"Effect of micronutrients and biofertilizer on yieldattributes of coriander (*Coriandrum sativum* L.) *cv*. RCR-41"

Abstract

The current study, named "effect of micronutrients and biofertilizer on yield parameters of coriander Coriandrum sativum (L.) cv. RCR-41," is planned to be carried out in the Research Field, Department of Horticulture, College of Agriculture, Gwalior, M.P., during **Rabi 2020-21 and 2021-22**. The experiment was designed ~~using the~~~~Randomised Block Design~~**in aCompletely Randomized Block Design (CRBD)with two factors conceptsi.e.,Micronutrients** (**$ZnSo_4$ (0.5%), $FeSo_4$ (0.5%), $CuSo_4$ (0.5%), Biofertilizers (Phosphorus Solubilizing Bacteria (PSB), Azotobacter, Potassium Solubilizing Bacteria (KSB) and replicated three times**and included three replications. At the time of coriander seeding, ~~the following~~ treatments combinations including RDF doses of fertilisers and biofertilizers, ~~namely Azotobactor and PSB,~~ were used. The results showed that treatment M1 (ZnSO4 @ 0.5%) was the optimum micronutrient level treatment for coriander production. Treatment B2 (Azotobacter) was shown to be the optimal biofertilizer level for coriander production. The treatment combination M1B2 (ZnSo4 @ 0.5% x Azotobacter) was shown to be considerably better among all treatment combinations, yielding the highest coriander yield characteristics.

Key words:~~Quality~~, Coriander, Biofertilizers, Micronutrients, Fertilizers, **Yield attributes**

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Comment [MZ2]: The type of design not mentioned or explained in Materials and Methods

1. Introduction

Annuals bear the coriander (Coriandrum sativum L.) herbaceum. Consider it to be among the earliest seed spices utilised by Homo sapiens. Coriander, a member of the Apiaceae (Umbelliferae) family, is predominantly grown year-round from its seeds (Mhemdi et al. 2011). It is also referred to in Hindi as "Dhaniya." The seeds have a distinct flavour, are round to ovoid in shape, and are golden brown or brown in colour with vertical ridges. Curry powder relies heavily on the seeds as an essential component (Ramadan et al. 2002). Ayurvedic medicinal herb Coriandrum sativum is extensively utilised as a flavouring agent due to its distinctive aroma and taste. Vermaet al. (2011) report that coriander is a significant source of the compounds a-pinene, a-terpinene, limonene, and ncymene, in addition to numerous non-linalool alcohols and esters.

The primary nutritional value of coriander seeds and foliage is their high vitamin A and C content. The raw leaves of this plant are composed of the following elements: 87.9% moisture, 3.3% protein, 6.5% carbohydrates, 1.7% total ash, 0.4% calcium, 0.06 percent phosphorus, 0.01% iron, 60mg vitamin B2 per 100g, 0.8mg vitamin C per 100g, and 10,460 International units (IU) per 100g of vitamin A. According to Peter (2004), 100g of coriander seed comprises approximately 30g of unrefined fibre, 20g of fat, 11g of protein, and nearly 11g of carbohydrate (**Reference about this**).

The utilisation of inorganic fertilisers was crucial for short-lived cereals (Aakash et al., 2022). Micronutrients are indispensable in minute amounts for optimal plant development and yield. Nevertheless, insufficiencies of these nutrients disrupt the plant's physiological and metabolic processes significantly (Singh *et al*., 2021). The utilisation of micronutrients is a critical factor in ensuring that crops are of superior quality and produce a substantial yield (**Lalita et al., 2022**)**No Reference Found**. The involvement of micronutrients in various metabolic processes of the plant, including photosynthesis, N-fixation, and respiration, has been extensively documented (Naga et al. 2013). Multiple researchers have documented the impact of micronutrient foliar fertiliser on the growth and yield enhancement of specific aromatic and medicinal plants (Mazaheri et al., 2013). The seed yield of coriander, the number of branches, umbels per plant, and seeds per umbel were all substantially impacted by the application of micronutrients (Kalidasuet al. 2008).

In addition to being more cost-effective, environmentally benign, and sustainable, biofertilizers are anticipated to gain prominence when used in conjunction with inorganic fertilisers (Malhotra et al. 2006). (Mahfouz and Sharaf-Eldin 2007) The use of biofertilizers containing various microbial strains has reduced reliance on chemical fertilisers and produced high-quality goods devoid of agrochemicals that are hazardous to human health. Biofertilizers that contribute positively to crop production include mycorrhizae, Azotobacter, Azospirillium, blue green algae, Azolla, PSB, and KSB (Meena et al., 2022). Nevertheless, in practise, the performance of bio-fertilizers is unreliable and inconsistent, notwithstanding their immense potential and advantages (Aakash et al., 2023). Azotobacter, PSB, and KSB are biofertilizers that are extensively utilised and provide plants with substantial N and P contributions, in addition to enhancing their resistance to water stress (Solanki et al., 2023).

With the aforementioned information in consideration, a field experiment is conducted to determine how different micronutrients and biofertilizer affect coriander yield parameters.

2. Material and methods

The experiment was conducted at Experimental Field, Department of Horticulture, College of Agriculture, Gwalior M.P.

~~2.2.2~~2.1**Variety RCr-41:**It is a tall, straight type with round, small seeds that take longer to produce shoots after they germinate. The type is very immune to wilt and stem gall diseases when grown in the field. It takes 130–140 days to fully grow, and each hectare of land creates an average of 920 kg of seeds.

~~2.2.1~~2.2 Experimental design and treatments details

Micronutrients:

M_0 = Control**(What is the type of control treatment?)**
M_1 = $ZnSo_4$ (0.5%)
M_2 = $FeSo_4$ (0.5%)
M_3 = $CuSo_4$ (0.5%)
M_4 = $MnSo_4$ (0.5%)

Biofertilizers:

B_0 = Control**(What is the type of control treatment?)**
B_1 = PSB**(What is PSB?.... Define)**
B_2 = *Azotobacter*
B_3 = KSB**(What is PSB?... Define)**

What are the concentrations of biofertilizers?

