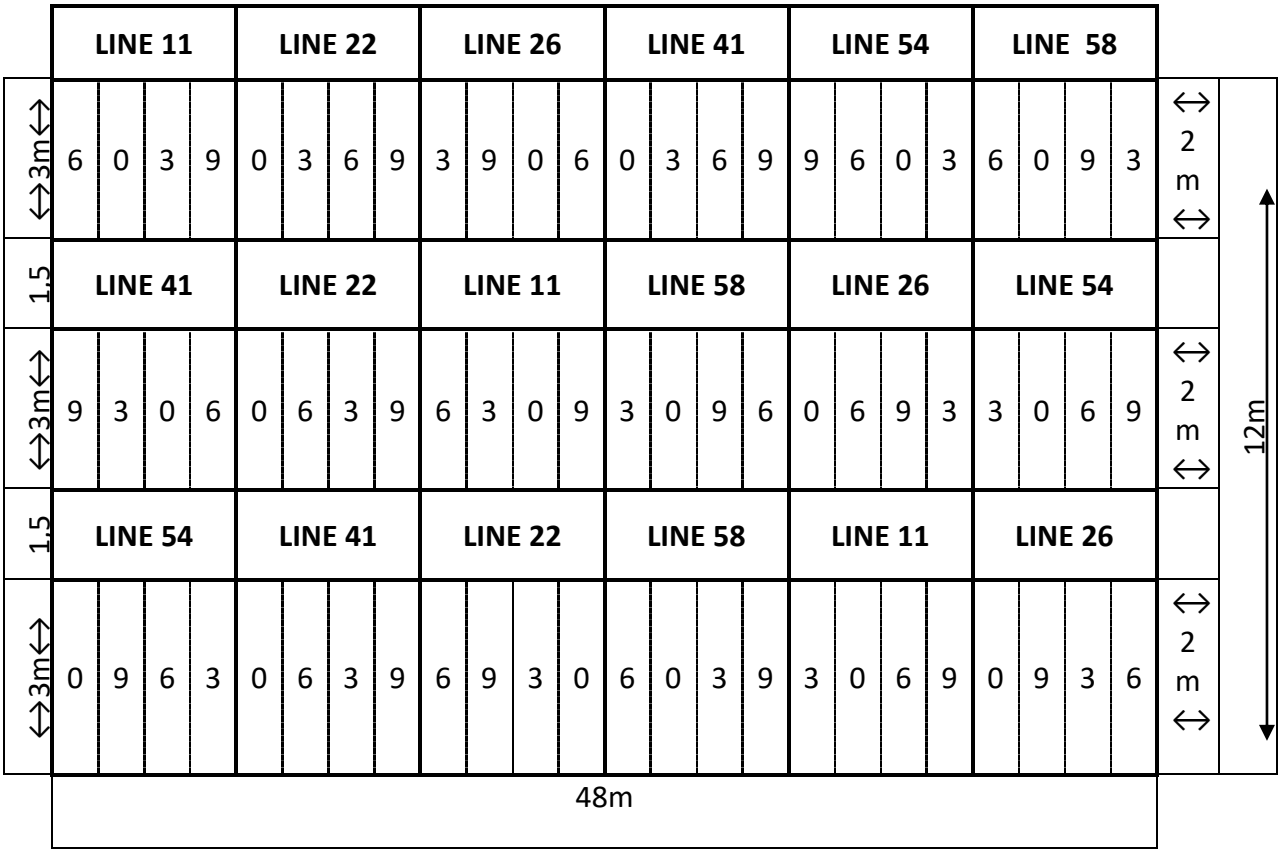
The experimental layout is presented in Table 1. As shown in Table 1, the length of each block (excluding paths) is 48 meters, and the width is 3 meters. The distance between each block is 1.5 meters.

Including the paths, the total block length is 52 meters, and the total width (three blocks with paths) is 14 meters, resulting in a total trial area of 728 m².

