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EFFECT OF INDIVIDUAL AND COMBINED APPLICATION OF BIOFERTILIZERS, MICRONUTRIENTS ON GROWTH, LEAF YIELD AND QUALITY OF CORIANDER (*CORIANDRUM SATIVUM* L.) CV. SADHANA

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Abstract

A field experiment was conducted during *rabi* 2015-16 at Research Farm, College of Horticulture, Dr.Y.S.R. Horticultural University, Anantharajupeta (Andhra Pradesh), India, to study the effect of individual and combined application of biofertilizers, micronutrients on growth, leaf yield and quality 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 plant height, number of primary branches, leaf area, fresh leaf yield per plant, leaf yield per plot, leaf yield per hectare, dry matter production,protein content, ascorbic acid content and moisture content. While, the lowest Days to germination and chlorophyll content in leaf was maximum with seed inoculation of azospirillum + phosphate solubilising bacteria + foliar spray of ferrous sulphate @ 0.5%.

Key words : Coriander, growth, biofertilizers, micronutrients, quality, yield.

Introduction

Coriander (*Coriandrum sativum* L.) is an annual herb, generally called "Dhania" belongs to family Apiaceae (Umbelliferae) with diploid chromosome number (2n =22). It is native of the Mediterranean region near Eastern region and is now commercially grown in India. It is one of the earliest spices known to mankind for its intrinsic and fragrant qualities of both seed and leaves. 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.

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).

Micronutrients are present in lower concentrations in soil than macronutrients but are equally significant in plant nutrition, since, plants grown in micronutrient deficient soils show similar reductions in productivity as those grown in macronutrient-deficient soils (Havlin *et al*., 2005). The prerequisite criteria for improved growth, yield and quality of crops is balanced fertilization. However, nutrients can be applied either by conventional methods or by foliar application but the major advantage

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of foliar application the instant availability of nutrients to plants. 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, College of Horticulture, 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, *viz*., B_1M_1-Seed inoculation with Azospirillum + foliar spray of $ZnSO_4$ @ 0.5%, B_1M_2-Seed inoculation with Azospirillum + foliar spray of $FeSO_4$ @ 0.5%, B_1M_3-Seed inoculation with Azospirillum+ foliar spray of $CuSO_4$ @ 0.5%, B_1M_4-Seed inoculation with Azospirillum, B_2M_1- Seed inoculation with PSB + foliar spray of $ZnSO_4$@ 0.5%, B_2M_2-Seed inoculation with PSB + foliar spray of $FeSO_4$ @ 0.5%, B_2M_3-Seed inoculation with PSB + foliar spray of $CuSO_4$@ 0.5%, B_2M_4-Seed inoculation with PSB, B_3M_1-Seed inoculation with Azospirillum + PSB + foliar spray of $ZnSO_4$@ 0.5%, B_3M_2-Seed inoculation with Azospirillum + PSB + foliar spray of $FeSO_4$ @ 0.5%, B_3M_3-Seed inoculation with Azospirillum + PSB + foliar spray of $CuSO_4$ @ 0.5%, B_3M_4-Seed inoculation with Azospirillum +PSB, B_4M_1-Foliar spray of $ZnSO_4$ @ 0.5%, B_4M_2- Foliar spray of $FeSO_4$ @0.5%, B_4M_3-Foliar spray of $CuSO_4$ @ 0.5%, B_4M_4-Control. Seeds were sown at2 m × 2m plots with a 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 *i.e.* at 20 and 40 DAS. Need based cultural and plant protection operations were taken up to the leaf harvest. Five plant samples from each replication were selected at random to record data on morphological, yield and quality attributingcharacters. The experimental data was analysed statistically by the method of analysis of variance as out lined by Panse and Sukhatme (1995).

Results and Discussion

Morphological characters

Morphological characters such as plant height, number of primary branches per plant (table 1), leaf area per plant (table 2) showed significant variation with different biofertilizers and micronutrients. Among the biofertilizers, seed inoculation with Azospirillum + Phosphate solubilising bacteria recorded highest plant height at harvest (29.03cm), number of primary branchesat harvest (4.30) and leaf area (67.95cm^2) at 45 days of leaf harvest. Days to germination (table 1) of coriander seed was significantly influenced by seed treatment with biofertilizers. As the application of micronutrients was post- emergence of the crop, the micronutrient effect and the interaction between biofertilizers and micronutrients application were found to be non-significant.

It could be due to the availability of atmospheric nitrogen and soil phosphorus, which might have led to better root and shoot development, better uptake of water, nutrients and their transportation. The results were in accordance with Rahimi *et al*. (2009) in coriander, Mehta *et al*. (2012) in fenugreek.