Try to write the materials and methods like this comes after…

A completely Randomized Block Design (CRBD) with three replications was conducted included two factors concepts with combination of 60 treatments (5 Micronutrients×4 Biofertilizers× 3 replicates).The first factor was induced by

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Comment [MZ5]: In Papers, it should be written in on paragraph

Comment [MZ6]: Define the type of control treatment, as un treated plant, or treated with water or what?

Comment [MZ7]: In the first mention of the sentence, write the all sentence then the abbreviation,
After, you can use the abbreviation in the context

Comment [MZ8]: Phosphorus Solubilizing Bacteria (PSB)

Comment [MZ9]: Potassium Solubilizing Bacteria (KSB)

micronutrients treatments i.e., $ZnSo_4$ (0.5%), $FeSo_4$ (0.5%), $CuSo_4$ (0.5%), $MnSo_4$ (0.5%), along with untreated (plants or seed) as a control treatment. The second factor was assigned to biofertilizer treatments *i.e.*, Phosphorus Solubilizing Bacteria(PSB), Azotobacter, Potassium Solubilizing Bacteria (KSB), along with the untreated (Seeds or plant) as a control treatment.

Field procedure

Try to write a paragraph first about the field condition and the procedure of the experiment before fertilizer application i.e., diameter of experimental unite (plot), ridges per unite or plot, long and width of ridges, deep of sowing seed, how many plants per ha, the period of growing plants, days to harvest crop and so on,.

~~2.2.3 2.3 Fertilizer application(~~

Comment [MZ10]: It is integrated into the steps of preparing the land for agriculture and in explaining the conditions of the experiment, and it does not take a separate section. It is not a factor in the study. It made me confused.

~~It was evenly spread out with~~**Experimental units were fertilized with**60 kg of nitrogen, 40 kg of phosphorus, and 20 kg of urea, diammonium phosphate, and muriate of potash. An initial dose of 30 kg N/ha and full doses of phosphorus and potassium were drilled into the ground by hand ploughing about 5 to 7 cm deep. The last amount of nitrogen through urea was spread out evenly over two sections and watered in.

Where are the method of applying your treatments?

How do you apply micronutrients and biofertilizer application?

At which stages of growing crop, you apply your treatments?

Pl, give me a wide explain about your treatments?

~~2.2.4~~2.4 Observations Recorded

Yield characters

1) **Number of umbels per plant**

At harvest, the umbels of five tagged plants were counted from each plot, and the average number of umbels/plant was computed.

2) **Number of umbellate per umbel**

At harvest, twenty umbels were chosen at random from the five tagged plants, and total umbellets were tallied. The average umbellets/umbel was then calculated.

3) **Number of seed per umbel**

At harvest, twenty umbels were chosen at random from the five tagged plants, and the total quantity of seeds was tallied. The average number of seeds per umbel was then calculated.

4) **Weight of seed per umbel (g)**

Five plants were chosen at random from each plot, permanently tagged, and used to calculate the weight of seed per umbel (g). Weighing using a weighing machine was used to record the weight of seed per umbel.

5) **Test weight (g)Weight of 1000 seeds (g)**

The seeds of all five randomly chosen plants were combined, and 1000 seeds were randomly picked and weighed from this lot.

6) **Leaf yield (g/plant)**

The weight of the fresh green leaf yield of five tagged plants was recorded, and the average was calculated to produce fresh green leaf yield/plant in gramme ~~and kilogramme~~.

7) **Seed yield (g/plant)**

The product obtained from each plant was threshed in order to calculate seed yield. The seeds were washed, dried, and weighed in grammes per plant.

Statistical analysis

Did you analyze data statistically according to the analysis of variance (ANOVA), or what is your method?
Pl mention your method and the used program i.e., (Excel, R, M-stat, Co-stat, IBM)
Pl mention how you calculated C.D. and S.E.

3. Result

3.1 Number of umbels per plant

The data pertaining to the quantity of umbels per plant is shown in Table 1. The treatment M1 (ZnSo4 @ 0.5%) had the highest number of umbels per plant (22.16, 22.20, and 22.18) in the first year, second year, and overall. On the other hand, the treatment M0 (Control) had the lowest number of umbels per plant (17.82, 17.83, and 17.82) in the first year, second year, and overall.

It's not true, Table (1) and all Tables came after showed the interaction effects between factors under study (Micronutrients and biofertilizers). But not shown the main effects of each factor. So Mean No. of 22.16, 22.20, and 22.18, do not refer to the mean effects of ZnSo4 treatment, but they belong to the mean effect of ZnSo4 under all the levels of biofertilizers.

So if you want to study the main effects of factors the table must be in this form,

Table (1): Main effects of micronutrients and biofertilizers treatments on Number of umbels per plant of coriander, during the two growing seasons 20/21 and 21/22.

Treatments/Traits	Number of umbels per plant		
	2020/2021	2021/2022	Combined
Micronutrients			
M_0			
M_1			
M_2			
M_3			
M_4			
Mean			
S.E			
C.D			
Biofertilizers			
B_0			
B_1			
B_2			
B_3			
Mean			
S.E			
C.D			

So pl notify that, all means in all Tables, not belongs to the main effects of factors, but to the interaction between factors,

So you have to write the results in the way I have mentioned before,

Or, if you want to keep your works in this way, you have to modified it again, but not talking about these Number as main effects of factors, but the interaction effects between factors.

So I will pass all Results, because it's same.

The highest number of umbels per plant (21.33, 21.38, and 21.36) in the first year, second year, and overall was observed in treatment B2 (Azotobacter), which had the highest biofertilizer level. Conversely, the lowest number of umbels per plant (18.51, 18.52, and 18.51) in the first year, second year, and overall was recorded in treatment B0 (Control), which had no biofertilizer.