Each block was divided into six main plots, and each main plot was further divided into four sub-plots. Each sub-plot measured 3 meters in length and 2 meters in width, totaling 6 m². The row spacing within the sub-plots was 40 cm. Each sub-plot contained five plant rows.

Figure 1. Images from the flowering stage of the trial

Table 1. Experimental Layout



Sowing was carried out on March 26, 2004. The sowing process began with parceling the experimental area and marking 40 cm row spacing using a marker to open planting furrows. Into these furrows, 3.2 g of seeds were sown for the large-seeded lines and 2.0 g of seeds for the small-seeded lines. After sowing, the furrows were covered with soil using a rake, and then a roller was passed over the surface to compact the soil and complete the sowing process.

Since the aim of the experiment was to investigate the effects of different nitrogen doses on yield and yield components of various coriander lines, nitrogen fertilization at varying doses was applied. Approximately three months after sowing, on June 14, 2004, when the plants had reached a height of 20–25 cm, fertilization was carried out. The predetermined nitrogen doses were applied individually to each sub-plot.

Harvesting began in early August, when the plants had completed their growth. The appropriate harvest time was determined by signs such as yellowing of the aboveground parts and hardening of the seeds.

As a result of the study, the targeted yield and yield components were as follows: Plant height, Number of branches, Number of umbels, Number of umbels with seeds, Seed yield per plant, Thousand seed weight, Essential oil content, Biological yield, Seed yield, Harvest index.

Plant Height (cm): Plant height was determined by randomly selecting ten plants from each sub-plot and measuring the distance from the crown (root collar) to the highest point of the plant using a measuring tape. The total values obtained were summed and then divided by ten to calculate the average plant height.

Number of Branches (count): The total number of branches on each plant was counted. This process was repeated for ten plants, and the branch numbers were averaged by dividing the total by ten.

Number of Umbels (count): Umbels are characteristic inflorescences of plants belonging to the Apiaceae family, such as coriander, found at the ends of the plant's branches, consisting of smaller branchlets that arise from a single point and bear seeds. The number of umbels was determined by counting all umbels on each plant. Measurements were taken from ten plants, and the total was divided by ten to calculate the average number of umbels.

Number of Seed-Bearing Umbels (count): Not all umbels develop seeds—either due to failed fertilization or subsequent developmental issues. The number of seed-bearing umbels was determined by counting only those umbels that formed seeds on each plant. Measurements from ten plants were summed and divided by ten to determine the average number of seed-bearing umbels.

Seed Yield per Plant (kg/da): The seeds from each of the ten selected plants were harvested and weighed. The total seed weight was then divided by ten to calculate the average seed yield per plant.

Thousand Seed Weight (kg/da): For each sub-plot, one hundred seeds were counted and weighed in grams. This procedure was repeated four times per sub-plot, resulting in the seed weights of four hundred seeds. The average of these four measurements was calculated and multiplied by ten to estimate the thousand seed weight.

Essential Oil Content (%): The essential oil content was determined using steam distillation. Coriander seeds were boiled with one liter of water in glass flasks for 3.5 hours. The first 30 minutes were to bring the mixture to boiling point, and the remaining three hours were for extracting the essential oils. The steam containing volatile oils condensed upon contact with a cold-water-cooled condenser and accumulated in a graduated cylinder. The volume of the collected oil was then measured as a percentage.

Biological Yield (kg/da): After harvesting, plants from each sub-plot were gathered into separate bundles without mixing and weighed to determine biological yield.

Seed Yield (kg/da): Following harvest, the plants from each sub-plot were threshed, the seeds were cleaned, and the total seed weight was recorded to determine seed yield.

Harvest Index (%): The harvest index is the ratio of seed yield to biological yield, expressed as a percentage. It was calculated by dividing seed yield by biological yield and multiplying by 100.

