Wiley
International Journal of Agronomy
Volume 2026, Article ID 4105994, 11 pages
https://doi.org/10.1155/ioa/4105994

WILEY

Research Article

Effects of Blended NPSB Fertilizer Application Rates on Coriander (*Coriandrum sativum* L.) Varieties' Growth, Yield, and Yield Components

Tamene Haile, Desalegn Negasa Soresa, and Alemu Hailu

Department of Plant Science, Wollega University, Nekemte, Ethiopia

Correspondence should be addressed to Desalegn Negasa Soresa; gemechubekam@gmail.com

Received 5 September 2025; Revised 14 November 2025; Accepted 2 December 2025

Academic Editor: Maria Serrano

Copyright © 2026 Tamene Haile et al. International Journal of Agronomy published by John Wiley & Sons Ltd. This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

A study conducted in 2024 G.C. in western Ethiopia, Horro Guduru Wallaga zone, Horro district, aimed to investigate the influence of blended NPSB fertilizer rates on the growth, yield, and yield attributes of coriander varieties. The experiment involved 16 treatment combinations of four coriander varieties (Darara, Walta-I, Gadisa, and local Dimbilal) and four rates of NPSB blended fertilizers (0, 50, 100, and 150 kgha^{-1}). Data on phenological, growth, yield, and yield-related variables were collected and analyzed using Genstat software Version 14. The analysis of variance showed that all parameters were significantly affected by the interaction effects, except days to emergence. The Darara variety recorded the highest seed yield (3.99 tha^{-1}) and thousand seed weight (67.59 g) at a NPSB blended fertilizer rate of 150 kg ha^{-1}. The highest net benefit (964,980 EBirr ha^{-1}) was achieved at 150 kgha^{-1} NPSB, but the highest marginal rate of return was recorded with 100 kg/ha NPSB blended fertilizer. Even though it needs more time and locations, the study concluded that using the Darara variety with 100 kgha^{-1} NPSB blended fertilizer is economically important.

Keywords: blended; coriander varieties; net benefit; NPSB fertilizer

1. Introduction

Coriander, a spice native to the Middle East and Mediterranean region, has been cultivated since ancient times [1]. It is one of the first spices used by humans and has been cultivated in Africa, particularly in Ethiopia. Global coriander production reached approximately 2.83 million tons, with an average yield of 1.2 tons per hectare. In Ethiopia, coriander is a significant spice crop, particularly in highland regions of SNNPR, Oromia, and Amhara, primarily cultivated by smallholder farmers. However, productivity remains low, with a total yield of 4856.38 tons, averaging only 0.8 tons per hectare [2]. Research on spices, particularly coriander, in Ethiopia is limited, especially in the Horro district. While coriander plays a significant role in local diets, traditional medicine, and potential export market value, there has been insufficient focus on its agronomic practices, such as soil nutrition, varieties, and pest control. Studies by [3] indicate that the absence of improved, high-yielding coriander varieties is a key constraint. Poor soil fertility management in western Ethiopian soils is also hindering crop productivity. The Ethiopian Soil Information System [4] and other studies highlight deficiencies in essential nutrients like nitrogen (N), phosphorus (P), potassium (K), sulfur (S), zinc (Zn), boron (B), and copper (Cu) in western Ethiopian soils. However, no site-specific fertilizer recommendations have been made for coriander, leading to inefficient nutrient use and poor coriander performance [5]. Some literature suggests that applying around 50 kgha^{-1} of NPSB blended fertilizer may be optimal for coriander, but the correct application is often difficult to measure accurately [6].

Farmers in Horro district relied primarily on local landraces of coriander, which were characterized by low

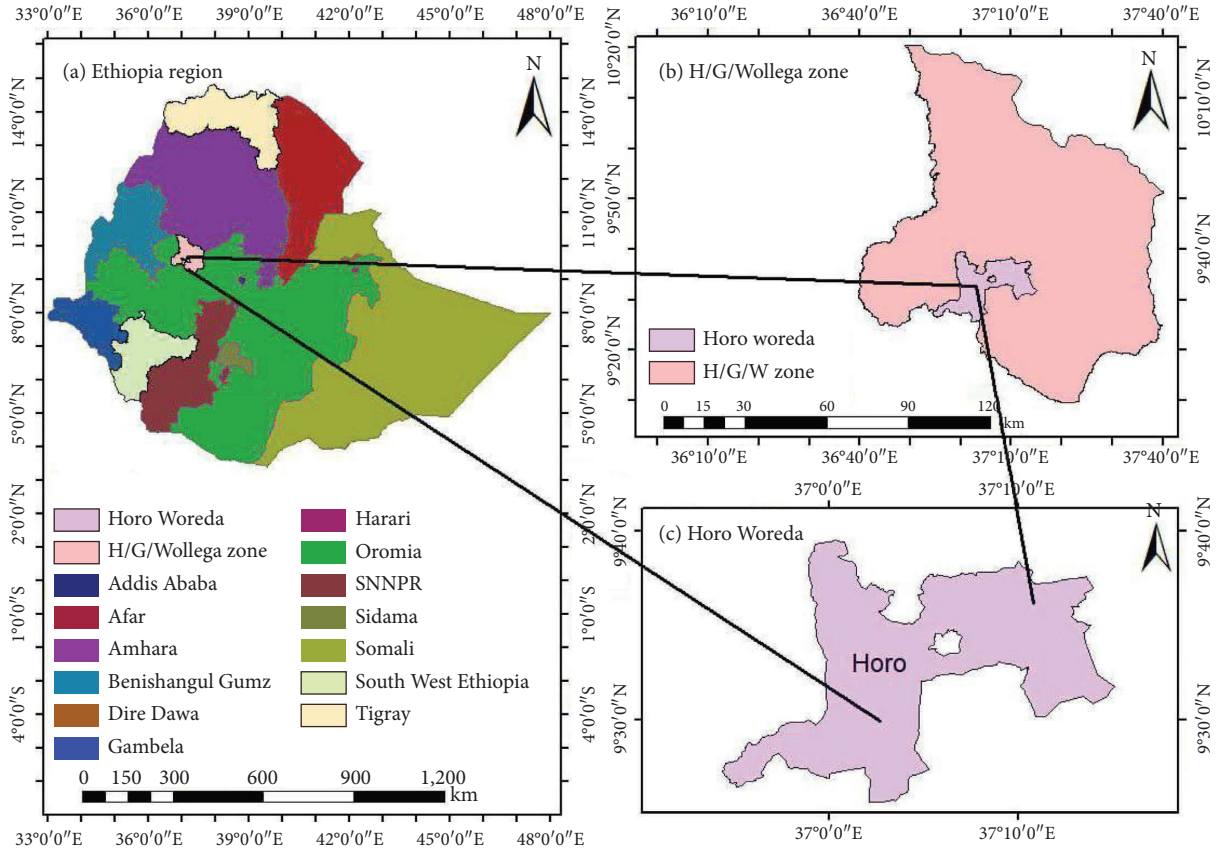


Figure 1: Map of the study area.

yields, poor uniformity, and inferior seed quality, limiting market value and competitiveness. Research on optimizing agronomic practices for the region was limited, and fertilizer application in the area was inconsistent. Poor nutrient management, due to the lack of region-specific fertilizer recommendations, exacerbated the problem. Having this information therefore, this study aimed to investigate the influence of blended NPSB fertilizer rates on growth, yield, and yield components of coriander varieties in the study area.