Among different micronutrients, foliar application of zinc sulphate @ 0.5% (M_1) recorded significantly highest plant heightat harvest (30.81cm), number of primary branches at harvest (3.83) and leaf area (61.55 cm^2) at 45 days of leaf harvest. This could be attributed to fact that zinc is an activator of enzyme and involved in protein synthesis and has direct effect on the enzymatic regulation in plants. The synthesis of tryptophan in the presence of zinc, the precursor of IAA, which stimulated the growth of plant tissues. The results were in accordance with findings of Ingle *et al*. (1993) in chilli, Chhibba *et al*. (2007) in fenugreek.

Combination of biofertilizers and micronutrients on seed inoculation with Azospirillum + Phosphate solubilising bacteria + foliar spray of zinc sulphate @0.5% B_3M_1 recorded significantly highest plant heightat harvest (36.31cm), number of primary branchesat harvest (4.40) and leaf area (75.65cm^2) at 45 days of leaf harvest.

Yield and yield attributes

The yield and yield attributing characters, such as fresh leaf yield per plant, leaf yield per plot, leaf yield per hectare (table 3) and dry matter production (table 2) were also showed significant variation among the different biofertilizers and micronutrients. Among the biofertilizers, seed inoculation with Azospirillum + Phosphate solubilising bacteria recorded maximum leaf yield per plant (3.74g), leaf yield per plot (0.48 kg), leaf yield per hectare (1.22t) and dry matter production (0.97g per plant). Application of biofertilizers might have enhanced the availability of nitrogen, phosphorus and other nutrients along with the production of growth hormones like IAA, GA_3 and cytokines to cause the increase in the length and breadth of leaves leading to increased leaf yield. Singh *et al.* (2012) and Sonali *et al.* (2012) in fenugreek.

Table 1 : Effect of biofertilizers and micronutrients on days to germination, Plant height (cm) at harvest and Number of primary branches at harvest of coriander cv. Sadhana.

Micronutrients	Days to germination					Plant height (cm) at harvest					Number of primary branches at harvest				
	Biofertilizers														
	B_1	B_2	B_3	B_4	Mean	B_1	B_2	B_3	B_4	Mean	B_1	B_2	B_3	B_4	Mean
M_1	6.64	7.57	7.46	7.20	7.22	27.31	26.48	36.31	23.02	30.81	4.25	3.40	4.40	3.00	3.83
M_2	7.60	7.20	6.47	7.17	7.11	27.80	28.01	32.68	22.49	26.20	3.95	3.98	4.25	3.15	3.76
M_3	7.47	7.17	7.47	8.37	7.62	26.00	27.68	31.21	23.15	26.04	3.68	3.21	4.35	3.02	3.57
M_4	7.22	7.47	7.87	8.13	7.67	24.21	24.81	26.00	20.25	23.82	3.51	2.25	4.20	2.85	3.20
Mean	7.23	7.35	7.31	7.72		27.56	28.05	29.03	22.23		3.85	3.21	4.30	3.01	
Source	B		M	B×M		B		M	B×M		B		M	B×M	
S. Em±	0.13		0.13	0.25		0.17		0.17	0.34		0.02		0.02	0.05	
CD (*P=0.05*)	0.37		NS	NS		0.49		0.49	0.99		0.07		0.07	0.13	

Table 2 : Effect of biofertilizers and micronutrients on leaf area (cm^2), dry matter production (g per plant) and moisture (%) of coriander cv. Sadhana.

Micronutrients	Leaf area (cm^2)					Dry matter production (g per plant)					Moisture (%)				
	Biofertilizers														
	B_1	B_2	B_3	B_4	Mean	B_1	B_2	B_3	B_4	Mean	B_1	B_2	B_3	B_4	Mean
M_1	66.21	64.18	75.65	40.15	61.55	0.60	0.63	0.78	0.53	0.64	85.28	84.65	90.15	85.21	86.32
M_2	63.65	56.82	71.25	38.65	57.59	0.62	0.62	0.68	0.50	0.61	84.56	82.65	88.19	83.65	84.76
M_3	58.34	48.68	64.25	33.25	51.13	0.63	0.64	0.65	0.48	0.60	83.85	84.65	88.65	84.34	85.37
M_4	50.15	44.21	60.65	27.35	45.59	0.59	0.50	0.58	0.46	0.53	85.65	86.00	86.25	82.28	85.04
Mean	59.59	53.47	67.95	34.85		0.61	0.60	0.67	0.49		84.84	84.48	88.31	83.87	
Source	B		M	B×M		B		M	B×M		B		M	B×M	
S. Em±	0.35		0.35	0.69		0.003		0.003	0.008		0.56		0.56	1.13	
CD (*P=0.05*)	1.00		1.00	2.00		0.01		0.01	0.02		1.63		1.63	3.26	

Among different micronutrients, foliar application of zinc sulphate @ 0.5% (M_1) recorded significantly maximum leaf yield per plant (3.60g), leaf yield per plot (0.46kg), leaf yield per hectare (1.18t) and dry matter production (0.64g per plant). Similar results were observed by Chhibba *et al*. (2007) in fenugreek.