To determine the statistical significance of the interaction between these data obtained from the study, variance analyses were conducted. The Duncan Test was also conducted to determine the significance of these statistical differences. The Duncan Test is a statistical significance and multiple comparison test developed for pairwise comparisons of n numbers of means to determine whether there are differences between groups. All statistical analyses were performed using SPSS software (SPSS Inc., Chicago, IL, USA).

Results and Discussion

The analysis of variance (ANOVA) results revealed that the effects of genotype (Lines, A), nitrogen doses (B), and their interactions (A × B) varied depending on the evaluated traits.

For several traits, the effect of genotype (Lines) was found to be statistically significant ($p < 0.01$), indicating substantial genetic variability among the studied lines. Similarly, nitrogen doses showed

significant effects on some traits ($p < 0.05$ or $p < 0.01$), suggesting that nitrogen application levels play an important role in trait expression.

The interaction between genotype and nitrogen doses (A × B) was also significant for certain parameters ($p < 0.05$ or $p < 0.01$), demonstrating that different genotypes respond differently to nitrogen levels. This indicates the presence of genotype-specific nitrogen use efficiency and adaptability.

However, for some traits, neither nitrogen doses nor the interaction effect was statistically significant, implying that these traits are predominantly controlled by genetic factors rather than environmental inputs such as nitrogen fertilization.

The significance of block effects in some traits suggests that environmental heterogeneity within the experimental field may have influenced the results.

These findings are consistent with previous studies reporting that both genetic factors and nitrogen fertilization significantly affect plant growth and yield-related traits (e.g., Smith et al., 2005; Khan et al., 2010). Moreover, the significant genotype × nitrogen interaction observed in this study supports earlier reports indicating differential genotype responses under varying nitrogen conditions.

According to the ANOVA results, the effects of coriander lines and nitrogen doses on yield and quality parameters varied depending on the trait evaluated.

Plant Height (cm) According to the analysis of variance, genotype (A), nitrogen doses (B), and their interaction (A × B) had no significant effect on plant height. Plant height values ranged between 40.7 cm and 46.6 cm, with Line 58 producing the tallest plants and Line 11 the shortest. Although numerical differences were observed among nitrogen doses, these differences were not statistically significant.”The variance analysis related to plant height in coriander lines applied different nitrogen fertilizer doses, the statistical examination of the lines, nitrogen doses and line x nitrogen doses interaction in terms of plant height and the results of the Duncan Test performed to determine the significance level of the differences found are given in Appendix-1.

Number of Branches According to the analysis of variance, genotype (A) had a significant effect on the number of branches, whereas nitrogen doses (B) and the A × B interaction were not statistically significant. Line 26 had the highest number of branches (6.2), while Line 22 had the lowest (4.7), indicating genetic variability among the lines. Although the average number of branches ranged between 5.05 and 5.67 across nitrogen doses, these differences were not statistically significant.

Number of Umbels The maximum number of umbels (14.5) was obtained from Line 26 with 3 kg/da nitrogen. Overall, nitrogen applications increased umbel numbers across all lines, supporting previous studies that reported enhanced reproductive structures with moderate nitrogen supplementation.

The statistical analysis of variance analysis related to the number of umbels in coriander lines applied with different nitrogen fertilizer doses and the results of the Duncan Test performed to determine the significance level of the differences found are included in Appendix 3.

Number of Seed-Bearing Umbels The highest value (9.39) was observed in Line 26, while the lowest (2.70) was found in Line 22. The 3 kg/da dose resulted in the best outcomes, suggesting that optimal nitrogen supports successful pollination and seed set.

The statistical analysis of variance analysis related to the number of seed umbels in coriander lines applied with different nitrogen fertilizer doses and the results of the Duncan Test performed to determine the significance level of the differences found are included in Appendix 4.

Seed Yield per Plant (kg/da) Lines 11 and 54 showed the highest average yields (0.79 kg/da). The peak yield (1.33 kg/da) was achieved in Line 26 under 3 kg/da nitrogen, highlighting the strong interaction between genotype and moderate nitrogen availability.