2. Materials and Method

2.1. Description of the Study Site. The experiment was conducted in 2024 GC during the main cropping season at Horo District, western Ethiopia. The study site is situated approximately 315 km from Finfinnee (Addis Ababa) (Figure 1). The site is geographically positioned at 9° 34′ 30″ N latitude and 37° 6′ 30″ E longitude, with an elevation ranging from 2350 m above sea level [7]. The mean annual rainfall of the district was 2500 mm; the average temperature of the area is 17°C [8]. The soil type is clay loam with a pH of 6.3. The soil fertility is moderate, particularly in terms of nitrogen, phosphorus, and sulfur boron content as indicated by the results of the soil chemical analysis.

2.2. Experimental Materials. The fertilizer used for the experiment was blended NPSB fertilizer. It is blended at a ratio of 19N:38P_2O_5:76.95S:0.1B. Varieties were selected for both seed and leaf purposes, with seed varieties producing seed more quickly than leaf varieties. All selected varieties for this study were seed varieties. Among the varieties used, all the improved varieties listed are from SARC (Table 1), and the local seed was purchased from a farmer in Horo district.

2.3. Treatments, Experimental Design, and Field Managements. The treatments consisted of four coriander varieties (local, Gadisa, Walta-I, and Darara) and four rates of blended NPSB fertilizer: 0, 50, 100, and 150 kg ha^{-1}. The fertilizer rates were based on the findings of [10] as a benchmark. Nitrogen fertilizer, UREA, was applied to all plots at a fixed rate, 60 kg ha^{-1}.

The trial was laid out as a 4 × 4 factorial experiment, arranged in a randomized complete block design with three replications. Each treatment combination was randomly assigned to experimental units within each block. The experimental area consisted of 48 plots, corresponding to 16 treatment combinations. A row spacing of 30 cm and plant spacing of 20 cm were maintained, with 6 rows and 11 plants per row. One row was used as a border effect at the beginning, resulting in a total of 66 plants per plot. Blended NPSB fertilizer was applied at a specified rate. Half of the UREA fertilizer was applied during sowing time, with the other half applied uniformly at the flower initiation stage. All cultural practices were followed. Harvesting was done in July 2025, when over 90% of plants showed physiological maturity and the seeds changed color from green to yellowish-brown.

Table 1: Descriptions of planting material.

Variety	Released by	Year of release	Accession code	Yield tons (ha)		Altitude (m)	RF (mm/year)	Maturity days	Fertilizer recommendation (kg/ha)		Seed color
				Research site	Farmers field				NPSB	UREA	
Walta-I	SARC	2006	229,710	1.0–2.4	0.5–0.8	1800–2550	500–750	120	100	100	Light brown
Darara	SARC	2021	240,574–1	2.5	1.2–2	1700–2300	400–800	110	100	100	Brown
Gadisa	SARC	2019	MAB-030	1.5–3.3	1.2–2.1	1650–2400	550–750	123	100	100	Brown

Note: Ethiopian Agricultural Authority [9].
Abbreviation: SARC, Sinana Agricultural Research Center.

Table 2: Soil physical and chemical properties of the experimental site before planting.

Soil physical properties	Values	Ratings	References
Clay (%)	63.2		
Silt (%)	15.1		
Sand (%)	21.7		
Textural class	Sandy	Sandy clay loam	USDA (1987)
Chemical properties			
PH (%) (1:2:5 H2O)	6.3	Slightly acidic	[15]
Organic carbon (%)	0.95	Medium	[15]
Total nitrogen (%)	0.18	Medium	[15]
Available P (mg/kg)	13.6	Medium	[16]
CEC (meq/100 g soil)	17.3	Medium	[17]
Available sulfur (mg/kg)	11.53	Medium	[15]
Available boron (mg/kg)	0.38	Medium	[18]
Available potassium (mg/kg)	102	Medium	[17]
Organic matter (%)	3.2	Medium	[15]

2.3.1. Physical and Chemical Properties of the Soil. The soil sample was taken randomly from the top 30 cm before planting, and a composite of one sample was created for physical and chemical analysis. The subsample was labeled, foreign materials removed, air-dried, ground, and sieved to determine physicochemical and organic matter. Soil pH was determined using a glass electrode attached to a digital pH meter, and soil texture was determined using the Bouyoucos hydrometer method. The Walkley–Black [11] method was used to determine soil organic carbon content, while the percentage of organic matter was calculated by multiplying the percentage by a factor of 1.724. Total nitrogen was determined using the [12] Kjeldahl method, and available phosphorus was determined using the Olsen method [13]. The value of exchangeable basic cations (Ca, Mg, K, B, Na) was determined by saturating the soil samples with a 1 M NH4OAC solution at pH 7.0 [14].

The laboratory analysis of soil properties before planting revealed that the soil content of clay, silt, and sand was 63.4%, 15.1%, and 21.7%, respectively, indicating a clay soil texture (Table 2). The soil's pH was 6.3, slightly acidic, and the cation exchange capacity (CEC) was 17.3 meq/100 g soils, indicating medium fertility. The soil's organic carbon content was 0.95%, indicating medium potential for nitrogen supply. The organic matter content was 3.2%, moderate (Table 3). The available phosphorus was 13.6 mg/kg, indicating coriander requires a good supply of readily available phosphorus. Nitrogen fertilizer application is necessary for optimal growth. The soil's sulfur content was 11.53 mg/kg, considered optimal, although intensive cultivation may have contributed to its depletion. The mean boron content was 0.38 mg/kg, suggesting the need for boron-containing fertilizers (Table 2). Overall, the soil's physicochemical properties were crucial for optimal crop growth.

2.3.2. Data Collected. Data were recorded on phonologies, growth, yield, and yield-related parameters. Crop phonologies (days to 50% of plant emergence, days to flowering, and days to maturity) and growth parameters including plant height (cm), leaf number, primary, and secondary branches per plant were recorded following [19] method. Yield and related parameters (umbel number per plant, seed number per umbel, thousand seed weight, above-ground dry biomass, and harvest index (HI) [%]) were recorded as follows [20]. Seed yield was determined from the three central rows of nine randomly selected plants per plot, while above-ground dry biomass was recorded from three enteral rows of nine plants. The HI was calculated by dividing the seed yield by the total above-ground biomass yield, expressed as a percentage.

The oil ratio was calculated using the Soxhlet method, which involves powdered seeds being packed into a thimble and placed in a Soxhlet extractor [21]. The Soxhlet method was used to extract oil from seeds.

Table 3: Interaction effect of blended fertilizer and coriander varieties on its phenologies.