The treatment combination M1B2, which consisted of ZnSo4 at a concentration of 0.5% and Azotobacter, had a substantial effect on the number of umbels per plant. It resulted in the highest number of umbels per plant (23.41, 23.47, and 23.44) in the first year, second year, and overall. In the first year, it was equivalent to the treatment combination M1B1 (ZnSo4 at a concentration of 0.5% combined with PSB). In the second year, it was equivalent to the treatment combination M1B1 (ZnSo4 at a concentration of 0.5% combined with PSB) and M2B2 (FeSo4 at a concentration of 0.5% combined with Azotobacter). These results were combined and analysed.

Table 1. Effect of micronutrients and bio-fertilizers on number of umbel per plant of coriander

Number of umbel per plant					
I[st] Year					
	B_0	B_1	B_2	B_3	MEAN
M_0	17.40	17.96	18.34	17.57	**17.82**
M_1	19.07	23.21	23.41	22.95	**22.16**
M_2	18.90	22.74	23.00	22.42	**21.77**
M_3	18.63	21.41	21.68	20.76	**20.62**
M_4	18.55	19.80	20.23	19.61	**19.55**
MEAN	**18.51**	**21.02**	**21.33**	**20.66**	

	M	**B**	**M*B**		
SE(m)	0.069	0.062	0.138		
CD(5%)	0.198	0.178	0.397		
IInd Year					
M_0	17.43	17.86	18.39	17.65	**17.83**
M_1	19.00	23.28	23.47	23.03	**22.20**
M_2	18.94	22.80	23.10	22.49	**21.83**
M_3	18.65	21.49	21.74	20.81	**20.67**
M_4	18.58	19.76	20.22	19.64	**19.55**
MEAN	**18.52**	**21.04**	**21.38**	**20.72**	
	M	**B**	**M*B**		
SE(m)	0.083	0.075	0.167		
CD(5%)	0.239	0.214	0.479		
Pooled					
M_0	17.42	17.91	18.36	17.61	**17.82**
M_1	19.04	23.25	23.44	22.99	**22.18**
M_2	18.92	22.77	23.05	22.45	**21.80**
M_3	18.64	21.45	21.71	20.79	**20.65**
M_4	18.57	19.78	20.22	19.62	**19.55**
MEAN	**18.52**	**21.03**	**21.36**	**20.69**	
	M	**B**	**M*B**		
SE(m)	0.077	0.069	0.153		
CD(5%)	0.220	0.197	0.440		

3.2 Number of umbellate per umbel

Table 2 displays the statistics on the number of umbellate per umbel. In the first year, second year, and overall, the treatment M1 ($ZnSo_4$ @ 0.5%) had the highest number of umbellate per umbel (5.98, 6.00, and 5.99), while the treatment M0 (Control) had the lowest number of umbellate per umbel (5.24, 5.24, and 5.24) among the different micronutrient levels.

The highest number of umbellate per umbel (5.88, 5.88, and 5.88) was observed in treatment B2 (Azotobacter) in the first year, second year, and when the data was pooled. Conversely, the lowest number of umbellate per umbel (5.51, 5.54, and 5.53) was recorded in treatment B0 (Control), among the different biofertilizer levels.

The interaction effect of micronutrient and biofertilizer levels did not have a significant impact on the number of umbellate per umbel in coriander.

Table 2. Effect of micronutrients and bio-fertilizers on number of umbellate per umbel of coriander

Number of umbellate per umbel					
Ist Year					
	B_0	**B_1**	**B_2**	**B_3**	**MEAN**
M_0	5.10	5.26	5.43	5.14	**5.24**
M_1	5.69	6.09	6.10	6.04	**5.98**
M_2	5.64	6.00	6.07	5.97	**5.92**
M_3	5.61	5.91	5.94	5.88	**5.84**
M_4	5.53	5.76	5.84	5.74	**5.72**
MEAN	**5.51**	**5.81**	**5.88**	**5.76**	
	M	**B**	**M*B**		
SE(m)	0.065	0.058	0.130		
CD(5%)	0.186	0.167	NS		
IInd Year					
M_0	5.14	5.24	5.45	5.15	**5.24**
M_1	5.70	6.12	6.12	6.04	**6.00**
M_2	5.67	6.02	6.07	6.00	**5.94**
M_3	5.65	5.87	5.95	5.86	**5.83**
M_4	5.55	5.76	5.83	5.73	**5.72**
MEAN	**5.54**	**5.80**	**5.88**	**5.76**	
	M	**B**	**M*B**		
SE(m)	0.066	0.059	0.133		
CD(5%)	0.191	0.171	NS		
Pooled					
M_0	5.12	5.25	5.44	5.15	**5.24**
M_1	5.69	6.11	6.11	6.04	**5.99**
M_2	5.66	6.01	6.07	5.99	**5.93**
M_3	5.63	5.89	5.95	5.87	**5.84**
M_4	5.54	5.76	5.83	5.73	**5.72**
MEAN	**5.53**	**5.81**	**5.88**	**5.76**	
	M	**B**	**M*B**		

SE(m)	0.066	0.059	0.131		
CD(5%)	0.188	0.169	NS		

3.3 Number of seed per umbel

The statistics on the amount of seeds per umbel is shown in Table 3. The highest number of seeds per umbel (25.92, 25.94, and 25.93) was observed in the first year, second year, and pooled data for treatment M1 (ZnSo4 @ 0.5%). Conversely, the lowest number of seeds per umbel (20.88, 20.93, and 20.91) was noted in the first year, second year, and pooled data for treatment M0 (Control).

The highest number of seeds per umbel (24.86, 24.91, and 24.88) in the first year, second year, and overall was observed in treatment B2 (Azotobacter), while the lowest number of seeds per umbel (21.82, 21.83, and 21.82) in the first year, second year, and overall was recorded in treatment B0 (Control).

The treatment combination M1B2, consisting of ZnSo4 at a concentration of 0.5% and Azotobacter, had a substantial effect on the number of seeds per umbel. It resulted in the highest number of seeds per umbel (27.40, 27.45, and 27.43) in the first year, second year, and overall. The therapy combination M1B1 (ZnSo4 @ 0.5% x PSB) and M2B2 (FeSo4 @ 0.5% x Azotobacter) showed similar results to the control group in the first year, second year, and overall.