The statistical analysis of variance analysis related to seed yield per plant in coriander lines applied different nitrogen fertilizer doses and the results of the Duncan Test performed to determine the significance level of the differences found are included in Appendix 5.

Thousand Seed Weight (g) The heaviest seeds (14.4 g) were recorded in Line 41, while the lightest (7.7 g) were from Line 26. Nitrogen at 3 kg/da positively influenced this parameter as well, enhancing seed filling and weight.

The statistical analysis of variance analysis regarding 1000 seed weight in coriander lines applied different nitrogen fertilizer doses and the results of the Duncan Test performed to determine the significance level of the differences found are given in Appendix 6.

Essential Oil Content (%) The highest essential oil content (0.30%) was found in Lines 22 and 58. Again, the 3 kg/da dose yielded the highest oil content across nitrogen levels, confirming its importance for quality traits.

The statistical analysis of variance analysis related to the amount of coriander essential oil in coriander lines applied different nitrogenous fertilizer doses and the results of the Duncan Test conducted to determine the significance level of the differences found are included in Appendix-7.

Biological Yield (kg/da) The highest biological yield (1086.3 kg/da) was recorded in Line 22, and the lowest (387.5 kg/da) in Line 26. The 3 kg/da nitrogen dose resulted in the highest overall average biological yield.

The statistical analysis of variance analysis related to biological yield in coriander lines applied different nitrogen fertilizer doses and the results of the Duncan Test performed to determine the significance level of the differences found are included in Appendix-8.

Seed Yield (kg/da): The highest seed yield average of 413.58 kg/da was obtained from line 41, while the lowest seed yield, 96.01 kg/da, was obtained from line 26. In terms of nitrogen doses, seed yield averages ranged from 264.20 to 325.18 kg/da, with the highest value obtained from a 3 kg/da nitrogen dose. When the Lines x Nitrogen Doses interaction was examined, the highest value (498.65 kg/da) was obtained from the 9 kg/da nitrogen treatment of Line 22, demonstrating the importance of nitrogen on seed yield.

The statistical analysis of variance analysis for seed yield in coriander lines applied different nitrogen fertilizer doses and the results of the Duncan Test performed to determine the significance of the differences are presented in Appendix 9.

Harvest Index (%): The highest harvest index average of 46.70% was obtained from line 41, while the lowest was obtained from line 26, at 24.76%. Harvest index averages varied between 37.15% and 33.57% across nitrogen doses, with the highest value obtained from a 9 kg/da nitrogen dose. When examining the Lines x Nitrogen Doses interaction, the highest value (50.64%) was obtained from line

41 treated with 6 kg/da nitrogen. The relationship between seed viability and nitrogen is also demonstrated by the harvest index data.

The statistical analysis of the variance analysis for the harvest index in coriander lines treated with different nitrogen fertilizer doses and the results of the Duncan Test, conducted to determine the significance of the differences, are presented in Appendix 10.

In general, the effects of nitrogen fertilization on coriander varied depending on the trait evaluated. While nitrogen doses had a significant influence on certain yield and biochemical parameters, their effects on some morphological traits such as plant height and branch number were not statistically significant. This indicates that the response to nitrogen application is trait-dependent.

The relatively better performance observed at the 3 kg/da nitrogen level for several parameters is in partial agreement with previous studies. Rahman et al. (1990) reported optimum seed and oil yield at 60 kg/ha, while Das et al. (1991) found peak yield at 40 kg/ha with reductions at higher doses. Similarly, Bhat and Sulikeri (1992) reported maximum seed yield at 40 kg/ha N combined with P and K fertilization. Ughreja and Chundawat (1992a-b) also observed improvements in plant height, branching, and oil content with nitrogen application.