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 leaf yield per plant (3.94g), leaf yield per plot (0.50 kg), leaf yield per hectare (1.30t) and dry matter production (0.78g per plant).

Quality characters

With regards to quality characters, such as moisture content (table 2), ascorbic acid content, protein content and chlorophyll 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 moisture content (88.31%), ascorbic acid content (140.47 $mg100g^{-1}$), protein content (3.72%) andchlorophyll content (1.33mg $100g^{-1}$). Similar results were observed by Singh (2015) in coriander.

Among different micronutrients, foliar application of zinc sulphate @ 0.5% (M_1) recorded significantly maximum moisture content (86.32%), ascorbic acid content (137.32$mg100g^{-1}$) and protein content (3.63%). While, chlorophyll content in leaf was maximum (1.27 $mg100g^{-1}$) withfoliar application of ferrous sulphate @ 0.5% (M_2). The enhancement of available P in soil applied with Phosphate solubilising bacteria was due to coating of sesqui-oxides by organic materials that reduced phosphorus fixation in soil and mobilization of fixed phosphorus into available form by PSB. These results are in line with the earlier findings of Rajamanickam *et al*. (2011) in mint.

Table 3 : Effect of biofertilizers and micronutrients on leaf yield per plant (g), leaf yield per plot (kg) and leaf yield per hectare (t) of coriander cv. Sadhana.

Micronutrients	Leaf yield per plant (g)					Leaf yield per plot (kg)					Leaf yield per hectare ($t\ ha^{-1}$)				
	Biofertilizers														
	B_1	B_2	B_3	B_4	Mean	B_1	B_2	B_3	B_4	Mean	B_1	B_2	B_3	B_4	Mean
M_1	3.65	3.54	3.94	3.28	3.60	0.42	0.40	0.50	0.45	0.46	1.20	1.18	1.30	1.05	1.18
M_2	3.29	3.32	3.80	3.00	3.35	0.44	0.47	0.49	0.42	0.44	1.10	1.10	1.25	0.97	1.11
M_3	3.28	3.25	3.79	2.93	3.31	0.43	0.44	0.46	0.38	0.42	1.08	1.08	1.22	0.95	1.08
M_4	3.19	3.07	3.43	2.80	3.12	0.44	0.43	0.40	0.37	0.40	1.05	1.00	1.13	0.93	1.03
Mean	3.35	3.30	3.74	3.00		0.45	0.44	0.48	0.41		1.11	1.09	1.22	0.97	
Source	B		M	B×M		B		M	B×M		B		M	B×M	
S. Em±	0.02		0.02	0.04		0.01		0.01	0.02		0.01		0.01	0.02	
CD (*P=0.05*)	0.06		0.06	0.12		0.03		0.03	0.09		0.02		0.02	0.04	

Table 4 : Effect of biofertilizers and micronutrients on Ascorbic acid ($mg100\ g^{-1}$), Total Chlorophyll ($mg100\ g^{-1}$) and Protein (%) of coriander cv. Sadhana

Micronutrients	Ascorbic acid ($mg100\ g^{-1}$)					Total Chlorophyll ($mg100\ g^{-1}$)					Proteins (%)				
	Biofertilizers														
	B_1	B_2	B_3	B_4	Mean	B_1	B_2	B_3	B_4	Mean	B_1	B_2	B_3	B_4	Mean
M_1	140.85	139.68	146.68	123.68	137.72	1.22	1.21	1.34	1.13	1.23	3.66	3.69	3.80	3.38	3.63
M_2	136.21	135.25	142.28	119.24	133.25	1.24	1.28	1.40	1.17	1.27	3.58	3.56	3.72	3.25	3.53
M_3	134.85	128.45	138.65	117.75	129.93	1.20	1.18	1.34	1.08	1.20	3.60	3.48	3.78	3.15	3.50
M_4	129.61	125.00	134.25	115.38	126.06	1.19	1.16	1.25	1.00	1.15	3.38	3.40	3.58	2.85	3.30
Mean	135.38	132.10	140.47	119.01		1.21	1.20	1.33	1.10		3.56	3.53	3.72	3.16	
Source	B		M	B×M		B		M	B×M		B		M	B×M	
S. Em±	0.85		0.85	1.70		0.01		0.01	0.02		0.02		0.02	0.04	
CD (*P=0.05*)	2.45		2.45	4.90		0.02		0.02	0.05		0.06		0.06	0.13	