Varieties	NPSB	Flowering days (day)	Maturity days (day)
Local	0	71.5^{k}	147.0^{d}
	50	81.5^{j}	155.7^{c}
	100	92.0^{h}	163.5^{b}
	150	101.9^{e}	175.4^{a}
Darara	0	83.9^{i}	103.9^{m}
	50	97.6^{f}	108.4^{l}
	100	109.3^{d}	118.1^{i}
	150	116.8^{c}	123.0^{g}
Gadisa	0	61.3^{l}	90.8^{o}
	50	72.8^{k}	99.3^{n}
	100	84.3^{i}	104.9^{m}
	150	94.6^{g}	110.5^{k}
Walta-I	0	94.9^{g}	113.1^{j}
	50	110.5^{d}	121.5^{h}
	100	120.8^{b}	131.5^{f}
	150	128.7^{a}	141.8^{e}

Note: The means followed by the same letter within the same column are not significantly different at 5% level of significance.

2.3.3. Economic Analysis. Partial budget analysis is a method used to evaluate the profitability of agricultural treatments by considering variable costs, such as fertilizer, labor, and seed, and comparing them against expected net benefits like yield and profit [22]. All costs and benefits were calculated per hectare in Birr. The best treatment recommendation was based on both the highest net benefit and an acceptable marginal rate of return (MRR). The MRR, which refers to the net income obtained by incurring the unit cost of fertilizer application, is calculated by dividing the net increase in coriander yield due to the application of each fertilizer rate [22]. For each pair of ranked treatments, the % MRR is calculated using the formula: MRR (%) = Change in Net Benefit/Change in Total Variable Cost) ∗ 100%. A 100% MRR implies a return of one birr on every birr spent on the given variable input.

2.4. Data Analysis. Data were subjected to analysis of variance (ANOVA) using appropriate procedures for a factorial experiment in a randomized complete block design using

Genstat 14th edition (64-bit) software [23]. The significant differences among treatments were separated by using the least significant difference (LSD) and 5% level of significance.

3. Results and Discussion

3.1. Phenology of Coriander. The result of ANOVA for the combination of blended NPSB fertilizer rate and variety, and the rate of blended NPSB fertilizer separately do not affect days to emergence on coriander varieties. Only varieties showed a significance difference. Varietal differences were found to be crucial in determining the number of days to reach 50% emergence, with Walta having the longest time (33.67 days) due to its slower early seedling development or more sensitive growth mechanisms that respond to nutrient availability in the soil. This could be linked to genetic traits that affect seedling vigor, seed coat structure, or root development. The earliest emergence (24.33 days) occurred in the Gadisa variety, indicating that this variety is genetically quicker to establish and germinate, even under fertilized conditions. This emphasizes the importance of genetic traits in early-stage growth and establishment in coriander, which have been shown to significantly influence emergence timing. The finding is consistent with the results of [24].

For days to 50% flowering, the result of ANOVA showed that there was a significant difference in the interaction of varieties and the rate of blended NPSB fertilizer application. Walta-I variety recorded (128.7 days) with the highest blended NPSB fertilizer application rate (150 $kgha^{-1}$). This delay in flowering can be attributed to the increased nitrogen content in the fertilizer, which promotes excessive vegetative growth, thereby delaying the transition to the reproductive phase. This may also be due to genetic differences in varieties. This result aligns with previous studies that found that nutrient-rich conditions, especially nitrogen, in coriander led to a prolonged flowering period due to enhanced vegetative growth. The earliest flowering (61.3 days) occurred in the Gadisa variety with no fertilizer application (0 $kgha^{-1}$ NPSB). This early flowering can be explained as a stress-induced response, where the absence of essential nutrients prompts the plant to flower sooner in order to complete its life cycle before depleting available resources. Nutrient availability is a key factor in determining the timing of flowering and overall plant development. This supports the idea that nitrogen extends the vegetative growth period, delaying flowering. Similarly, Reference [25] reported that high fertilizer levels delayed flowering in coriander by fostering robust vegetative growth.

Days to 90% physiological maturity also showed a significance difference in the interaction of varieties and rate of blended NPSB fertilizer application. The local variety treated with 150 $kgha^{-1}$ blended NPSB fertilizer delayed for 175.4 days to reach maturity, likely due to enhanced vegetative growth from nitrogen supplementation, which delayed reproductive maturity (Table 3). The Gadisa variety without fertilizer matured earlier (90.8 days), likely due to nutrient deficiencies triggering an accelerated reproductive cycle. The relatively early maturity observed in the Gadisa variety under nutrient deficiency conditions might be linked to the plant's genetic characteristics and its response to limited nutrients. The results also align with [26, 27] who observed similar trends in other crops, where higher fertilizer rates delayed maturity by enhancing vegetative growth, while nutrient deficiencies promoted early flowering and maturity in Apiaceae family plants like coriander. Generally, the study highlights the importance of varietal differences in coriander growth and flowering timing, as well as the role of nutrient stress and nutrient deficiencies in plant development.

3.2. Growth Parameters. The interaction effect of blended NPSB fertilizer rate and coriander varieties on growth parameters depicts a significant difference. The study analyzed plant height, leaf production, and number of primary branches in coriander varieties (Table 4). Darara variety had the highest plant height at 150 kg/ha NPSB, suggesting its high genetic potential to respond to nutrient availability. This increase is likely due to the balanced supply of nitrogen, phosphorus, sulfur, and boron in blended NPSB, which are essential for cell elongation, photosynthesis, and internode development. The shortest plant height (31.1 cm) was observed in the local variety without fertilizer application. This may be due to genetic differences and reduced growth due to nutrient deficiency, particularly nitrogen, which is critical for chlorophyll formation and vegetative development. Similar findings were reported by [28, 29], who noted varietal differences in response to NPSB fertilizer in sesame and coriander. Interestingly, the Walta-I variety (46.6 cm) outperformed the Darara variety (46.3 cm), suggesting that genetic factors, in addition to nutrient management, play a significant role in plant growth. The local coriander variety may also have lower genetic potential for height compared to varieties like Darara or Walta-I, which likely contributes to the shorter stature observed in this treatment.

The interaction between blended NPSB fertilizer levels and coriander varieties had a highly significant effect on the number of leaf per secondary branch (Table 4). The highest leaf number (54.60 leaf/branch) was recorded in the local variety treated with 150 $kgha^{-1}$ of NPSB fertilizer, suggesting that this variety has a strong vegetative response under optimal nutrient supply. The synergistic roles of nitrogen, phosphorus, and sulfur in promoting shoot elongation, chlorophyll formation, and enzymatic activity can be attributed to the synergistic roles of nitrogen, phosphorus, and sulfur in promoting shoot elongation, chlorophyll formation, and enzymatic activity. Similar responses have been documented in previous studies. Reference [30] reported that coriander plants treated with 60 kg N/ha produced up to 38.4 leaves per plant, while control plants showed as low as 18.6 leaves, confirming the importance of nitrogen in vegetative development. In contrast, the lowest leaf number (21.40 leaves/branch) was recorded in the Darara variety without NPSB fertilizer, likely due to nutrient deficiency and lower adaptability of the variety under stress conditions. These consistent results from coriander and cumin underline the crucial role of integrated nutrient management and responsive genotypes in achieving better vegetative growth and biomass accumulation in spice crops.