However, not all traits responded significantly to nitrogen in the present study. This partially contrasts with some reports in the literature (Tiwari and Banafar, 1995; Malav and Yadav, 1997; Vinay et al., 1999; Kızıl and İpek, 2004; Oliveira et al., 2003), which generally indicate a positive response to nitrogen fertilization. Such differences may be attributed to variations in genotype, environmental conditions, soil characteristics, and irrigation regimes, as also emphasized by Singh and Rao (1994).

Conclusions

The results of this study indicate that nitrogen fertilization influences certain yield and quality traits in coriander, while its effect on some morphological traits remains limited. Among the tested doses, 3 kg/da nitrogen showed relatively higher values for several parameters, although these differences were not consistently statistically significant across all traits. These findings suggest that the optimum nitrogen level may vary depending on the specific trait and growing conditions.

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Attachments

Appendix-1: Variance Analysis Of Plant Height İn Coriander Lines Applied With Different Nitrogen Fertilizer Doses And Plant Heıght Averages (Cm)

Variation Source	Degrees of Freedom	Sum of Squares	Means of Squares	F Value
General	71	2607,94	-	-
Blocks	2	424,12	212,06	3,00
Lines (A)	5	404,75	80,95	1,14
Error 1	10	708,03	70,80	-
Nitrogen Doses (B)	3	127,22	42,41	2,20
A x B	15	248,94	16,60	0,86
Error 2	36	694,87	19,30	-

Lines	Nitrogen Doses				
	0 kg/da	3 kg/da	6 kg/da	9 kg/da	Ort.
11	39.29	41.34	40.16	42.31	40.77
22	42.58	47.40	45.18	48.73	45.97
26	49.53	45.30	45.77	43.17	45.94
41	38.23	45.43	42.05	40.45	41.54
54	37.52	45.15	41.69	44.75	42.28
58	43.82	47.43	46.56	48.63	46.61
Aver.	41.83	45.34	43.57	44.67	

Appendix-2: Variance Analysis Of Branch Number İn Coriander Lines Applied With Different Nitrogen Fertilizer Doses And Average Number Of Branches (Number)

Variation Source	Degrees of Freedom	Sum of Squares	Means of Squares	F Value
General	71	71.59	-	-
Blocks	2	7.47	3.73	6.49
Lines (A)	5	17.81	3.56	6.19 **
Error 1	10	5.75	0.57	-
Nitrogen Doses (B)	3	4.53	1.51	2.13
AxB	15	10.54	0.70	0.99

Error 2	36	25.50	0.71	-

**: Significant at 1% level

Lines	Nitrogen Doses				
	0 kg/da	3 kg/da	6 kg/da	9 kg/da	Ort.
11	5.04	5.33	4.97	5.33	5.17 cd 12
22	3.69	4.53	5.04	5.52	4.70 c 2
26	6.51	6.04	5.95	6.44	6.24 a 1
41	4.88	6.07	5.41	5.11	5.36 bcd 12
54	5.14	5.81	6.72	6.00	5.91 ab 1
58	5.05	6.13	5.08	5.60	5.46 bc 12
Aver.	5.05	5.65	5.52	5.67	

*: Letters indicate different groups at the 5% level and numbers indicate different groups at the 1% level.

Appendix-3: Varıance Analysıs On The Number Of Umbels In Corıander Lines Applied Wıth Different Nıtrogen Fertılızer Doses And Average Number Of Umbrellas (Pıeces)

Variation Source	Degrees of Freedom	Sum of Squares	Means of Squares	F Value
General	71	423.35	-	-
Blocks	2	3.82	1.91	2.26
Lines (A)	5	247.04	49.41	58.37 **
Error 1	10	8.46	0.85	-
Nitrogen Doses (B)	3	67.48	22.49	23.45 **
AxB	15	62.01	4.13	4.31 **
Error 2	36	34.53	0.96	-

