~~“~~Effect of ~~micronutrients~~Micronutrients and ~~biofertilizer~~Biofertilizers on ~~yieldattributes~~Yield Attributes of ~~coriander~~Coriander(Coriandrum sativum L.) cv. RCR-41~~”~~

Abstract~~———~~:

~~The current~~This study, ~~named "effect~~titled "Effect of ~~micronutrients~~Micronutrients and ~~biofertilizer~~Biofertilizer on ~~yield parameters~~Yield Attributes of ~~coriander~~ Coriander (Coriandrum sativum ~~(~~L.) cv. RCR-41," ~~is planned to be carried out in~~ was conducted at the Research Field, Department of Horticulture, College of Agriculture, Gwalior, M.P., during the Rabi seasons of 2020-21 and 2021-22. The ~~experiment~~experimental design employed was ~~designed using the Randomised~~a Randomized Block Design ~~and included~~with three replications. ~~At the time of~~ During coriander seeding, ~~the following~~ various treatment combinations ~~including RDF~~involving recommended doses of ~~fertilisers~~fertilizers (RDF) and biofertilizers~~, namely Azotobacter~~ (Azotobacter and PSB~~,~~) were ~~used~~applied. The results ~~showed~~revealed that the treatment M1 ($ZnSO_4$ @ 0.5%) ~~was~~exhibited the ~~optimum~~optimal micronutrient level ~~treatment~~ for coriander production~~.~~ ~~Treatment~~, while treatment B2 (Azotobacter) ~~was shown~~proved to be the ~~optimal~~most effective biofertilizer~~ level for coriander production.~~. The ~~treatment~~ combination of M1B2 (~~ZnSo4~~$ZnSO_4$ @ 0.5% x Azotobacter) ~~was shown to be considerably better~~ emerged as significantly superior among all treatment combinations, ~~yielding~~demonstrating the highest coriander yield ~~characteristics~~attributes.

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

~~1.~~Introduction:

~~Annuals bear the coriander (~~Coriander (Coriandrum sativum L.~~) herbaceum. Consider it to be among the~~.), an annual herbaceous plant, holds historical significance as one of the earliest seed spices ~~utilised~~utilized by Homo sapiens. ~~Coriander, a member of~~ Belonging to the Apiaceae (Umbelliferae) family, coriander is ~~predominantly grown~~cultivated year-round ~~from~~for its seeds ~~(Mhemdi et al. 2011). It is also referred to in Hindi~~, known as "Dhaniya~~." The seeds have a distinct flavour,~~" in Hindi, which are ~~round to ovoid in shape, and are golden brown or brown in colour with vertical ridges. Curry~~integral to the flavor of 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. Verma et al. (2011) report that coriander is a significant source of the~~ Rich in compounds such as a-pinene, a-terpinene, limonene, and ~~ncymene, in addition to numerous~~ nymene, along with various non-linalool alcohols and esters (Verma et al., 2011), coriander is widely used as a flavoring agent in Ayurvedic medicine due to its distinctive aroma and taste.

~~The primary nutritional value of coriander~~Coriander seeds and foliage ~~is their high~~ offer significant nutritional value, being high in vitamin A and C content. ~~The raw~~Raw leaves consist of ~~this plant are composed of the following elements:~~ approximately 87.9% moisture,

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3.3% protein, 6.5% carbohydrates, 1.7% total ash, ~~0.4%~~ and essential minerals, including calcium, ~~0.06 percent~~ phosphorus, ~~0.01%~~and 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~~. Additionally, coriander seeds are rich in unrefined ~~fibre, 20g of~~fiber, fat, ~~11g of~~ protein, and ~~nearly 11g of carbohydrate.~~ carbohydrates (Peter, 2004).