Table 4: Interaction effect of blended NPSB fertilizer and coriander varieties on plant growth.

Varieties	NPSB	Plant height (cm)	Leaf number/secondary branch	Primary branch number	Secondary branch number
Local	0	31.1^{i}	35.13^{bc}	3.0^{j}	21.3^{e}
	50	49.8^{fgh}	35.87^{bc}	4.0^{hi}	26.0^{e}
	100	74.8^{de}	49.80^{a}	5.7^{ef}	37.7^{cde}
	150	107.2^{c}	54.60^{a}	6.7^{cd}	60.7^{c}
Darara	0	46.2^{gh}	21.40^{g}	3.7^{ij}	27.3^{e}
	50	61.5^{ef}	25.47^{fg}	6.3^{cde}	58.7^{c}
	100	110.6^{c}	29.83^{def}	7.7^{b}	92.8^{ab}
	150	138.5^{a}	34.40^{cd}	9.3^{a}	112.4^{a}
Gadisa	0	38.6^{hi}	28.60^{ef}	3.7^{ij}	21.5^{e}
	50	59.9^{fg}	35.60^{bc}	5.0^{fg}	33.6^{de}
	100	101.1^{c}	36.70^{bc}	6.0^{de}	87.7^{b}
	150	113.1^{bc}	39.60^{b}	7.0^{bc}	95.0^{ab}
Walta-I	0	46.6^{gh}	28.20^{ef}	4.7^{gh}	25.0^{e}
	50	46.2^{gh}	29.80^{def}	6.0^{de}	55.7^{cd}
	100	61.5^{ef}	32.80^{cde}	7.0^{bc}	98.0^{ab}
	150	110.6^{c}	34.80^{bc}	8.7^{a}	99.0^{ab}
LSD (0.005)		14.2	4.8	0.9	23.6
CV (%)		10.6	8.4	9.3	23.8

Note: The means followed by the same letter within the same column are not significantly different at 5% level of significance.

The highest number of primary branches per plant (9.3) was recorded for the Darara variety treated with the highest rate (150 kg/ha) of blended NPSB fertilizer, possibly due to the role of phosphorus in promoting cell division and vegetative growth. This result was in line with the finding of [31] who reported that the highest number of primary branches (11.85) was observed with the application of 150 $kgha^{-1}$ blended NPSB and 40/30 $kgha^{-1}$ N/P_2O_5 for black cumin. The lowest number of primary branches (3.0) was recorded for the local variety without fertilizer application, likely due to genetic variation in the production of primary branches among the varieties. This finding was also supported by [29, 31] who reported that the number of primary branches per coriander plant showed high variability among genotypes, ranging from 2.82 to 15.10 branches. Previous studies also reported that the number of primary branches in coriander varied between 4.67 and 15.20 branches [32] and between 5.13 and 7.33 branches [33]. This indicates that certain varieties naturally tend to produce more primary branches under low or no fertilizer conditions, while others produce fewer branches, likely due to differences in genetic makeup, physiological responses, and environmental adaptability [33]. In this study, such differences are critical for identifying varieties that can perform well in resource-limited settings, where fertilizer application may not always be feasible.

The highest number of secondary branches (112.4) was obtained from the combination of the highest rate of blended NPSB (150 $kgha^{-1}$) and the Darara variety, followed by Walta-I (99.0) with blended NPSB 150 $kgha^{-1}$ (Table 4). This increase in the number of primary and secondary branches could be attributed to the application of nitrogen, which promotes exuberant growth of basal buds, leading to increased branching.

Different coriander varieties have varying genetic potential for branching and nutrient utilization, particularly for nitrogen and phosphorus. Higher nitrogen levels lead to enhanced vegetative growth, resulting in more secondary branches. Phosphorus and boron are essential for root and flower development, indirectly influencing branch number. The local variety with the minimum number of secondary branches (21.3) had the lowest number of branches without blended NPSB fertilizer application (Table 3). Micronutrient deficiencies can reduce canopy growth, premature senescence, and decrease spice crop yields like fennel, cumin, and coriander. Reference [34] reported that micronutrient deficiencies can reduce canopy growth, cause premature senescence, and thereby decrease the yields of spice crops such as fennel, cumin, and coriander.

3.3. Yield Parameters. The study reveals that the number of umbels per plant (NUPP) in coriander is significantly influenced by the interaction between NPSB fertilizer rates and coriander varieties (Table 5). The maximum NUPP (1121.8) was recorded when the variety Darara was applied with 150 kg per ha blended NPSB fertilizer compared to the variety Walta_I (1040.4). This variability suggests that different coriander varieties have distinct genetic potentials influencing their response to fertilizer applications. The blended NPSB fertilizer, containing nitrogen (N), phosphorus (P), sulfur (S), and boron (B), plays a crucial role in enhancing plant growth by supporting essential physiological processes. Phosphorus promotes root development, sulfur aids in protein synthesis and metabolic functions, and boron is critical for flower and seed development. The application of optimal blended NPSB fertilizer rates can stimulate the production of umbels, as these nutrients are vital for promoting floral initiation and development. The lowest NUPP (63.4) was obtained from the local variety at zero level of blended NPSB fertilizer, indicating that without fertilizer application, the local variety produced significantly fewer umbels, highlighting

Table 5: Interaction effect of blended fertilizer and coriander varieties on yield parameters.

Varieties	NPSB	Umbel number/plant	Umbellet number/plant	Seed number/umbel	Thousand seed weight (gm)
Local	0	63.4^{k}	152.1^{m}	12.6^{j}	23.37^{i}
	50	145.1^{j}	496.8^{kl}	20.9^{h}	24.28^{hi}
	100	402.0^{fg}	1185.3^{i}	39.8^{f}	25.48^{ghi}
	150	677.2^{e}	3334.1^{f}	50.3^{d}	29.98^{fg}
Darara	0	152.4^{j}	690.8^{jk}	32.3^{g}	25.23^{ghi}
	50	396.1^{g}	1903.9^{h}	47.8^{e}	40.89^{e}
	100	943.0^{c}	4814.7^{c}	$76.\ 0^{b}$	57.44^{b}
	150	1121.8^{a}	5630.4^{a}	97.3^{a}	67.59^{a}
Gadisa	0	91.2^{k}	301.8^{lm}	16.3^{h}	24.18^{hi}
	50	207.0^{i}	897.9^{g}	33.1^{g}	29.78^{fgh}
	100	442.2^{f}	2461.7^{g}	49.0^{de}	41.68^{e}
	150	1021.4^{b}	4163.5^{d}	76.1^{b}	47.71^{d}
Walta-I	0	90.2^{k}	447.3^{l}	18.3^{i}	24.52^{ghi}
	50	352.5^{h}	1257.0^{i}	39.1^{f}	49.67^{cd}
	100	832.6^{d}	3715.2^{e}	59.1^{c}	49.67^{cd}
	150	1010.4^{b}	5112.9^{b}	76.7^{b}	54.89^{bc}
LSD (0.005)		41.1	241.6	12.6	9.1
CV (%)		4.9	0.6	20.9	2.7

