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Influence of Biofertilizers and Micronutrients on Seed yield, Essential oil and Oleoresins of coriander (*Coriandrum sativum* L.) cv. Sadhana

Y. Mounika[1]*, G. Thanuja Sivaram[1], P. Syam Sundar Reddy[2] and M. Ramaiah[3]1Ph.D Scholar,
College of Horticulture, Dr. YSR Horticultural University
Anantharajupeta -516 105, YSR Dist. (A.P.), India
E-mail: ymounikaspma@gmail.com

ABSTRACT
A field experiment was conducted during rabi 2015-16 at Research Farm, Horticultural College and Research Institute, Dr.Y.S.R. Horticultural University, Anantharajupet (Andhra Pradesh), India; to study the Influence of biofertilizers and micronutrients on seed yield, essential oil and oleoresins of coriander (Coriandrum sativum L.) cv. Sadhana. The experiment was evaluated in randomized block design with factorial concept consists two factors like biofertilizers and micronutrients. The first factor comprised of seed inoculation with Azospirillum, Phosphate solubilising bacteria, Azospirillum + Phosphate solubilising bacteria and control (without any biofertilizer) and the second factor consists foliar spray of Zinc sulphate, Copper sulphate, Ferrous sulphate each at @ 0.5% and control (without any micronutrient). Sixteen treatment combinations were replicated thrice. Among the treatments, seed inoculation with Azospirillum + Phosphate solubilising bacteria+ foliar spray of zinc sulphate @ 0.5% recorded maximum seeds per umbel, 100 seed weight, seed yield g per plant, seed yield kg per hectare, essential oils and oleoresins content.
Key words: Coriander, biofertilizers, micronutrients, quality, yield

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INTRODUCTION

Coriander (*Coriandrum sativum L.*) is one of the major seed spices grown in India. India is the largest producer of coriander in the world and is mainly cultivated in Rajasthan, Gujarat, Andhra Pradesh, Madhya Pradesh, Tamil Nadu, Orissa, Karnataka, Uttar Pradesh and Bihar producing 52.4 million tonnes from 54.3 million hectares (NHB, 2013). Andhra Pradesh ranks second in production of coriander and ranks first in the Southern states of the country. The share of Andhra Pradesh is maximum i.e. 26,000 metric tonnes from 21,800 hectares (NHB, 2015). The fresh green herb, called Cilantro or Chinese parsley, is also very popular all over the world for the usefulness in soups, salads, dressing of vegetables, seasoning and chutney. They are also rich in Vitamin A, C and B_2.

The crop has to survive under residual soil moisture throughout the cropping period and generally experiences terminal moisture stress which results in poor yields, which is the major constraint in production of coriander in Andhra Pradesh (Sarada *et al*., 2008). In recent years, biofertilizers have emerged as an important component of integrated nutrient supply system and have shown promise to improve crop yields and nutrient supplies. Azotobacter, PSB and Azospirillum are the most wide spread biofertilizers significantly contributing N, P and K to plants and also providing resistance to drought situation (Maheshwari *et al.* 1991).

Kalidasu *et al.* (2008) reported that foliar application of micronutrients on crop growth may be due to the improved ability of the crop to absorb nutrients, photosynthesis and better sink source relationship as these play vital role in various biochemical processes. Information regarding the use of biofertilizers and micronutrients suitable for rain fed vertisols in Andhra Pradesh is very meagre. Keeping this in view, the present field experiment was conducted to study the effect of biofertilizers and micronutrients on growth, leaf yield and quality of coriander.

MATERIALS AND METHODS

Present field experiment was conducted during *rabi* 2015-16 at Research Farm, Horticultural College and Research Institute, Dr. Y.S.R. Horticultural University, Anantharajupeta, Andhra Pradesh (India). The experiment was laid out in randomized block design with factorial concept triplicate with sixteen treatments. Seeds were sown in the plot of 2 m × 2m at spacing of 20 cm × 15 cm. The crop was fertilized with 10 t of FYM along with NPK @ 30: 40: 20 kg/ha as basal. Two third of nitrogen was applied as top dressing in two equal splits before irrigation i.e. at 20 and 40 DAS. Need based cultural and plant protection operations were taken up to harvest good crop. Five plant samples from each replication were selected at random to record data morphological, yield and quality attributing and quality characters. The experimental data was analysed statistically by the method of analysis of variance as out lined by Panse and Sukhatme (1995).