Table 3 Effect of micronutrients and bio-fertilizers on number of seed per umbel of coriander

Number of seed per umbel					
Ist Year					
	B_0	**B_1**	**B_2**	**B_3**	**MEAN**
M_0	20.30	21.09	21.42	20.73	**20.88**
M_1	22.66	27.28	27.40	26.35	**25.92**
M_2	22.42	25.78	27.02	25.31	**25.13**
M_3	21.98	24.67	24.95	23.77	**23.84**
M_4	21.75	23.24	23.53	22.90	**22.86**
MEAN	**21.82**	**24.41**	**24.86**	**23.81**	
	M	**B**	**M*B**		
SE(m)	0.076	0.068	0.151		
CD(5%)	0.217	0.194	0.434		

II^{nd} Year					
M_0	20.34	21.11	21.48	20.80	**20.93**
M_1	22.69	27.30	27.45	26.30	**25.94**
M_2	22.39	25.77	27.06	25.29	**25.13**
M_3	21.94	24.70	24.99	23.82	**23.86**
M_4	21.78	23.30	23.55	23.00	**22.91**
MEAN	**21.83**	**24.44**	**24.91**	**23.84**	
	M	**B**	**M*B**		
SE(m)	0.067	0.060	0.134		
CD(5%)	0.192	0.171	0.383		
Pooled					
M_0	20.32	21.10	21.45	20.76	**20.91**
M_1	22.68	27.29	27.43	26.33	**25.93**
M_2	22.41	25.78	27.04	25.30	**25.13**
M_3	21.96	24.69	24.97	23.80	**23.85**
M_4	21.76	23.27	23.54	22.95	**22.88**
MEAN	**21.82**	**24.43**	**24.88**	**23.83**	
	M	**B**	**M*B**		
SE(m)	0.071	0.064	0.143		
CD(5%)	0.205	0.183	0.410		

3.4 Weight of seed per umbel (g)

The inquiry has determined that the weight of each seed cluster, known as an umbel, is shown in Table 4. In terms of micronutrient levels, the highest weight of seed per umbel (0.311, 0.312, and 0.312 g) was observed in the first year, second year, and overall in treatment M1 (ZnSo4 @ 0.5%). Conversely, the lowest weight of seed per umbel (0.215, 0.216, and 0.215 g) was recorded in the first year, second year, and overall in treatment M0 (Control).

The highest weight of seed per umbel (0.291, 0.293, and 0.292 g) was observed in treatment B2 (Azotobacter) in the first year, second year, and overall. Conversely, the lowest weight of seed per umbel (0.234, 0.234, and 0.234) was recorded in treatment B0 (Control) in the first year, second year, and overall.

The treatment combination M1B2, consisting of ZnSo4 at a concentration of 0.5% and Azotobacter, had a substantial effect on the weight of seeds per umbel. It resulted in the highest weight of seeds per umbel, measuring 0.340 g, 0.342 g, and 0.341 g in the first year, second year, and overall, respectively. The treatment combination M1B1 ($ZnSo_4$ @ 0.5% x PSB) and M2B2 ($FeSo_4$ @ 0.5% x Azotobacter) were equally effective in the first year and when the data was combined. In the second year, the treatment combination M1B1 ($ZnSo_4$ @ 0.5% x PSB) was equally effective.

Table 4 Effect of micronutrients and bio-fertilizers on weight of seed per umbel (g) of coriander

Weight of seed per umbel (g)					
Ist Year					
	B_0	**B_1**	**B_2**	**B_3**	**MEAN**
M_0	0.205	0.218	0.226	0.211	**0.215**
M_1	0.249	0.336	0.340	0.318	**0.311**
M_2	0.245	0.308	0.330	0.300	**0.296**
M_3	0.238	0.285	0.292	0.274	**0.272**
M_4	0.232	0.262	0.267	0.256	**0.254**
MEAN	**0.234**	**0.282**	**0.291**	**0.272**	
	M	**B**	**M*B**		
SE(m)	0.002	0.002	0.005		
CD(5%)	0.007	0.006	0.014		
IInd Year					
M_0	0.206	0.218	0.227	0.212	**0.216**
M_1	0.251	0.338	0.342	0.319	**0.312**
M_2	0.245	0.309	0.332	0.301	**0.297**
M_3	0.239	0.287	0.294	0.275	**0.274**
M_4	0.232	0.263	0.268	0.256	**0.255**
MEAN	**0.234**	**0.283**	**0.293**	**0.273**	
	M	**B**	**M*B**		
SE(m)	0.002	0.001	0.003		
CD(5%)	0.005	0.004	0.009		
Pooled					
M_0	0.206	0.218	0.227	0.211	**0.215**
M_1	0.250	0.337	0.341	0.319	**0.312**
M_2	0.245	0.309	0.331	0.301	**0.296**

M_3	0.239	0.286	0.293	0.274	**0.273**
M_4	0.232	0.262	0.267	0.256	**0.254**
MEAN	**0.234**	**0.282**	**0.292**	**0.272**	
	M	**B**	**M*B**		
SE(m)	0.002	0.002	0.004		
CD(5%)	0.006	0.005	0.012		

3.5 Test weight (g)

Table 5 displays the statistics on the test weight, measured in grammes. Regarding micronutrient levels, the highest test weight (11.95, 12.01, and 11.98 g) was observed in the first year, second year, and overall, in treatment M1 (ZnSo4 @ 0.5%). Conversely, the lowest test weight (10.29, 10.31, and 10.30 g) was recorded in the first year, second year, and overall, in treatment M0 (Control).

The highest test weight (11.65, 11.69, and 11.67 g) was observed in treatment B2 (Azotobacter) in the first year, second year, and overall. Conversely, the lowest test weight (10.72, 10.73, and 10.72 g) was detected in treatment B0 (Control) in the first year, second year, and overall.