Note: The means followed by the same letter within the same column are not significantly different at 5% level of significance.

the importance of balanced fertilization for optimal umbel production. This variability can be attributed to genetic factors, as indicated by previous studies. This result is consistent with the findings of [25] who indicated that the lowest number of umbels was obtained without nitrogen application. The NUPP in coriander was highly significantly influenced by the interaction between blended NPSB fertilizer rates and coriander varieties, as revealed by the ANOVA (Table 5). Darara variety exhibited the highest umbellet count, particularly when combined with the highest NPSB fertilizer rate of 150 $kgha^{-1}$, resulting in 5630.4 umbellets per plant. On average, Darara also recorded the highest umbellet number across treatments (690.8), confirming the important role of genetic factors in enhancing flowering and umbellet formation. The local variety produced the lowest average number of umbellets per plant (152.1), suggesting both a lower genetic capacity and a weaker response to fertilization. Thus, determining the optimal fertilizer rate is essential to maximizing umbellet production without compromising plant vigor. Studies by [35] also support these findings, highlighting that both genotype and balanced nutrient management play a critical role in achieving higher umbellet yields in coriander. Overall, the study highlights the importance of determining the optimal fertilizer rate to maximize umbellet production without compromising plant vigor and the role of genotype and balanced nutrient management in achieving higher umbellet yields in coriander. The Darara variety showed the highest number of seeds per umbel (97.3) at the highest blended NPSB rate (150 $kgha^{-1}$) (Table 5). This indicates that both genetic capacity and adequate nutrient availability are crucial for maximizing seed number per umbellet. Phosphorus, blended in NPSB, is vital for cell division and reproductive development, while boron enhances flower and seed formation. Nitrogen and phosphorus together stimulate cytokinin synthesis, which further promotes seed development through enhanced nuclear division and pod filling.

The interaction between fertilizer level and variety is crucial, as some varieties, like Darara and Gadisa, show significantly better performance at higher blended NPSB rates, while others respond poorly under nutrient-deficient conditions. The findings are consistent with previous studies that highlight the importance of both genotype and nutrient management in improving seed yield traits like the number of seeds per umbel. Nitrogen and phosphorus together stimulate cytokinin synthesis, which further promotes seed development through enhanced nuclear division and pod filling [35]. Previous studies have also indicated a significant interactive effect of blended NPS fertilizer levels and varieties on the number of seeds per capsule in black cumin. Reference [32] reported an increase in the number of black cumin seeds per capsule from 74.07 (Natore variety) to 99.13 (Iran variety) as the N:P fertilizer rate increased from 40:20 to 120:40 kg/ha, respectively.

The ANOVA and mean comparison for thousand seed weight in coriander as influenced by different rates of blended fertilizer (NPSB) and varieties revealed statistically significant differences due to NPSB levels, variety types, and their interaction effects (Table 5). The highest 1000-seed weight was recorded in the Darara variety at 150 $kgha^{-1}$ blended NPSB, with a mean value of 67.59 g, significantly superior to all other treatments. These results reinforce earlier work by [36] who found that increasing NPSB levels improved seed development traits in coriander, especially in improved genotypes. This finding supports [31], who demonstrated that higher fertilizer application in coriander leads to better nutrient accumulation, which translates into larger and heavier seeds. This result aligns with previous work by [37, 38], who reported that improved coriander varieties, particularly Darara, respond strongly to blended fertilizer application, showing increased seed size and weight under high nutrient availability. Higher blended NPSB levels also improve seed development traits in coriander, especially in improved genotypes.

Table 6: Interaction effect of blended fertilizer and coriander varieties on yield parameters (seed yield, above-ground dry biomass, and harvest index).

Varieties	NPSB	SY (tha$^{-1)}$	AGDB (g)	HI (%)	OSR
Local	0	0.77^{j}	725^{n}	27.9^{m}	0.22^{k}
	50	0.84^{ij}	800^{l}	32.3^{i}	0.32^{i}
	100	0.96^{i}	1085^{f}	37.1^{g}	0.41^{fg}
	150	1.26^{h}	1240^{d}	38.8^{f}	0.43^{f}
Darara	0	1.16^{h}	817^{k}	31.5^{j}	0.41^{fg}
	50	2.00^{f}	942^{j}	39.1^{f}	0.45^{e}
	100	3.67^{b}	1082^{f}	42.9^{b}	0.57^{b}
	150	3.99^{a}	1514^{a}	44.8^{a}	0.62^{a}
Gadisa	0	0.79^{j}	737^{m}	30.2^{k}	0.27^{j}
	50	0.85^{ij}	989^{i}	33.4^{h}	0.35^{h}
	100	1.82^{g}	1015^{h}	40.2^{d}	0.39^{g}
	150	2.42^{e}	1330^{c}	42.8^{b}	0.48^{d}
Walta-I	0	0.89^{ij}	814^{k}	29.5^{l}	0.29^{j}
	50	1.16^{h}	1044^{g}	31.2^{j}	0.42^{f}
	100	2.72^{d}	1143^{e}	39.7^{e}	0.48^{d}
	150	3.21^{c}	1444^{b}	41.4^{c}	0.52^{c}
LSD (0.005)		1.36	11.3	0.5	0.02
CV (%)		4.6	0.6	0.8	3.3

Note: LSD, least significant difference test. The means followed by the same letter within the same column are not significantly different at 5% level of significance.

Abbreviations: AGDB, above-ground dry biomass; HI, harvest index; OSR, oil-to-seed ratio; SY, seed yield.

The lowest 1000-seed weight was observed in the local variety at 0 kg NPSB ha^{-1}, with a mean of 23.37 g, statistically similar to other low-performing treatments. This result may be due to genetic differences and differences in blended NPSB fertilizer rate. This finding corresponds with observations by [39], who noted that local coriander varieties often perform poorly in nutrient-deficient soils due to limited nutrient uptake capacity and lower genetic potential for seed mass. Improved varieties like Darara show a stronger response to fertilizer compared to local varieties.

The highest seed yield was obtained from the Darara variety at blended NPSB fertilizer rate of 150 kgha^{-1}, producing 3.99 tha^{-1} (Table 6). This suggests that Darara is highly responsive to increased fertilizer rates and performs best under given agroecological conditions. These findings are supported by [26] showed a similar recorded 1.89 tha^{-1}seed yield at 125 kgha^{-1} of NPK application.

The lowest coriander seed yield was recorded from the local variety with no seed application (0 kg/ha), producing only 0.77 tha^{-1}, designated as reference. This indicates that both the absence of improved variety and lack of seed input significantly limit productivity.