Table 1: Details of treatments

S.No	Treatments	Treatment combinations
1.	$B_1 M_1$	Seed inoculation with Azospirillium + foliar spray of $ZnSO_4$ @ 0.5% at 20 & 30 DAS
2.	$B_1 M_2$	Seed inoculation with Azospirillium + foliar spray of $FeSO_4$ @ 0.5% at 20 &30 DAS
3.	$B_1 M_3$	Seed inoculation with Azospirillium + foliar spray of $CuSO_4$ @ 0.5% at 20 & 30 DAS
4.	$B_1 M_4$	Seed inoculation with Azospirillium
5.	$B_2 M_1$	Seed inoculation with PSB + foliar spray of $ZnSO_4$ @ 0.5% at 20 &30 DAS
6.	$B_2 M_2$	Seed inoculation with PSB + foliar spray of $FeSO_4$ @ 0.5% at 20 &30 DAS
7.	$B_2 M_3$	Seed inoculation with PSB + foliar spray of $CuSO_4$ @ 0.5% at 20 &30 DAS
8.	$B_2 M_4$	Seed inoculation with PSB
9.	$B_3 M_1$	Seed inoculation with Azospirillium + PSB + foliar spray of $ZnSO_4$ @ 0.5% at 20 & 30 DAS
10.	$B_3 M_2$	Seed inoculation with Azospirillium + PSB + foliar spray of $FeSO_4$ @ 0.5% at 20&30 DAS
11.	$B_3 M_3$	Seed inoculation with Azospirillium + PSB + foliar spray of $CuSO_4$ @ 0.5% at 20 &30 DAS
12.	$B_3 M_4$	Seed inoculation with Azospirillium + PSB
13.	$B_4 M_1$	Foliar spray of $ZnSO_4$ @ 0.5% at 20 &30 DAS
14.	$B_4 M_2$	Foliar spray of $FeSO_4$@ 0.5% at 20 &30 DAS
15.	$B_4 M_3$	Foliar spray of $CuSO_4$ @ 0.5% at 20 &30 DAS
16.	$B_4 M_4$	Control (No seed inoculation and foliar application)

RESULTS AND DISCUSSION

Yield and yield attributing characters

The yield and yield attributing characters, such as seeds per umbel, 100 seed weight(Table 2), seed yield g per plant and seed yield kg per hectare (Table 3) were also showed significant variation among the different biofertilizers and micronutrients. Among the biofertilizers, seed inoculation with Azospirillum + Phosphate solubilising bacteria recorded maximum Number of seeds per umbel (35.49), 100 seed weight (1.63), seed yield g per plant (5.00) and seed yield kg per hectare (1196.75 kg).

Table 2: Effect of biofertilizers and micronutrients on no. of seeds per umbel, 100 Seed weight fcoriander cv. Sadhana.

	Number of seeds per umbel					100 Seed weight				
	Biofertilizers					Biofertilizers				
Micronutrients	**B_1**	**B_2**	**B_3**	**B_4**	**Mean**	**B_1**	**B_2**	**B_3**	**B_4**	**Mean**
M_1	30.00	31.69	38.73	28.00	**32.11**	1.55	1.50	1.80	1.40	**1.60**
M_2	27.53	30.00	36.81	25.63	**29.99**	1.48	1.58	1.72	1.30	**1.52**
M_3	26.20	32.15	34.21	23.61	**29.04**	1.45	1.49	1.65	1.39	**1.46**
M_4	24.53	32.18	32.19	23.00	**27.98**	1.38	1.42	1.48	1.29	**1.39**
Mean	27.07	31.51	35.49	25.06	Mean	1.47	1.54	1.63	1.35	Mean
S.Em±		**CD at 5%**			**S.Em±**			**CD at 5%**		
Biofertilizer (B)	0.19		0.54		0.01				0.03	
Micronutrient (M)	0.19		0.54		0.01				0.03	
Interaction (B XM))	0.38		1.09		0.02				0.06	

It is obvious that availability of P improved by PSB, N taped from atmosphere by Azospirillum and soil was already have sufficient amount of K leads to balance supply of major nutrients and ultimately contributed to higher yield and yield attributing characters. These results are in agreement with those reported by Belimov *et al.* (1995) in barley.

Among different micronutrients, foliar application of zinc sulphate @0.5 % (M_1) recorded significantly maximum Number of seeds per umbel (32.11), 100 seed weight (1.60), seed yield g per plant (4.91) and seed yield kg per hectare (1149.90 kg).

Table 3: Effect of biofertilizers and micronutrients on seed yield (g per plant), seed yield (kg per ha) of coriander cv. Sadhana.