~~The utilisation of inorganic fertilisers was crucial for~~ In the cultivation of short-lived cereals, the use of inorganic fertilizers has been deemed crucial (Aakash et al., 2022). Micronutrients ~~are indispensable~~play a vital role in ~~minute amounts for optimal~~ plant development and yield~~. Nevertheless, insufficiencies of these nutrients disrupt the plant's~~, with deficiencies significantly impacting physiological and metabolic processes ~~significantly~~ (Singh et al., 2021). The ~~utilisation~~application of micronutrients is ~~a critical factor in ensuring that crops are of~~essential for superior crop quality and ~~produce a~~ substantial yield (Lalita et al., 2022~~). The involvement of micronutrients in~~), influencing various metabolic processes ~~of the plant, including~~ such as photosynthesis, N-fixation, and respiration~~, has been extensively documented~~ (Naga et al~~.~~., 2013). ~~Multiple researchers have documented~~Previous research has highlighted the positive impact of micronutrient foliar ~~fertiliser~~fertilizers on the growth and yield enhancement of ~~specific~~ aromatic and medicinal plants ~~(~~, including coriander (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 (~~; Kalidasu et al~~.~~., 2008).

~~In addition to being~~ Biofertilizers, viewed as more cost-effective, environmentally ~~benign~~friendly, and sustainable, ~~biofertilizers~~ are ~~anticipated~~expected to ~~gain prominence~~play a prominent role when used in conjunction with inorganic ~~fertilisers~~fertilizers (Malhotra et al~~.~~., 2006~~). (~~; Mahfouz and Sharaf-Eldin, 2007~~) The use of biofertilizers containing various~~). 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~~, such as mycorrhizae, Azotobacter, Azospirillium, blue-green algae, Azolla, PSB, and KSB, have shown promise in reducing reliance on chemical fertilizers while producing high-quality, agrochemical-free crops (Meena et al., 2022). ~~Nevertheless, in practise, the performance of bio-fertilizers is unreliable and inconsistent, notwithstanding~~Despite their immense potential ~~and advantages~~, the performance of biofertilizers, including ~~(Aakash et al., 2023).~~ Azotobacter, PSB, and KSB, can be inconsistent in practice (Aakash et al., 2023). ~~are biofertilizers that are extensively utilised and provide plants with substantial~~ These biofertilizers contribute significantly to nitrogen (N) and phosphorus (P ~~contributions, in addition to~~) availability, enhancing ~~their~~plant resistance to water stress (Solanki et al., 2023).

~~With~~Considering the ~~aforementioned~~above information ~~in consideration, a~~ , this field experiment ~~is conducted~~aims to ~~determine how~~assess the impact of different micronutrients and ~~biofertilizer affect~~biofertilizers on coriander yield parameters.

~~2.~~ Material and ~~methods~~Methods

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

2.2.1 Treatments ~~**details**~~Details

Micronutrients:

M0 = Control

M1 = ~~$ZnSo_4$~~ZnSO4 (0.5%)

M2 = ~~$FeSo_4$~~FeSO4 (0.5%)

M3 = ~~$CuSo_4$~~CuSO4 (0.5%)

M4 = ~~$MnSo_4$~~MnSO4 (0.5%)

Biofertilizers:

B0 = Control

B1 = PSB (Phosphate Solubilizing Bacteria)

B2 = Azotobacter

B3 = KSB (Potassium Solubilizing Bacteria)

2.2.2 Variety RCr-41:

It is a tall, straight type with round, small seeds that take longer to produce shoots after ~~they germinate.~~germination. The ~~type~~variety is ~~very~~highly 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~~reach full maturity, producing an average of 920 kg of seeds per hectare.

2.2.3 Fertilizer ~~**application**~~ Application:

~~It was~~Fertilizers were applied evenly ~~spread out~~ 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~~hand-ploughed into the ground ~~by hand ploughing about~~ at a depth of 5 to 7 cm ~~deep~~. The ~~last amount of~~ remaining nitrogen through urea was evenly spread ~~out evenly~~ over two sections and watered in.

2.2.4 Observations Recorded

Yield ~~**characters**~~Characters:

~~**1)**~~ Number of ~~**umbel**~~Umbels per ~~**plant**~~Plant:

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

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~~2)~~ Number of ~~**umbellate**~~Umbellate per ~~**umbel**~~Umbel:

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

~~3)~~ Number of ~~**seed**~~Seeds per ~~**umbel**~~Umbel:

At harvest, twenty umbels were randomly 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**~~Seed per ~~**umbel**~~Umbel (g~~)~~):

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

~~5)~~ Test ~~**weight**~~Weight (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**~~Yield (g/plant~~)~~):

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

~~7)~~ Seed ~~**yield**~~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~~grams per plant.