Above-ground total biomass dry weight consistently increased with higher rates of blended NPSB application. The highest biomass (1514 g) was recorded for the Darara variety at 150 kgha^{-1} of NPSB, while the lowest (737 g) was observed in the local variety with no fertilizer (Table 6). The increase in dry matter yield is likely due to improved nutrient availability, especially phosphorus and sulfur, which are critical for enhancing photosynthetic activity, branching, and overall plant growth. Sulfur's role in improving nitrogen use efficiency further contributed to better biomass accumulation. These findings are supported by studies in other crops, such as soybean, faba bean, and mung bean. A 108.8% increase in biomass was recorded for Darara over the local variety at zero NPSB, highlighting the influence of both varietal potential and nutrient management. Genotypic differences among coriander varieties also played a role, as shown by [24], where the Erbaa cultivar produced the highest biomass among 17 genotypes. Overall, the study underscores the synergy between improved varieties and balanced nutrient application in maximizing coriander biomass yield.

The HI is a crucial measure of crop productivity, indicating the plant's efficiency in converting biomass into economic yield. The highest HI was recorded for the Darara variety at a 150 kgha^{-1} blended NPSB fertilizer rate, demonstrating superior dry matter partitioning to seed yield (Table 6). This improvement can be attributed to enhanced seed yield resulting from nutrient availability, especially nitrogen and phosphorus. Reference [35] observed a significant "variety × fertilizer" interaction for coriander, with the highest HI (30.86%) recorded for the Erbaa variety at optimal NPSB application. This finding is consistent with [24], who found the Erbaa cultivar to have the highest HI among various coriander genotypes. The lowest HI (27.93%) was observed in the local variety under control (no fertilizer) treatment, suggesting an inefficient partitioning of dry matter, with more energy being allocated to vegetative growth rather than seed production in the absence of adequate nutrients. Reference [35] reported the lowest HI (23.04%) for the Erbaa variety under a control application of no fertilizer, further confirming the importance of fertilizer in improving HI.

The highest oil-to-seed ratio (0.62) was recorded for the Darara variety at 150 kgha^{-1} NPSB fertilizer application rate, likely due to the balanced supply of nitrogen, phosphorus, and sulfur, which enhance photosynthetic activity and lead to the production of secondary metabolites like essential oils. Phosphorus, known for its role in root development and seed development, enhances the oil content by improving plant metabolism [40]. Furthermore, sulfur is essential for the synthesis of oils and secondary metabolites in oilseed crops [41]. The superior genetic traits of the Darara variety, combined with proper fertilization, likely contributed to its higher oil content.

The lowest oil-to-seed ratio (0.22) was recorded for the local variety under control (no fertilizer) treatment, indicating an inefficient partitioning of biomass, with more energy allocated to vegetative growth instead of oil production. Reference [35] reported similar results for the Arslan variety, with a lowest oil content of 0.27 under control conditions.

The study highlights the importance of fertilizer in optimizing oil production in coriander. It highlights the impact of genetic traits and nutrient management on oil content in coriander. High-performing varieties like Darara and optimizing fertilizer use are key strategies for improving oil yield in coriander production. Genetic differences among coriander varieties also play a significant role in oil yield.

Table 7: Marginal rate of return analysis for coriander production with NPSB fertilizer application and different varieties (ranked by net benefit).

NPSB	Variety	UASY (tha^{-1})	ASY (tha^{-1})	GFB (ETB ha^{-1})	TVC (ETB ha^{-1})	NB (ETB ha^{-1})	MRR	MRR (%)
0	Local	0.77	0.63	170,100	33,300	136,800	0	0
50	Local	0.84	0.756	204,120	35,500	168,620	14.4636	1446.36
100	Local	0.96	0.864	233,280	37,700	195,580	12.2545	1225.45
150	Local	1.26	1.134	306,180	39,900	266,280	32.1363	3213.63
0	Darara	1.16	1.044	292,320	33,900	258,420	1.31	131.00
50	Darara	2.00	1.80	504,000	36,100	467,900	95.2181	9521.81
100	Darara	3.67	3.303	924,840	38,300	886,540	190.29	19,029.00
150	Darara	3.99	3.591	1,005,480	40,500	964,980	35.6545	3565.45
0	Walta-I	0.89	0.801	224,280	33,900	190,380	117.3	11,730.00
50	Walta-I	1.16	1.044	292,320	36,100	356,220	75.3818	758.18
100	Walta-I	2.72	2.448	685,440	38,300	647,140	132.236	13,223.60
150	Walta-I	3.21	2.889	808,920	40,500	768,420	55.1272	5512.72
0	Gadisa	0.79	0.711	199,080	33,900	165,180	91.4000	9140.00
50	Gadisa	0.85	0.765	214,200	36,100	178,100	5.8727	587.27
100	Gadisa	1.82	1.638	458,640	38,300	420,340	110.1090	11,010.900
150	Gadisa	2.42	2.178	609,840	40,500	569,340	67.7272	6772.72

Note: The market price of improved coriander seed was 300 ETB kg^{-1} and for local variety 250 EBirr kg^{-1}, the cost of NPSB fertilizer was 44 ETB kg^{-1} during the experimental period. The cost of urea = 42 EBirr kg^{-1}, agronomic cost = 33,300. $ETBha^{-1}$ = Ethiopian Birr per hectare.
Abbreviations: ASY = adjusted seed yield, GFB = gross field benefit, MRR = marginal rate of return, NB = net benefit, TVC = total variable costs, UASY = unadjusted seed yield.

Darara, with higher oil content, may have superior genetic traits for oil biosynthesis, which were enhanced by the application of blended NPSB fertilizers. Previous research has shown that essential oil ratios differ among cultivars, with the highest average oil ratio recorded in the Erbaa variety and the lowest in the Arslan variety under the semiarid climate of the Southeastern Anatolia Region in Turkey. The Darara variety, combined with proper fertilization, likely contributed to its higher oil content. The lowest oil-to-seed ratio was recorded for the local variety under control treatment, indicating an inefficient partitioning of biomass. Similar results were reported for the Arslan variety. Reference [42] found that mung bean varieties lacking NPSB fertilization had lower oil content, highlighting the impact of nutrient deficiencies on oil production.

3.4. Partial Budget Analysis. The partial budget analysis of different NPSB fertilizer application rates for coriander production provides valuable insights for farmers. The highest MRR recorded in this study was from the treatment with 100 $kgha^{-1}$ NPSB fertilizer, which achieved an MRR of 19,029.00% (Table 7). This high rate of return indicates that investing in 150 $kgha^{-1}$ NPSB fertilizer is economically viable and highly profitable, particularly for farmers looking to maximize their returns CIMMYT [22]. The highest net benefit was achieved at 150 $kgha^{-1}$ NPSB with the combination of Darara variety, indicating that investing in this fertilizer is economically viable and highly profitable. However, the higher fertilizer application rate could pose challenges for smallholder farmers due to upfront costs, making it important to evaluate affordability and accessibility. The highest net benefit from the highest performing treatment, 150 $kgha^{-1}$ NPSB applied to the Darara variety, was 964,980 Birr/ha, the highest among the tested treatments. This high net benefit suggests that not only does this combination of fertilizer and variety provide higher yields but also offers a significant economic advantage to farmers. Further trials are recommended to determine the sustainability of the fertilizer application rate across different seasons and locations. The Darara variety is not only the best performer in terms of yield but also shows excellent potential for economic returns when paired with the optimal fertilizer rate.