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 moisture content (90.15%), ascorbic acid content ($146.68mg100g^{-1}$) and protein content (3.80%).While, chlorophyll content in leaf was maximum ($1.40\ mg100g^{-1}$) with seed inoculation of Azospirillum + Phosphate solubilising bacteria + foliar spray of ferrous sulphate @ 0.5%.

The results obtained from the present investigation inferred that the combination of seed inoculation with Azospirillum + Phosphate solubilising bacteria along with foliar application of $ZnSO_4$ @ 0.5 per cent showed significant influence on vegetative growth leaf yield and quality parameters in coriander cv. Sadhana.

References

Chhibba, M., V. K. Nayyar and J. S. Kanwar (2007). Influence of Mode and Source of Applied Iron on Fenugreek (*Trigonella corniculata*L.) in a TypicUstochrept in Punjab, India. *Intl. J. Agric. Biol.*, **9(2)** : 254–256.

Havlin, J. L., J. D. Beatson, S. L. Tisdale andW. L. Nelson (2005). Soil Fertility and Fertilizers -An Introduction to Nutrient Management, (7th ed.) Pearson Education, Inc, Pearson Prentice Hall.

Ingle, V. G., A. U. Thakre, S. B. Badhe and M. A. H. Khan (1993). Effect of foliar spray of auxins, micronutrients with urea on fruit drop and yield of chilli cv. CA 960. *Punj. Kris. Vidya. Res. J.*, **17** : 142-145.

Maheshwari, S. K., S. K. Gangreede and K. C. Trived (1991). Comparative responses of palmarosa to Azotobacter and nitrogen under rainfed and irrigated swards. *Ind. Perf.*, **35(2)** : 108-111.

Mehta, R. S., M. M. Anwer, O. P. Aishwath and R. S. Meena (2012). Growth, yield and quality of fenugreek (*Trigonella foenum graecum* L.) as influenced by nitrogen, phosphorus and bio-fertilizers. *Indian. J. Hort.*, **69(1)** : 94-97.

National Horticulture Board (2013). Area and Production statistics of Horticulture Crops. Ministry of Agriculture, Government of India.

National Horticulture Board (2015). Area and Production statistics of Horticulture Crops. Ministry of Agriculture, Government of India.

Panse, V. G. and P. V. Sukhatme (1995). *Statistical Methods for Agricultural Workers*. 4th Edition, I C A R, New Delhi. 1-347.

Rahimi, A. R., K. Mashayekhi, S. Amini and E.Soltani (2009). Effect of Mineral vs. Biofertilizer on the Growth, Yield and Essential Oil Content of Coriander (*Coriandrum sativum* L.). *Medicinal and Aromatic Plant Science and Biotechnology*. Global Science Books.

Rajamanickam, V., S. Venkatesan and A. Shakila (2011). Effect of organic manures, consortium of biofertilizers and inorganic fertilizers on yield, nutrient uptake and profitability of mint (*Mentha arvensis* L.). *Asian. J. Hort.*, **6 (1)** : 191-194.

Sarada, C., K. Giridhar and T. Yellamanda Reddy (2008). Effect of bio-regulators and their time of application on growth and yield of coriander (*Coriandrum sativum*). *Journal Spi. Aro. Cro.*, **17** : 183-186.

Singh, S., M. R. Choudhary, O. P. Garhwal, M. L. Jakhar and B. L. Yadav (2012). Effect of biofertilizers and inorganic sources of Nitrogen and Phosphorus on quality production of kasturimethi (*Trigonella corniculata*). *Intl. J. Seed Spi*., **2(2)** : 38-40.

Singh, S. P. (2015). Effect of $ZnSO_4$, $FeSO_4$, $CuSO_4$ and $MnSO_4$ on growth, yield and economics of Coriander (*Coriandrum sativum*L.) cv. Pant Haritima. *J. Eco-fri. Agri.*, **10(1)** : 32-35.

Sonali, R. A., A. P. Soyam,V. N. Wagh, P. K. Dod, N. Nagre and R. N. Gade (2012). Effect of different biofertilizers on growth, yield and quality of fenugreek. *Asian. J. Hort*., **7(1)** : 28-30.