**: Significant at 1% level

Lines	Nitrogen Doses				
	0 kg/da	3 kg/da	6 kg/da	9 kg/da	Ort.
11	8.91 hı 5-8	10.49 e-h 3-6	9.78 f-l 4-7	11.58 c-f 234	10.19
22	5.51 k 9	6.90 jk 89	8.04 ıj 789	9.67 ghı 4-7	7.53
26	12.94 a-d 12	14.50 a 1	11.29 d-g 2-5	13.30 abc 12	13.01
41	8.86 hı 5-8	11.37 d-g 2-5	11.33 d-g 2-5	10.13 fgh 3-7	10.42
54	10.27 fgh 3-7	13.19 abc 12	13.65 ab 12	13.50 ab 12	12.65
58	7.96 ıj 78	12.30 b-e 123	8.02 ıj 678	10.19 fgh 3-7	9.62

Aver.	9.07	11.46	10.35	11.39

*: Letters indicate different groups at the 5% level and numbers indicate different groups at the 1% level.

Appendix-4: Varıance Analysıs On The Number Of Seed Umbels In Corıander Lines Applıed With Dıfferent Nıtrogen Fertılızer Doses And Average Number Of Seeded Umbrellas (Number)

Variation Source	Degrees of Freedom	Sum of Squares	Means of Squares	F Value
General	71	177.46	-	-
Blocks	2	8.38	4.19	7.00
Lines (A)	5	61.53	12.31	20.55 **
Error 1	10	5.99	0.60	-
Nitrogen Doses (B)	3	31.81	10.60	11.80 **
AxB	15	37.39	2.49	2.77 **
Error 2	36	32.36	0.90	-

**: Significant at 1% level

Lines	Nitrogen Doses				
	0 kg/da	3 kg/da	6 kg/da	9 kg/da	Ort.
11	4.75 ef 3-6	5.11 def 3-6	4.27 fg 56	4.90 ef 3-6	4.76
22	2.70 g 6	4.64 ef 3-6	4.24 fg 56	5.55 c-f 2-5	4.28
26	5.80 c-f 2-5	9.39 a 1	5.75 c-f 2-5	7.82 b 12	7.19
41	4.86 ef 456	6.00 c-f 2-5	5.56 c-f 2-5	4.60 ef 456	5.25
54	4.48 ef 456	6.29 b-e 2-5	7.11 bc 23	5.79 c-f 2-5	5.92
58	4.37 fg 56	5.83 c-f 2-5	4.49 ef 456	6.90 bcd 234	5.40
Aver.	4.49	6.21	5.24	5.93	

*: Letters indicate different groups at the 5% level and numbers indicate different groups at the 1% level.

Appendix-5: Varıance Analysıs Of Seed Yıeld Per Plant In Corıander Lınes Applıed With Dıfferent Nıtrogen Fertılızer Doses Average Seed Yıeld Per Plant (Kg/Da)

Variation Source	Degrees of Freedom	Sum of Squares	Means of Squares	F Value
General	71	4.46	-	-
Blocks	2	0.16	0.08	15.61
Lines (A)	5	1.02	0.20	38.82 **
Error 1	10	0.05	0.00	-
Nitrogen Doses (B)	3	0.89	0.30	31.07 **

AxB	15	2.00	0.13	13.96 **
Error 2	36	0.34	0.01	-

**: Significant at 1% level

Lines	Nitrogen Doses				
	0 kg/da	3 kg/da	6 kg/da	9 kg/da	Ort.
11	0.71 c-h 3-8	0.96 b 2	0.69 d-h 3-12	0.80 b-e	0.79
22	0.27 m	0.56 g-k 5-12	0.44 j-m 9-13	0.70 c-h 3-8	0.49
26	0.46 j-m 8-13	1.33 a 1	0.38 k-m 10-13	0.49 ı-l 7-13	0.66
41	0.62 e-j 4-10	0.76 c-f 2-6	0.74 c-g 2-7	0.52 h-k 6-13	0.66
54	0.76 c-f 2-6	0.67 d-ı 3-9	0.89 bc 23	0.85 bcd 234	0.79
58	0.32 lm 1213	0.58 f-j 5-11	0.33 lm 11-13	0.79 b-e 2-5	0.51
Aver.	0.52	0.81	0.58	0.69	

*: Letters indicate different groups at the 5% level and numbers indicate different groups at the 1% level.