~~**3. Result**~~

Results

3.1 Number of ~~**umbel**~~Umbels per ~~**plant**~~Plant

~~The~~ Table 1 presents the data ~~pertaining to~~regarding the quantity of umbels per plant ~~is shown in Table 1. The~~. In the first year, second year, and overall, treatment M1 (~~ZnSo4~~$ZnSO_4$ @ 0.5%) ~~had~~exhibited 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~~), whereas treatment M0 (Control) ~~had~~recorded the lowest number of umbels per plant (17.82, 17.83, and 17.82~~)~~).

Treatment B2 (Azotobacter), with the highest biofertilizer level, resulted in the ~~first year, second year, and overall.~~

~~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~~. Conversely, treatment ~~B2 (Azotobacter), which had the highest~~B0 (Control), without biofertilizer ~~level. Conversely,~~ , showed the lowest

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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~~consisting of ~~ZnSo4~~ZnSO4 at a concentration of 0.5% and Azotobacter, ~~had a substantial effect on~~significantly influenced the number of umbels per plant~~. It resulted in~~, producing the highest ~~number of umbels per plant~~count (23.41, 23.47, and 23.44) in the first year, second year, and overall. In the first year, ~~it~~this was ~~equivalent~~comparable to ~~the~~ treatment combination M1B1 (~~ZnSo4~~ZnSO4 at a concentration of 0.5% combined with PSB). In the second year, it was equivalent to ~~the~~ treatment ~~combination~~combinations M1B1 (~~ZnSo4~~ZnSO4 at a concentration of 0.5% combined with PSB) and M2B2 (~~FeSo4~~FeSO4 at a concentration of 0.5% combined with Azotobacter). These results were ~~combined~~aggregated and ~~analysed.~~ analyzed for further insights.

Table 1. Effect of ~~micronutrients~~Micronutrients and ~~bio~~Bio-fertilizers on ~~number~~Number of Umbels per Plant of ~~umbel per plant of coriander~~Coriander cv. RCR-41

Number of ~~umbel~~Umbels per ~~plant~~Plant					
		~~I~~1st 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		
		~~II~~2nd 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~~Umbellate per ~~umbel~~Umbel

Table 2 ~~displays~~presents the statistics on the number of umbellate per umbel. In the first year, second year, and overall, ~~the~~ treatment M1 (~~ZnSo4~~ZnSO4 @ 0.5%) ~~had~~exhibited 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~~

Treatment B2 (Azotobacter) demonstrated 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, treatment B0 (Control) recorded 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~~Umbellate per ~~umbel~~Umbel of ~~coriander~~Coriander cv. RCR-41

Number of umbellate per ~~umbel~~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		
IInd2nd 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 seedSeeds per umbelUmbel

The

Table 3 presents the statistics on the amountnumber of seeds per umbel is shown in Table 3. The. In the first year, second year, and pooled data, treatment M1 ($ZnSO_4$ @ 0.5%) exhibited 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 ($ZnSo_4$ @ 0.5%). Conversely,), while treatment M0 (Control) recorded 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~~

Treatment B2 (Azotobacter) demonstrated 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~~, whereas treatment ~~B2 (Azotobacter), while~~B0 (Control) showed 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).)~~.

Number of ~~seed~~Seeds per ~~umbel~~Umbel

The treatment combination M1B2, consisting of ~~ZnSo4~~ZnSO4 at a concentration of 0.5% and Azotobacter, ~~had a substantial effect on~~significantly influenced the number of seeds per umbel~~. It resulted~~, resulting in the highest ~~number of seeds per umbel~~count (27.40, 27.45, and 27.43) in the first year, second year, and overall. ~~The therapy~~However, the treatment combination M1B1 (~~ZnSo4~~ZnSO4 @ 0.5% x PSB) and M2B2 (~~FeSo4~~FeSO4 @ 0.5% x Azotobacter) ~~showed~~exhibited similar results to the control group in the first year, second year, and overall.