4. Conclusion

The study found that applying blended NPSB fertilizers significantly improves coriander yield, with the optimal rate of 150 $kgha^{-1}$ blended NPSB being most effective. Varieties like Darara respond well to higher fertilizer rates, leading to increased seed yield, better quality, and higher economic returns. The study emphasizes the need for adapted fertilization strategies based on crop variety and soil conditions, as not all varieties respond equally. Proper fertilizer use can boost farmers' income, making it a profitable investment. However, further research across different agroecologies and multiple seasons is needed to confirm these findings and develop broader recommendations for coriander cultivation. The recommendation is to adopt 150 $kgha^{-1}$ NPSB fertilizer, particularly for the Darara variety, as it showed the highest yield and economic return. Further trials will help establish a more comprehensive fertilizer application strategy for optimal coriander production across diverse regions.

Data Availability Statement

The data that support the findings of this study are available upon request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Ethics Statement

The research does not involve human participants or groups of humans to health-related interventions or animal subjects.

Conflicts of Interest

The authors declare no conflicts of interest.

Author Contributions

Tamene Haile: conceptualization; ideas; formulation or evolution of overarching research goals and aims; data curation; and management activities to annotate (produce metadata), scrub data, and maintain research data (including software code, where it is necessary for interpreting the data itself) for initial use and later re-use.

Desalegn Negasa Soresa: formal analysis, application of statistical, mathematical, computational, or other formal techniques to analyze or synthesize study data; manuscript preparation; and review and editing.

Alemu Hailu: review and editing, and assistance in conceptualization.

Funding

This work was funded by Wollega University.

Acknowledgments

This work was supported by Wollega University, and materials were obtained from Sinana Agricultural Research.

References

[1] L. N. Horn, E. P. Mulima, and F. M. Fwanyanga, "Coriander Cultivation and Agricultural Practices," in *Handbook of Coriander (Coriandrum sativum)* (CRC Press, 2023), 11–20.

[2] Food Agricultural Organization, *FAOSTAT Database* (Food and Agriculture Organization, 2023).

[3] A. Abnet, S. Abrham, and B. Abraham, "NPS Fertilizer and Spacing Effects on Yield and Quality of Coriander (*Coriandrum sativum* L.)," *Journal of Plant Sciences* 18, no. 1 (2023): 12–21, https://doi.org/10.3923/jps.2023.12.21.

[4] Ethiopian Soil Information System, "Soil Fertility and Fertilizer Tentative Recommendation Oromia Region. Ministry of Agriculture (MoA) and Agricultural Transformation Agency (ATA)" (2014).

[5] M. H. Saleem, X. Wang, S. Ali, et al., "Interactive Effects of Gibberellic Acid and NPK on Morpho-Physio-biochemical Traits and Organic Acid Exudation Pattern in Coriander (*Coriandrumsativum* L.) Grown in Soil Artificially Spiked With Boron," *Plant Physiology and Biochemistry* 167 (2021): 884–900, https://doi.org/10.1016/j.plaphy.2021.09.015.

[6] J. Singh, P. Verma, and R. Meena, "Coriander: An Important Spice Crop for Indian Farmers," *International Journal of Current Microbiology and Applied Sciences* 9, no. 5 (2020): 2312–2319.

[7] M. Z. Jaleta, A. Jalata, and A. Wagari, "Effects of Weeding Frequency and NPS Fertilizer Rates on Barley (Hordeum vulgare L.) Yield Performance, Western Ethiopia," *International Journal of Agricultural Science and Food Technology* 10, no. 3 (2024): 114–123, https://doi.org/10.17352/2455-815x.000215.

[8] N. S. Desalegn, N. Gomathi, and Z. Jaleta, "Heterosis in Tomato (*Solanum lycopersicum* L.) for Yield and Yield Component Traits," *Advances in Research* 21, no. 9 (2020): 141–152, https://doi.org/10.9734/air/2020/v21i930242.

[9] Ethiopian Agricultural Authority, "Plant Variety Release, Protection and Seed Quality Control Directorate" (2022).

[10] A. Abnet and A. S.& A. Belay, "NPS Fertilizer and Spacing Effects on Yield and Quality of Coriander (*Coriandrum sativum* L.)," *Journal of Plant Sciences* 18, no. 1 (2023): 12–21, https://doi.org/10.3923/jps.2023.12.21.

[11] Sk. Arafat, H. MahjabinMazrina, and Md. Habibullah Habib, "Determination of Organic Carbon of Soil by the Walkley & Black Method" (2023).

[12] P. Saez, M. J Navas, S. Wybraniec, T. Michałowski, and A. G. Asuero, "An Overview of the Kjeldahl Method of Nitrogen Determination. Part II. Sample Preparation," *Working Scale, Instrumental Finish, and Quality Control* 43, no. 4 (2013).

[13] S. R. Olsen, C. V. Cole, and F. S. Watanabe, "Estimation of Available Phosphorus in Soils by Extraction With Sodium Bicarbonate," *USDA Circular No. 939* (Washington, DC, USA: US Government Printing Office, 1954).

[14] Ch. Rajesh, J. Mollinedo, E. Thomas, and J. L. Julson, "Effect of Biochar on Chemical Properties of Acidic Soil," *Archives of Agronomy and Soil Science* 60, no. 3 (2013): 393–404, https://doi.org/10.1080/03650340.2013.789870.

[15] E. Teklu, F. Laekemariam, Wu. Abera, and L. Tamene, "Evolution of Soil Fertility Research and Development in Ethiopia: From Reconnaissance to Data-Mining Approaches," *Experimental Agriculture*, 2022 (Cambrage University Press, 2022), 1–12, https://doi.org/10.1017/S0014479721000235.

[16] MoA (Ministry of Agriculture), *Animal and Plant Health Regulatory Directorate Crop Variety Register* (MoA, 2012).

[17] P. Hazelton and B. Murphy, *Interpreting Soil Test Results: What Do all the Numbers Mean*, 2nd ed. (CSIRO Publishing, 2007).

[18] J. B. Jones, "Plant Mineral Nutrition," in *Agronomic Handbook: Management of Crops, Soils and Their Fertility* (Boca Raton, FL, USA: CRC Pres, 2003), 325.

[19] R. K. Sarkar and D. &Basu, "Effect of Nitrogen and Phosphorus on Growth, Yield and Quality of Coriander (*Coriandrum sativum* L.)," *Journal of Spices and Aromatic Crops* 23, no. 1 (2021): 42–45.

[20] D. Sh. Eticha, N. Dachassa, T. Desalegn, and T. Balami, "Effect of Applying Integrated Mineral and Organic Fertilizers on Seed Yield, Yield Components and Seed Oil Content of Black Cumin in Central Highlands of Ethiopia," *International Journal of Horticultural Science and Technology* 10, no. 1 (2023): 97–114.