Appendix-6: Analysıs Of Varıance On 1000 Seed Weıght In Corıander Lınes Applıed With Dıfferent Nıtrogen Fertılızer Doses Average Weıght Of 1000 Seeds (G)

Variation Source	Degrees of Freedom	Sum of Squares	Means of Squares	F Value
General	71	779.92	-	-
Blocks	2	29.71	14.86	1.11
Lines (A)	5	492.12	98.42	7.36 **
Error 1	10	133.70	13.37	-
Nitrogen Doses (B)	3	20.38	6.79	3.26 *
AxB	15	29.01	1.93	0.93
Error 2	36	75.00	2.08	-

*: Significant at the 5% level, **: Significant at the 1% level

Lines	Nitrogen Doses				
	0 kg/da	3 kg/da	6 kg/da	9 kg/da	Ort.
11	12.20	15.26	12.78	11.88	13.03 a 12
22	8.29	8.43	7.89	9.37	8.50 b 23
26	7.33	8.08	7.21	8.49	7.77 b 3
41	13.77	15.17	14.91	13.90	14.44 a 1
54	12.10	12.66	11.17	12.54	12.12 a 123

58	8.39	9.31	6.52	8.64	8.21 b23
Aver.	10.34 b	11.48 a	10.08 b	10.80 ab	

*: Letters indicate different groups at the 5% level and numbers indicate different groups at the 1% level.

Appendıx-7: Varıance Analysıs Of Essentıal Oıl In Corıander Lınes Applıed Wıth Dıfferent Nıtrogen Fertılızer Doses And Essentıal Oıl Averages (%)

Variation Source	Degrees of Freedom	Sum of Squares	Means of Squares	F Value
General	71	0.54	-	-
Blocks	2	0.02	0.00	0.26
Lines (A)	5	0.35	0.07	14.53 **
Error 1	10	0.05	0.00	-
Nitrogen Doses (B)	3	0.05	0.02	8.38 **
AxB	15	0.03	0.00	1.11
Error 2	36	0.07	0.00	-

**: Significant at 1% level

Lines	Nitrogen Doses				
	0 kg/da	3 kg/da	6 kg/da	9 kg/da	Ort.
11	0.18	0.19	0.15	0.19	0.18 bc 2
22	0.30	0.35	0.25	0.31	0.30 a 1
26	0.16	0.32	0.18	0.26	0.23 b 12
41	0.13	0.16	0.10	0.14	0.13 c 2
54	0.13	0.17	0.12	0.16	0.14 c 2
58	0.29	0.33	0.31	0.29	0.30 a 1
Aver.	0.20 b 2	0.25 a 1	0.19 b 2	0.23 a 12	

*: Letters indicate different groups at the 5% level and numbers indicate different groups at the 1% level.

Appendıx-8: Varıance Analysıs Of Bıologıcal Yıeld In Corıander Lınes Applıed Wıth Dıfferent Nıtrogen Fertılızer Doses And Bıologıcal Yıeld Averages (Kg/Da)

Variation Source	Degrees of Freedom	Sum of Squares	Means of Squares	F Value
General	71	6169229.87	-	-
Blocks	2	311847.25	155923.62	2.99
Lines (A)	5	3130514.29	626102.86	12.01 **
Error 1	10	521281.58	52128.16	-

Nitrogen Doses (B)	3	456555.82	152185.27	7.26 **
AxB	15	994917.76	66327.85	3.17 **
Error 2	36	754113.17	20947.59	-