The treatment combination M1B2, consisting of ZnSo4 at a concentration of 0.5% and Azotobacter, had a substantial impact on the test weight. It resulted in the highest test weight of 12.40, 12.47, and 12.44 grammes in the first year, second year, and overall, respectively. The treatment combination M1B1 (ZnSo4 @ 0.5% x PSB) and M2B2 (FeSo4 @ 0.5% x Azotobacter) showed similar results to the treatment combination at the first year, second year, and when the data from both years was combined.

Table 5. Effect of micronutrients and bio-fertilizers on test weight (g) of coriander

Test weight (g)					
I^{st} Year					
	B_0	**B_1**	**B_2**	**B_3**	**MEAN**
M_0	10.11	10.34	10.56	10.17	**10.29**

M_1	11.00	12.33	12.40	12.07	**11.95**
M_2	10.95	11.96	12.23	11.87	**11.75**
M_3	10.85	11.55	11.72	11.51	**11.41**
M_4	10.68	11.26	11.34	11.18	**11.12**
MEAN	**10.72**	**11.49**	**11.65**	**11.36**	
	M	**B**	**M*B**		
SE(m)	0.071	0.064	0.143		
CD(5%)	0.204	0.183	0.409		
IInd Year					
M_0	10.13	10.33	10.57	10.19	**10.31**
M_1	11.04	12.37	12.47	12.14	**12.01**
M_2	10.93	11.99	12.28	11.91	**11.78**
M_3	10.90	11.60	11.78	11.55	**11.46**
M_4	10.65	11.29	11.36	11.14	**11.11**
MEAN	**10.73**	**11.51**	**11.69**	**11.39**	
	M	**B**	**M*B**		
SE(m)	0.060	0.054	0.121		
CD(5%)	0.173	0.155	0.346		
Pooled					
M_0	10.12	10.34	10.57	10.18	**10.30**
M_1	11.02	12.35	12.44	12.10	**11.98**
M_2	10.94	11.98	12.25	11.89	**11.76**
M_3	10.87	11.58	11.75	11.53	**11.43**
M_4	10.67	11.27	11.35	11.16	**11.11**
MEAN	**10.72**	**11.50**	**11.67**	**11.37**	
	M	**B**	**M*B**		
SE(m)	0.066	0.059	0.132		
CD(5%)	0.189	0.169	0.379		

3.6 Leaf yield (g/plant)

The data on leaf yield (g/plant) is shown in Table 6. Observations revealed that the highest leaf yield (11.42, 11.46, and 11.44 g/plant) in the first year, second year, and overall was observed in treatment M1 (ZnSo4 @ 0.5%). Conversely, the lowest leaf yield (8.23, 8.24, and 8.24 g/plant) in the first year, second year, and overall was recorded under treatment M0 (Control).

The data shows that the highest leaf yield (10.85, 10.87, and 10.86 g/plant) in the first year, second year, and overall was observed in treatment B2 (Azotobacter) among the different biofertilizer levels. Conversely, the lowest leaf yield (8.97, 9.00, and 8.99 g/plant) in the first year, second year, and overall was observed in treatment B0 (Control).

The leaf yield (g/plant) was considerably impacted by the interaction effect of micronutrient and biofertilizer levels. The treatment combination M1B2, which consisted of ZnSo4 at a concentration of 0.5% and Azotobacter, was shown to be considerably superior compared to all other treatment combinations. This combination resulted in the highest leaf yield of 12.29, 12.36, and 12.33 g/plant in the first year, second year, and overall, respectively. The treatment combination M1B1 (ZnSo4 @ 0.5% x PSB) and M2B2 (FeSo4 @ 0.5% x Azotobacter) were equally effective in the first year and when the results were combined. In the second year, the treatment combination M1B1 (ZnSo4 @ 0.5% x PSB) was equally effective.

Table 6 Effect of micronutrients and bio-fertilizers on leaf yield (g/plant) of coriander

Leaf yield (g/plant)					
I^{st} Year					
	B_0	B_1	B_2	B_3	MEAN
M_0	8.00	8.30	8.50	8.12	**8.23**
M_1	9.57	12.06	12.29	11.75	**11.42**
M_2	9.34	11.51	11.91	11.48	**11.06**
M_3	9.11	10.82	11.39	10.55	**10.47**
M_4	8.85	10.02	10.16	9.85	**9.72**
MEAN	**8.97**	**10.54**	**10.85**	**10.35**	
	M	**B**	**M*B**		
SE(m)	0.096	0.086	0.191		
CD(5%)	0.275	0.246	0.549		
II^{nd} Year					
M_0	8.04	8.26	8.52	8.14	**8.24**
M_1	9.61	12.08	12.36	11.80	**11.46**
M_2	9.32	11.54	11.87	11.53	**11.06**

M_3	9.14	10.87	11.42	10.61	**10.51**
M_4	8.88	10.11	10.19	9.90	**9.77**
MEAN	**9.00**	**10.57**	**10.87**	**10.40**	
	M	**B**	**M*B**		
SE(m)	0.074	0.066	0.147		
CD(5%)	0.211	0.189	0.423		
Pooled					
M_0	8.02	8.28	8.51	8.13	**8.24**
M_1	9.59	12.07	12.33	11.78	**11.44**
M_2	9.33	11.52	11.89	11.51	**11.06**
M_3	9.13	10.85	11.41	10.58	**10.49**
M_4	8.86	10.06	10.18	9.88	**9.74**
MEAN	**8.99**	**10.56**	**10.86**	**10.37**	
	M	**B**	**M*B**		
SE(m)	0.085	0.076	0.171		
CD(5%)	0.245	0.219	0.490		

3.7 Seed yield (g/plant)

The analysis determined that the seed yield (measured in grammes per plant) is shown in Table 7. The highest seed yield (6.95, 7.00, and 6.98 g/plant) in the first year, second year, and overall was observed in treatment M1 (ZnSo4 @ 0.5%), while the lowest seed yield (3.83, 3.85, and 3.84 g/plant) in the first year, second year, and overall was recorded in treatment M0 (Control).