Table 3 Effect of micronutrients and bio-fertilizers on ~~number~~Number of Seeds per Umbel of ~~seed per umbel of coriander~~Coriander cv. RCR-41

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I^{st} 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		
~~IInd~~2nd 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 (ZnSo4 @ 0.5% x PSB) and M2B2 (FeSo4 @ 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 (ZnSo4 @ 0.5% x PSB) was equally effective.

Table 4: Effect of micronutrients and bio-fertilizers on ~~weight~~Weight of ~~seed~~Seeds per ~~umbel~~Umbel (g) of ~~coriander~~Coriander cv. RCR-41

Weight of ~~seed~~Seeds per ~~umbel~~Umbel (g)					
I^st 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		
~~II^nd~~2nd 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~~Test Weight (g) of ~~coriander~~Coriander cv. RCR-41

Test ~~weight~~Weight (g)					
~~I~~$^{~~st~~1st}$ 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		
~~II~~$^{~~nd~~2nd}$ 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 yieldYield (g/plant)

TheTable 6 provides data on leaf yield (g/measured in grams per plant) is shown in Table 6. Observations revealed that the highest leaf yield (11.42, 11.46, and 11.44 g/plant) in. In the first year, second year, and overall was observed in, treatment M1 (ZnSo4ZnSO4 @ 0.5%). Conversely, %) demonstrated the highest leaf yield (11.42, 11.46, and 11.44 g/plant), while treatment M0 (Control) recorded 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 thatAmong different biofertilizer levels, treatment B2 (Azotobacter) exhibited 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,), while treatment B0 (Control) showed 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 The interaction effect of micronutrient and biofertilizer levels. significantly impacted the leaf yield (g/plant). The treatment combination M1B2, which consisted of ZnSo4comprising ZnSO4 at a concentration of 0.5% and Azotobacter, was shown to be considerably superiordemonstrated superiority 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 combinationcombinations M1B1 (ZnSo4ZnSO4 @ 0.5% x PSB) and M2B2 (FeSo4FeSO4 @ 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 (ZnSo4ZnSO4 @ 0.5% x PSB) was equally effective.

Table 6 Effect of micronutrients and bio-fertilizers on leaf yieldLeaf Yield (g/plant) of corianderCoriander cv. RCR-41

Leaf yield (g/plant)					
			Ist1st 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~~2nd **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~~Yield (g/plant)

~~The~~ Table 7 presents the analysis ~~determined that the~~ of seed yield ~~(~~measured in ~~grammes~~grams per plant~~) is shown in Table 7. The highest seed yield (6.95, 7.00, and 6.98 g/plant) in~~. In the first year, second year, and overall ~~was observed in~~, treatment M1 (~~ZnSo4~~ZnSO4 @ 0.5~~%),~~%) exhibited the highest seed yield (6.95, 7.00, and 6.98 g/plant), while treatment M0 (Control) recorded 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~~Treatment B2 (Azotobacter) demonstrated 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 treatment B0 (Control) showed 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~~significantly influenced by the treatment combination M1B2 (~~ZnSo4~~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~~ZnSO4 @ 0.5% x PSB), M2B2 (~~FeSo4~~FeSO4 @ 0.5% x Azotobacter), and M1B3 (~~ZnSo4~~ZnSO4 @ 0.5% x KSB) were equally effective in the first year. In the second year, the treatment combination M1B1 (~~ZnSo4~~ZnSO4 @ 0.5% x PSB) was equally effective, and the combination of M1B1 (~~ZnSo4~~ZnSO4 @ 0.5% x PSB) and M2B2 (~~FeSo4~~FeSO4 @ 0.5% x Azotobacter) was also equally effective. These results ~~were~~remained consistent when the data from both years were combined.