[21] H. N. Pahalvi, L. Rafiya, S. Rashid, B. Nisar, and A. N. &Kamili, "Chemical Fertilizers and Their Impact on Soil Health," *Microbiota and Bio-Fertilizers, Ecofriendly Tools for Reclamation of Degraded Soil Environs* 2 (2015): 1–20, https://doi.org/10.1007/978-3-030-61010-4_1.

[22] Cimmyt (International Maize and Wheat Improvement Center), *From Agronomic Data to Farmer Recommendations: An Economics Workbook* (D.F.: CIMMYT, 1988).

[23] VSN International, *Genstat for Windows*, 14th ed. (VSN International, 2014).

[24] A. Basol, G. Yaldiz, and M. &Camlica, "Genetic Diversity, Analysis of Some Agro-Morphological and Quality Traits, and Utilization of Plant Resources of Coriander (*Coriandrum sativum*) Supported With Cluster and Multivariate Analyses,"

Biology 13, no. 11 (2024): 866–28, https://doi.org/10.3390/biology13110866.

[25] P. P. Javiya, J. N. Solanki, S. C. Kaneria, and V. V. Rupareliya, "Response of Coriander (*Coriandrum sativum* L.) to Nitrogen and Phosphorus in South Saurashtra Condition," *International Journal of Pure and Applied Bioscience* 5 (2017): 860–866.

[26] G. S. Thanuja, B. Srinivasulu, and K. M. Y.& K. Giridhar, "Effect of Organic Manures, PGPR and Micronutrients on Yield and Quality Enhancement in Ajwain (*Trachyspermumammmi*l)," *Journal of Spices and Aromatic Crops* 30, no. 1 (2021): 100–106, https://doi.org/10.25081/josac.2021.v30.i1.6576.

[27] S. Deresa, T. Afeta, and R. Nuguse, "Effect of Blended NPSB Fertilizer Rates and Varieties on Productivity of Chickpea (*Cicer arietinum* L.) in Midland of Guji Zone, Southern Oromia," *Austin Journal of Plant Biology* 10, no. 1 (2024): 1041, https://doi.org/10.26420/austinjplantbiol.2024.1041.

[28] A. Mushtaree, M. A. R. Sarkar, M. S. Kabiraj, S. K. Sarkar, M. H. Rashid, and S. K. Paul, "Performance of Aman Rice Varieties Under Different Nutrient Management," *Bangladesh Agronomy Journal* 25, no. 2 (2022): 89–96, https://doi.org/10.3329/baj.v25i2.65952.

[29] G. G. Geserto and Z. M. Adare, "Blended NPSB Fertilizer Rates Effect on Growth, Yield and Yield Components of Sesame (*Sesamum indicum* L.) Varieties at Konso, Southern Ethiopia," *International Journal of Scientific Research Updates* 3 (2022): 50–063.

[30] M. M. K. Ali, M. A. Hasan, and M. R. Islam, "Influence of Fertilizer Levels on the Growth and Yield of Black Cumin (*Nigella sativa* L.)," *The Agriculturists* 13, no. 2 (2011): 97–104, https://doi.org/10.3329/agric.v13i2.27335.

[31] Sh. Eticha, N. Dachassa, T. Desalegn, and T. Balami, "Effect of Applying Integrated Mineral and Organic Fertilizers on Seed Yield, Yield Components and Seed Oil Content of Black Cumin in Central Highlands of Ethiopia," *International Journal of Horticultural Science and Technology* 10, no. 1 (2023).

[32] P. Shiwangi, H. P. Hadimani, D. Satish, M. Awati, V. Kantharaju, and I. B. Biradar, "Assessment of Genetic Variability Parameters in Coriander (*Coriandrumsativum* L.) Genotypes for Growth, Foliage Yield and Quality Traits," *Plantar Arch* 20 (2020): 721–726.

[33] A. Hongal, N. Basavaraja, S. Hongal, N. K. Hegde, and S. Kulkarni, "Evaluation of Coriander (*Coriandrum sativum* L.) Genotypes for Yield and Quality Under Hill Zone (Zone-9) of Karnataka, India," *International Journal of Current Microbiology and Applied Sciences* 7, no. 05 (2018): 2494–2502, https://doi.org/10.20546/ijcmas.2018.705.287.

[34] C. K. Thankamani, V. Srinivasan, J. S. Remya, et al., "Organic Farming of Spices: Concepts, Issues, and Strategies," in *Handbook of Spices in India: 75 Years of Research and Development* (Singapore: Springer Nature Singapore, 2024), 3949–4054.

[35] G. Ozyazici, "Influence of Organic and Inorganic Fertilizers on Coriander (*Coriandrum sativum* L.) Agronomic Traits, Essential Oil and Components Under Semi-Arid Climate," *Agronomy* 11, no. 7 (2021): 1427, https://doi.org/10.3390/agronomy11071427.

[36] Y. M. &A. Daba, "Blended Fertilizer Rate Effect on Growth and Yield of Coriander (*Coriandrum sativum* L.) Varieties in Central Ethiopia," *African Journal of Plant Science* 15, no. 2 (2021): 56–66.

[37] W. Kebede, S. Mohammed, and T. Tadesse, "Effect of Blended Fertilizers on Growth and Yield of Coriander (*Coriandrum sativum* L.) in Ethiopia," *Journal of Agricultural Research* 15, no. 3 (2020): 122–130.

[38] D. Aishwarya and N. Amitabh, "Impact of Micronutrient Application in Coriander (*Coriandrum Sativuml.*) Cv. CO4," *Advanced Journal of Seed Science and Technology* 2 (2015): 42–46.

[39] A. Getachew and D. Nigussie, "Effect of Blended NPSB Fertilizer on Growth and Yield of Spice Crops Under Different Agro-Ecological Zones," *Journal of Spice and Aromatic Crop Science* 8, no. 1 (2019): 33–40.

[40] F. Nadeem, M. A. Hanif, M. I. Majeed, and Z. &Mushtaq, "Role of Macronutrients and Micronutrients in the Growth and Development of Plants and Prevention of Deleterious Plant Diseases-A Comprehensive Review," *International Journal of Chemical and Biochemical Sciences* 13 (2018): 31–52.

[41] T. Zenda, S. Liu, A. Dong, and H. &Duan, "Revisiting Sulfur. The Once Neglected Nutrient: Its Roles in Plant Growth, Metabolism, Stress Tolerance and Crop Production," *Agriculture* 11, no. 7 (2021): 626, https://doi.org/10.3390/agriculture11070626.

[42] M. Baza, D. Shanka, and M. &Bibiso, "Agronomic and Economic Performance of Mung Bean (*Vigna radiata* L.) Varieties in Response to Rates of Blended NPS Fertilizer in Kindokoysha District, Southern Ethiopia," *Open Life Sciences* 17, no. 1 (2022): 1053–1063, https://doi.org/10.1515/biol-2022-0461.