The highest seed yield (6.29, 6.34, and 6.31 g/plant) in the first year, second year, and overall was observed in treatment B2 (Azotobacter), whereas the lowest seed yield (4.34, 4.35, and 4.35 g/plant) in the first year, second year, and overall was identified in treatment B0 (Control).

The seed yield (g/plant) was considerably affected by the treatment combination M1B2 (ZnSo4 @ 0.5% x Azotobacter), resulting in the highest seed yield (7.95, 8.04, and 8.00 g/plant) in the first year, second year, and overall. The treatment combinations M1B1 (ZnSo4 @ 0.5% x PSB), M2B2 (FeSo4 @ 0.5% x Azotobacter), and M1B3 (ZnSo4 @ 0.5% x KSB) were equally effective in the first year. In the second year, the treatment combination M1B1 (ZnSo4 @ 0.5% x PSB) was equally effective, and the combination of M1B1 (ZnSo4 @ 0.5%

x PSB) and M2B2 (FeSo4 @ 0.5% x Azotobacter) was also equally effective. These results were consistent when the data from both years were combined.

Table 7Effect of micronutrients and bio-fertilizers on seed yield (g/plant) of coriander

Seed yield (g/plant)					
Ist Year					
	B_0	**B_1**	**B_2**	**B_3**	**MEAN**
M_0	3.57	3.92	4.15	3.70	**3.83**
M_1	4.75	7.81	7.95	7.30	**6.95**
M_2	4.64	7.01	7.60	6.73	**6.50**
M_3	4.44	6.10	6.34	5.68	**5.64**
M_4	4.31	5.18	5.40	5.02	**4.98**
MEAN	**4.34**	**6.00**	**6.29**	**5.69**	
	M	**B**	**M*B**		
SE(m)	0.116	0.104	0.232		
CD(5%)	0.333	0.298	0.665		
IInd Year					
M_0	3.59	3.90	4.18	3.74	**3.85**
M_1	4.76	7.86	8.04	7.35	**7.00**
M_2	4.64	7.04	7.67	6.78	**6.53**
M_3	4.46	6.16	6.40	5.73	**5.69**
M_4	4.31	5.20	5.41	5.03	**4.99**
MEAN	**4.35**	**6.03**	**6.34**	**5.73**	
	M	**B**	**M*B**		
SE(m)	0.077	0.069	0.154		
CD(5%)	0.221	0.197	0.441		
Pooled					
M_0	3.58	3.91	4.16	3.72	**3.84**
M_1	4.76	7.84	8.00	7.33	**6.98**
M_2	4.64	7.03	7.64	6.76	**6.51**
M_3	4.45	6.13	6.37	5.70	**5.66**
M_4	4.31	5.19	5.40	5.03	**4.98**
MEAN	**4.35**	**6.02**	**6.31**	**5.71**	
	M	**B**	**M*B**		

SE(m)	0.098	0.088	0.197		
CD(5%)	0.282	0.252	0.564		

4. Discussion

4.1 Effect of micronutrients on yield parameters of coriander

~~The treatment M1 (ZnSo4 @ 0.5%) had the highest levels of micronutrients, with the maximum number of umbel per plant and umbellate per umbel observed in both the first and second year. In contrast, the treatment M0 (Control) had the lowest levels of micronutrients, with the minimum number of umbel per plant and umbellate per umbel recorded in both the first and second year~~**(These are Results, don't mention again)**. Zinc enhances the process of photosynthesis and facilitates the movement of assimilates to various parts of the plant, resulting in an increased number of umbellate and umbels per plant. The findings are consistent with the studies conducted by Patel (2018) and **Lalita et al. (2022)**Reference not found. (**Take this discussion after your results**

Comment [MZ11]: I prefer to take the discussion after the Results, not in a separate partition

~~The treatment M1 (ZnSo4 @ 0.5%) had the highest number and weight of seeds per umbel in the first year, second year, and overall. Conversely, the treatment M0 (Control) had the lowest number and weight of seeds per umbel in the first year, second year, and overall, among the different micronutrient levels.~~ Mounika et al. (2018) similarly revealed similar findings for the majority of the characters (**Take this discussion after your results**).

~~Regarding micronutrient levels, treatment M1 (ZnSo4 @ 0.5%) exhibited the highest test weight (g) in the first year, second year, and overall. Conversely, treatment M0 (Control) had the lowest test weight (g) in the first year, second year, and overall.~~ The increase in seed weight may be attributed to improved mineral utilisation by plants, along with enhanced photosynthesis, additional metabolic activities, and increased allocation of food material to seeds. The findings are consistent with the results obtained by Aishwarya and Nehru (2014) as well as (Lalita et al. 2022) Reference not found. (**Take this discussion after your results)**

~~It was noted that the highest leaf yield per plant, per plot, and per hectare in the first year, second year, and overall was observed in treatment M1 (ZnSO4 @~~

0.5%), which had higher micronutrient levels. Conversely, the lowest leaf yield per plant, per plot, and per hectare in the first year, second year, and overall was recorded in treatment M0 (Control), which had no additional micronutrients. The rise in leaf production may be attributed to the influence of zinc on many growth mechanisms such as photosynthesis, nitrogen metabolism, protein synthesis, hormone generation, and control of auxin concentration in plants. The positive effects of zinc led to increased plant height, larger leaf area, higher leaf to stem ratio, and more dry matter output. The nutrient availability and absorption during the first phases were addressed with the application of ZnSO4 to the soil, followed by targeted foliar sprays at certain phenological stages of the crop. This may have resulted in increased yields of green fodder. Singh et al. (2021) and Patel (2018) similarly revealed similar findings for the majority of the characters. (**Take this discussion to the associated results)**

Comment [MZ12]: It should be in Results, if you not mention that in Results, take it there.