Micronutrients	Seed yield (g plant $^{-1}$)					Seed yield (kg ha^{-1})				
	Biofertilizers					Biofertilizers				
	B_1	**B_2**	**B_3**	**B_4**	**Mean**	**B_1**	**B_2**	**B_3**	**B_4**	**Mean**
M_1	4.80	4.96	5.82	4.08	**4.91**	1238.68	1100.25	1270.38	990.25	**1149.90**
M_2	4.24	4.68	5.00	3.98	**4.47**	1236.25	1060.35	1244.68	980.85	**1130.53**
M_3	4.36	4.20	4.80	3.70	**4.26**	1220.28	1050.48	1241.78	976.68	**1126.30**
M_4	4.28	4.15	4.37	3.25	**4.01**	1000.96	1020.21	1030.17	970.65	**1005.50**
Mean	**4.42**	**4.50**	**5.00**	**3.75**		**1174.04**	**1057.82**	**1196.75**	**979.61**	

	S.Em±	**CD at 5%**	**S.Em±**	**CD at 5%**
Biofertilizer (B)	0.03	0.08	7.00	20.22
Micronutrient (M)	0.03	0.08	7.00	20.22
Interaction (B XM)	0.06	0.17	14.00	40.44

Interaction effect of biofertilizers and micronutrients on seed inoculation with Azospirillum + Phosphate solubilising bacteria+ foliar spray of zinc sulphate @0.5% B_3M_1 recorded significantly maximum Number of seeds per umbel (38.73), 100 seed weight (1.80), seed yield g per plant (5.82) and seed yield kg per hectare (1270.38 kg).

Quality characters

Quality characters, such as essential oil content, oleoresins content (Table 4) were also showed significant variation among the different biofertilizers and micronutrients. Among the biofertilizers, seed inoculation with Azospirillum + Phosphate solubilising bacteria recorded maximum essential oil content (0.89%) and oleoresins content (0.75%). Similar observation was recorded by Rahimi *et al.* (2009), Sahu *et al.* (2012) in coriander crop.

Table 4: Effect of biofertilizers and micronutrients on essential oil (%) and oleoresin (%) content of coriander cv. Sadhana.

Micronutrients	Essential oil (%)					Oleoresin (%)				
	Biofertilizers					Biofertilizers				
	B_1	**B_2**	**B_3**	**B_4**	**Mean**	**B_1**	**B_2**	**B_3**	**B_4**	**Mean**
M_1	0.85	0.91	0.96	0.74	**0.87**	0.72	0.73	0.80	0.50	**0.70**
M_2	0.84	0.89	0.91	0.70	**0.84**	0.65	0.61	0.76	0.48	**0.63**
M_3	0.86	0.85	0.92	0.72	**0.84**	0.62	0.66	0.75	0.42	**0.61**
M_4	0.70	0.69	0.75	0.68	**0.71**	0.60	0.58	0.70	0.40	**0.57**
Mean	**0.81**	**0.83**	**0.89**	**0.71**		**0.66**	**0.65**	**0.75**	**0.45**	

	S.Em±	**CD at 5%**	**S.Em±**	**CD at 5%**
Biofertilizer (B)	0.01	0.02	0.004	0.011
Micronutrient (M)	0.01	0.02	0.004	0.011
Interaction (B XM)	0.02	0.03	0.008	0.02

Among different micronutrients, foliar application of zinc sulphate @0.5 % (M_1) recorded significantly maximum essential oil content (0.87%) and oleoresins content (0.70%).

The positive effect of zinc with to plant vegetative growth and yield with its attributes and quality is due to the fact that zinc favours the enzyme system, auxin and protein synthesis and seed production directly or indirectly. Zn improves photosynthesis and assimilates transportation to sinks and finally increased oleoresin contents.

Interaction effect of biofertilizers and micronutrients on seed inoculation with Azospirillum + Phosphate solubilising bacteria+ foliar spray of zinc sulphate @0.5% B_3M_1 recorded significantly maximum essential oil content (0.96%) and oleoresins content (0.80%).

CONCLUSION

The results obtained from the present investigation inferred that the combination of seed inoculation with Azospirillum + Phosphate solubilising bacteria and foliar application of $ZnSO_4$ @ 0.5% showed a beneficial influence on yield and yield attributing parameters and quality parameters of seeds at all crop growth stages of investigation.

Based on the trends of yield, quality and economical aspects observed in present study, it can be concluded that for getting higher yield coupled with superior quality of seeds, a combination of seed inoculation with Azospirillum + Phosphate solubilising bacteria and foliar application of $ZnSO_4$ @ 0.5% can be adopted.

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