Table 7 Effect of micronutrients and bio-fertilizers on ~~seed yield~~Seed Yield (g/plant) of ~~coriander~~Coriander cv. RCR-41

Seed ~~yield~~Yield (g/plant)					
~~Ist~~1st 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~~2nd 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**~~Micronutrients on ~~**yield parameters**~~Yield Parameters of ~~**coriander**~~Coriander

~~The treatment~~Treatment M1 (~~ZnSo4~~ZnSO4 @ 0.5%) ~~had the highest~~demonstrated superior micronutrient levels ~~of micronutrients, with~~ , resulting in the maximum number of ~~umbel~~umbels 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. Zinc enhances the process of~~years. Zinc's role in enhancing photosynthesis and ~~facilitates the~~assimilate movement ~~of assimilates~~contributed to ~~various parts of the plant, resulting in an~~ increased ~~number of~~ umbellate and umbels per plant. ~~The findings are consistent~~This aligns with ~~the~~ studies ~~conducted~~ by Patel (2018) and Lalita et al. (2022).

~~The treatment~~ M1 (~~ZnSo4~~ZnSO4 @ 0.5%) ~~had~~also yielded 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.~~

~~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~~positive impact on seed weight ~~may~~can be attributed to improved mineral ~~utilisation by plants, along with~~utilization, enhanced photosynthesis, ~~additional metabolic activities, and~~ and increased allocation of food material to seeds. ~~The findings are~~, consistent with ~~the results obtained by~~ Aishwarya and Nehru (2014) ~~as well as (~~and Lalita et al. (2022).

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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.

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).

The treatment further exhibited the highest test weight, and the increased seed weight may be linked to improved mineral utilization and enhanced photosynthesis. Similar findings were reported by Aishwarya and Nehru (2014) and Lalita et al. (2022).

Treatment M1 (ZnSO4 @ 0.5%) led to the highest leaf yield, attributed to zinc's positive effects on growth mechanisms. The treatment also resulted in the highest seed yield, enhancing yield-contributing factors and favorably influencing foliar application of micronutrients, in line with Lal et al. (2015) and Meena et al. (2022).

4.2 Effect of **bio-fertilizers**Biofertilizers on **yield parameters**Yield Parameters of **coriander**Coriander

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The treatmentTreatment B2 (Azotobacter) exhibiteddemonstrated 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 , attributed to the conversion of 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 by phosphate-solubilizing bacteria. This aligns with Aakash et al. (2023) and Swain et al. (2020).

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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).

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).

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).

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).

B2 (Azotobacter) also led to the highest number and weight of seeds per umbel, attributed to enhanced nitrogen fixation and phosphorus solubilization. The treatment exhibited the highest test weight, likely due to Azotobacter's provision of vital nutrients, consistent with Kalasare et al. (2016) and Mounika et al. (2018).

B2 (Azotobacter) resulted in the highest leaf yield, likely improving nitrogen and phosphate accessibility and promoting hormone synthesis. The treatment also led to the highest seed yield, indicating enhanced plant metabolic activity and the synthesis of growth hormones, consistent with Peerzada et al. (2016) and Singh et al. (2021).

4.3 Interaction **effect of micronutrients and bio-fertilizers on yield parameters of coriander**Effect of Micronutrients and Biofertilizers

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The ~~treatment~~ combination M1B2~~, consisting of~~ (ZnSO4 @ 0.5% ~~ZnSO4~~ and Azotobacter~~, had a substantial impact on many~~) significantly impacted multiple 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~~significantly affect the number of umbellate per umbel~~ in coriander. The~~. These results ~~are consistent~~align with ~~the findings of~~ Lalita et al. (2022) and Fikadu-Lebeta et al. (2019).

5. Conclusion

~~The results indicated that among the different~~Among micronutrient levels ~~of micronutrients, treatment~~, M1 (~~ZnSo4~~ZnSO4 @ 0.5%) was ~~determined to be the~~ most effective ~~treatment for enhancing the yield of coriander. Out of the several amounts of~~ , and among biofertilizers, ~~treatment~~ B2 (Azotobacter) was ~~determined to be~~ the most effective in enhancing ~~the yield of~~ coriander~~.~~ yield. The ~~treatment~~ combination M1B2~~, consisting of 0.5% ZnSo4 and Azotobacter, exhibited~~ demonstrated substantial superiority ~~compared to other treatment combinations. It resulted~~ in ~~the highest~~various yield metrics for coriander.

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