The results indicate that treatment M1 (ZnSo4 @ 0.5%) had the highest seed yield per plant, per plot, and per hectare in both the first and second years, as well as when the data from both years was combined. Conversely, treatment M0 (Control) had the lowest seed yield per plant, per plot, and per hectare in all three cases. The rise in seed output may be related to the enhancement of yield-contributing factors, such as augmented plant development, maximum number of umbels and seeds. This improvement was favourably influenced by the foliar application of micronutrients. The results are consistent with the findings of Lal et al. (2015) and Meena et al. (2022). (**Take this discussion to the associated results)**

4.2 Effect of bio-fertilizers on yield parameters of coriander

The treatment B2 (Azotobacter) exhibited the highest number of umbels per plant and umbellate per umbel in the first year, second year, and overall. Conversely, the treatment B0 (Control) showed the lowest number of umbels per plant and umbellate per umbel in the first year, second year, and overall. Phosphate solubilising bacteria, a kind of biofertilizer, converts phosphorus into a form that is easily absorbed by plants. This leads to increased fruit production in coriander by improving the development of its flower clusters. The results are consistent with the findings of Aakash et al. (2023) and Swain et al. (2020). (**Take this discussion to the associated results)**

~~Among the different amounts of biofertilizer, treatment B2 (Azotobacter) exhibited the highest number and weight of seeds per umbel in the first year, second year, and overall. Conversely, treatment B0 (Control) showed the lowest number and weight of seeds per umbel in all three time periods.~~ The enhanced number and weight of seeds per umbel can be attributed to the elevated concentration of humus-rich organic manures, which facilitate greater nitrogen fixation, phosphorus solubilization, and mobilisation by the microorganisms. As a result, the weight of the seeds has increased. In addition, biofertilizer enhances plant growth by synthesising phytohormones, fixing nitrogen, reducing root membrane potential, synthesising enzymes like ACC deaminase that regulate plant hormone levels, and solubilizing inorganic phosphates and mineralizing organic phosphates, thereby making phosphates accessible to plants. Findings are in accordance with those of Solanki et al. (2023) and Suman et al. (2018). **(Take this discussion to the associated results)**

~~The highest test weight (g) in the first year, second year, and overall was observed in treatment B2 (Azotobacter) among the different biofertilizer levels. Conversely, the lowest test weight (g) in the first year, second year, and overall was discovered in treatment B0 (Control).~~ The rise in test weight may be attributed to the augmented and harmonised provision of all vital nutrients by Azotobacter and Phosphate solubilising bacteria. This might have led to a greater generation of photosynthate and its subsequent accumulation in the washbasin. The results are corroborated by the discoveries of Kalasare et al. (2016), Mounika et al. (2018), and Suman et al. (2018). **(Take this discussion to the associated results)**

~~The data showed that treatment B2 (Azotobacter) had the highest leaf yield per plant, per plot, and per hectare in both the first and second year, as well as when the data from both years was combined. Conversely, treatment B0 (Control) had the lowest leaf yield per plant, per plot, and per hectare in all three cases.~~ The use of biofertilizers likely improved the accessibility of nitrogen, phosphate, and other essential nutrients, while also promoting the synthesis of growth hormones such as IAA, GA3, and cytokines. This resulted in a rise in both the size and quantity of leaves, ultimately leading to a higher leaf yield. The findings align with the results obtained by Peerzada et al. (2016), Singh et al. (2021), and Swain et al. (2020).**(Take this discussion to the associated results)**

~~The results indicated that treatment B2 (Azotobacter) had the highest seed yield per plant, per plot, and per hectare in both the first and second years, as well as when the data from both years was combined. Conversely, treatment B0 (Control) had the lowest seed yield per plant, per plot, and per hectare in all three scenarios.~~ Biofertilizers may have enhanced plant metabolic activity by providing essential micronutrients such as zinc, iron, copper, manganese, and others. These substances play a crucial role in the biochemical production of several phytohormones. In addition, Azotobacter plays a crucial part in the process of nitrogen fixation and is also actively engaged in the synthesis of plant growth hormones such as indole-3-acetic acid (IAA), gibberellic acid (GA3), and cytokinin-like compounds. Phosphate solubilizing bacteria aid in the process of dissolving and moving phosphorus in soil. The correlation between the use of advanced bio fertilisers such as Azotobacter and Phosphorous Solubilizing Bacteria and the increased seed output of coriander plants is evident. The findings are consistent with the studies conducted by Solanki et al. (2023) and Suman et al. (2018). (**Take this discussion to the associated results)**

4.3 Interaction effect of micronutrients and bio-fertilizers on yield parameters of coriander

The treatment combination M1B2, consisting of 0.5% ZnSO4 and Azotobacter, had a substantial impact on many yield metrics, including the number of umbels per plant, number of seeds per umbel, weight of seeds per umbel, test weight, leaf yield, and seed yield. The highest yield parameters were obtained in the first year, second year, and when the data from both years were combined. However, the interaction between the quantities of micronutrients and biofertilizers did not have a significant impact on the number of umbellate per umbel in coriander.(**If not mentioned in the results, skip to the relevant section**). The results are consistent with the findings of Lalita et al. (2022) and Fikadu-Lebeta et al. (2019).**(Take this discussion to the associated results)**

5. Conclusion

The results indicated that among the different levels of micronutrients, treatment M1 (ZnSo4 @ 0.5%) was determined to be the most effective treatment for enhancing the yield of coriander. Out of the several amounts of biofertilizers, treatment B2 (Azotobacter) was determined to be the most effective in enhancing the yield of coriander. The treatment combination M1B2, consisting of 0.5% ZnSo4 and Azotobacter, exhibited substantial superiority compared to other treatment combinations. It resulted in the highest yield metrics for coriander.

~~References~~:REFERENCES

Scientific names of crops must be in italics (*Zea mays*L)

The year of publishing Should come at the end of reference as the Journal explained, or its OK (Check out the Journal Board)

Aakash Singh MK, Saikia N, Bhayal L, Bhayal D. Effect of integrated nutrient management on growth, yield attributes and yield of green pea in humid subtropical climate of Indo-Gangetic Plains. Annals of Agricultural Research. 2023;44,2(Sep. 2023):190–196.