**: Significant at 1% level

Lines	Nitrogen Doses				
	0 kg/da	3 kg/da	6 kg/da	9 kg/da	Ort.
11	700.0 fgh 4-7	1222.7 ab 12	848.0 c-h 3-6	665.3 gh 5-7	859.0
22	836.0 c-h 3-6	1090.0 bc 123	1069.3 b-d 1-4	1350.0 a 1	1086.3
26	300.7 j 8	570.7 hı 678	381.3 ıj 78	297.3 j 8	387.5
41	876.7 c-g 2-6	918.7 c-g 2-6	902.7 c-g 2-6	678.7 f-h 5-7	844.1
54	688.7 fgh 5-7	805.3 d-h 3-6	736.7 e-h 3-7	993.3 b-e 2-5	806.0
58	826.0 c-h 3-6	957.7 b-f 23	788.7 d-h 3-6	866.7 c-g 67	859.7
Aver.	704.7	927.5	787.8	808.6	

*: Letters indicate different groups at the 5% level and numbers indicate different groups at the 1% level.

Appendix-9: Varıance Analysıs Of Seed Yıeld In Corıander Lınes Applıed Wıth Dıfferent Nıtrogen Fertılızer Doses And Seed Yield Averages (Kg/Da)

Variation Source	Degrees of Freedom	Sum of Squares	Means of Squares	F Value
General	71	1295416.00	-	-
Blocks	2	31841.30	15920.65	1.51
Lines (A)	5	792357.61	158471.52	15.04 **
Error 1	10	105366.77	10536.67	-
Nitrogen Doses (B)	3	40141.45	13380.48	2.93 *
AxB	15	161461.40	10764.09	2.36 *
Error 2	36	164247.47	4562.43	-

*: Significant at the 5% level, **: Significant at the 1% level

Lines	Nitrogen Doses				
	0 kg/da	3 kg/da	6 kg/da	9 kg/da	Ort.
11	286.66 efg	368.19 b-f	322.16 c-g	250.86 fgh	306.96
22	253.60 fgh	403.06 a-e	429.09 a-d	498.65 a	396.10
26	68.45 ı	133.42 hı	93.61 ı	88.55 ı	96.01
41	407.49 a-e	441.44 abc	458.68 ab	346.71 b-g	413.58
54	307.07 d-g	287.99 efg	322.89 c-g	435.57 a-d	338.38

58	261.90 fg	317.01 c-g	220.33 gh	284.81 efg	271.01
Aver.	264.20	325.18	307.79	317.52	

*: Letters indicate different groups at the 5% level and numbers indicate different groups at the 1% level.

Appendıx-10: Varıance Analysıs Of Harvest Index In Corıander Lınes Applıed Wıth Dıfferent Nıtrogen Fertılızer Doses Harvest İndex Averages (%)

Variation Source	Degrees of Freedom	Sum of Squares	Means of Squares	F Value
General	71	5009.71	-	-
Blocks	2	29.80	14.90	0.64
Lines (A)	5	3459.59	691.92	29.66 **
Error 1	10	233.26	23.33	-
Nitrogen Doses (B)	3	149.94	49.98	2.97 *
AxB	15	531.69	35.45	2.11 *
Error 2	36	605.42	16.82	-

*: Significant at the 5% level, **: Significant at the 1% level

Lines	Nitrogen Doses				
	0 kg/da	3 kg/da	6 kg/da	9 kg/da	Ort.
11	28.32 h-l	35.61 d-ı	37.43 c-f	39.41 b-e	35.19
22	29.12 g-l	34.97 d-ı	37.60 c-f	36.86 c-g	34.63
26	21.84 l	28.08 ı-l	22.29 kl	26.84 jkl	24.76
41	46.46 ab	48.80 ab	50.64 a	42.90 bcd	46.70
54	42.89 a-d	37.01 c-g	43.89 abc	44.04 abc	41.96
58	32.79 e-j	36.11 c-h	29.90 f-k	32.87 e-j	32.91
Aver.	33.57	36.43	36.96	37.15	

*: Letters indicate different groups at the 5% level.