Aakash, Thakur NS, Singh MK, Bhayal L, Meena K, Choudhary SK, Kumawat N, Singh RK, Singh UP, Singh SK. Sustainability in Rainfed Maize (*Zea mays* L.) Production Using Choice of Corn Variety and Nitrogen Scheduling. Sustainability. 2022;14(5):3116. Available:https://doi.org/10.3390/su14053116.

Aishwarya, D. and Nehru, A. (2014). Impact of micronutrient application in Coriander (*Coriandrum sativum* L.) cv. CO4. Advanced Journal of Seed Science and Technology 2 (1), pp 42-46.

Bhayal L, Aakash, Jain MP, Bhayal D, Meena K. Impact of foliar spray of NPK and Zn on soybean for growth, yield, quality, energetics and carbon foot print under dryland condition at Indore. Legume Research; 2022 Available:http://dx.doi.org/10.18805/LR-4748.

Fikadu-Lebeta, W., Diriba-Shiferaw, G. and Mulualem-Azene, M. (2019). The Need of Integrated Nutrient Management for Coriander (Coriandrum sativum L.) Production. International Journal of Food & Nutrition, 4(1): 1-13.

Kalasare, R.S., Patel, M.V., Patel, H.K., Kadu, S.P., Patel, A.P. and Umale, A.A. (2016). Role of INM on growth, yield, quality parameters and content of Rabi fennel (F. vulgare Mill.) in middle Gujarat condition. Green Farming, 7(5):1091-1095.

Kalidasu, G., Sarada, C. and Reddy, T.Y. (2008). Efficacy of biofertilizers on the performance of rainfed coriander (Coriandrumsativum) in vertisols. Journal of Spices and Aromatic Crops, 17(2):98-102.

Lal, G., Singh, B., Mehta, R.S. and Maheria, S.P. (2015). Performance of fenugreek (Trigonellafoenum-graecum L.) as influenced by sulphur and zinc. International Journal of Seed Spices, 5(1): 29-33.

Mahfouz, S.A. and Sharaf-Eldin, M.A. (2007) Effect of mineral vs. biofertilizer on growth, yield, and essential oil content of fennel (Foeniculum vulgare Mill.). International Agrophysics, 21(4): 361-366.

Malhotra, S.K., Vashishtha, B.B. and Apparao, V.V. (2006). Influence of nitrogen, Azospirillum sp. and farmyard manure on growth, yield and incidence of stem gall disease in coriander (Coriandrum sativum L.). Journal of Spices and Aromatic Crops, 15(2): 115-117.

Mazaheri, M., Fakheri, B., Piri, I. and Tavassoli, A. (2013). The effect of drought stress and micronutrient of Zn and Mn on yield and essential oil of (Cuminum cyminum L.). J. Novel Appl. Sci., 2:350-356.

Meena K, Singh RK, Meena RN, AakashMeena A, Bhayal L, Kumar A, Meena BL. Effect of Irrigation Schedules and Cow Urine Spray on Phalaris minor and Growth of Wheat (Triticum aestivum L.). Frontiers in Crop Improvement. 2022;10(Special Issue-III):1232-1236.

Mhemdi, H., Rodier, E., Kechaou, N. and Fages, J. (2011). A supercritical tuneable process for the selective extraction of fats and essential oil from coriander seeds. Journal of Food Engineering, 105(4): 609-616.

Mounika, Y., Thanuja Sivaram, G., Reddy, P.S.S. and Ramaiah, M. (2018). Effect of biofertilizers and micronutrients on growth, leaf yield, seed yield and quality of coriander (*Coriandrum sativum* L.) cv. Sadhana. J. Hortl. Sci., 12(2 :113-117.

Naga, S.K., Swain, S.K., Sandeep, V.V. and Raju, B. (2013). Effect of foliar application of micronutrients on growth parameters in tomato (Lycopersicon esculentum L.). J. Agric. Food Sci., 1:146-151

Patel, H.J. (2018). Effect of zinc and iron on growth and yield of coriander (Coriandrum sativum L.). MSc Thesis Dept. of agronomy, Junagarah.

Peerzada, O.H., Mor, V.S., Dahiya, O.S. and Tehlan, S.K. (2016). Effect of integrated nutrient management on seed yield and its attributes in fenugreek (Trigonellafoenum-graecum L.). Indian Journal of Ecology, 43: 455-457.

Peter , K.V. (2004). Hand Book of Herbs and Spices , Vol. 2, Woodhead Publishing Ltd, Cambridge, pp.158-174.

Ramadan, M., and Mörsel, J. T. (2002). Oil composition of coriander (Coriandrum sativum L.) fruit-seeds. European Food Research and Technology, 215(3): 204-209.

Singh SR, Singh MK, Aakash Meena K, Vishwakarma SP. Effect of Different NPK Levels on Fodder Production of Sudan Grass (Sorghum bicolor var. Sudanese). International Journal of Bio-resource and Stress Management. 2021;12(3):199-204. DOI: https://DOI.ORG/10.23910/1.2021.2229.

Solanki , K., Choudhary , S. K., Aakash, Singh , V., Singh , A., & Birla , D. (2023). Response of Bacillus megaterium and Bacillus mucilaginosus Strains on Yield and Quality of Soybean. *International Journal of Environment and Climate Change*, *13*(11), 776–783. https://doi.org/10.9734/ijecc/2023/v13i113226

Suman, P., Lakshminarayana, D., Prashant, P. and Naik, D.S. (2018). Effect of integrated nutrient management on growth parameters of coriander (Coriandrum sativum L.) cultivars under Telangana condition. International journal of current microbiology and applied science, 7(11):2871-2877.

Swain, A.A., Nayak, D.A., Mahapatra, P., Nandi, A., Jena, N.K. and Panda, J. (2020). Effect of bio-fertilizers on growth and green leaf yield of coriander (Coriandrum sativum L.) Int. J. Curr. Microbiol. App. Sci., 9(4): 826-832 826.

Verma, A., Pandeya, S.N., Yadav, S.K., Singh, S. and Soni, P. (2011). A review of Coriandrum sativum (Linn) : An Ayurvedic medicinal herbs of happiness. J. Pharm. Hlth. Res., 1: 28-48.