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Influence of bio-fertilizers on growth and yield of coriander (*Coriandrum sativum* L.) under Typic Haplustepts

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ABSTRACT

A field study was carried out to study the effect of PSB, *Azotobacter* and their combination on growth characters and yield attributes of coriander at NRCSS, Ajmer, Rajasthan during 2009-12. Splitted seeds of coriander were inoculated with *Azotobacter* and PSB alone and their combinations. Bacterial culture was used @ 10g kg^{-1} of seed. Results revealed that plant height at various stages and number of primary and secondary branches were higher with combine inoculation of PSB and *Azotobacter*. However, DAS to germination and DAS to 50% and complete flowering and number of umbels per plant were not influence with these inoculants. Numbers of umbellates/umbel, seed, straw and biological yields were highest with the combine use of biofertilizers, which was at par with individual inoculation. Per cent seed yield increased with the use of *Azotobacter*, PSB and their combinations of both was 8.8, 11.6 and 18.5, respectively, as compared to control. Carotinoids content at 60 DAS was more with PSB inoculation and protein content in straw was enhanced with individual and combine use of inoculants.

Key words : Coriander, *Coriandrum sativum, Azotobacter*, PSB, growth, yield.

INTRODUCTION

Beneficial microbial inoculants (biofertilisers) are presently attracting more attention in the context of sustainable agriculture. This is a consequence of the need to solve health and environmental problems caused by the excessive use of agrochemicals in traditional agriculture. Biofertilizers are the products which contains living cells of different types of microorganisms Vessey *et al.* (24) and Chen *et al.* (5) that have an ability to convert nutritionally important elements from unavailable to available form through biological processes Vessey *et al.* (24) and are known to help with expansion of the root system and better seed germination. Biofertilzers are less expensive, eco-friendly and sustainable likely to assume greater significance as a compliment or supplement to inorganic fertilizers (Malhotra *et al*., 14). *Azotobacter* is an aerobic, free-living gram negative bacterium which fixes nitrogen from the atmosphere (Dixon and Kahn, 7). Many investigators such as (Song *et al*. 22, Melero *et al*., 17), Kremer and Li (10) and Criquet *et al.* (6) explained the role of phosphate solubilising bacteria on the bases of increases in the availability of phosphorus in the soil through secretion of phosphatase enzyme which leads to transfer organic phosphorus to available form. Consequently, it increases phosphorus absorption and accumulation in plant tissues. Similarly increases in nutrient uptake as affected by combined inoculation of *Rhizobium* and PSB were reported by (Rudresh *et al.,* 21). Thus, it is well known that a considerable number of bacterial species possess a functional relationship and constitute a holistic system with plants. They are able to exert beneficial effects on plant growth (Vessey *et al.,* 24) and also enhance plant resistance to adverse environmental stresses, such as water and nutrient deficiency and heavy metal contamination (Wu *et al.*, 25). There are some studies available on the use of *Azotobactor* and PSB for the coriander production. However, the information on individual and combine use of these biofertilizers is very limited. It is also essential to take up such study at various places for site specific nutrient management and to assess the efficacy of biofertilizer. Therefore, present investigation was carried out to study the individual and confined effect of *Azotobacter* and PSB on the growth and yield of coriander.

MATERIALS AND METHODS

Location of experiment

The experiment was carried out during *Rabi* season 2009-2012 at the research farm of NRCSS, Tabiji, Ajmer which lies in between 74^0 35' 39" E to 74^0 36' 01" longitude and 26^0 22' 12" to 26^0 22' 31" N latitude at an altitude of 460.17 m above mean sea level in Ajmer district of Rajasthan. This zone is semi arid, eastern plain and receives the rainfall from 50-60 cm. Summer and winter temperatures are not as extreme as in the arid west but the summer temperature may reach around 42-45^{o}C and in the winter, minimum up to 2.0 ^{o}C.

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Experimental soil

The soil of experimental area comprises a member of fine loamy, mixed calcareous, hyperthermic family of Typic Heplustepts. The soil was more than 100 cm deep, brown to dark brown in colour, slightly to moderately alkaline, slightly calcareous having approximately 5.0% calcium carbonates. The texture of experimental soil was loamy sand and with subsurface sandy clay loam, which was analyzed by International Pipette method (Piper., 20). Soil was lower fertile in respect of nitrogen (116.7 kg ha^{-1}) and medium fertile with respect to availability of phosphorus (24.5 kg ha^{-1}) and potassium (135.1 kg ha^{-1}). Soil samples were analyzed for available nitrogen (Subbiah and Asija, 23), 0.5M $NaHCO_3$ extractable phosphorus (Olsen *et al.*, 19), and 1N NH_4OAc extractable potassium (Jackson, 9). Soil organic carbon (SOC) was estimated by wet digestion method as described by Walkley and Black (25). Initial soil organic carbon content was 0.23 per cent.

Treatments and observations

The treatments consist, control (without fertilizer), seed inoculation with *Azotobacter*, phosphate solublizing bacteria (PSB) and their combination. Inoculation was carried out by dipping the spilited coriander seeds in the cells suspension of 10^8 CFU/ml for 15 minutes (10% w/v) Sucrose solution in water was prepared from Jaggery and used as a sticking material for seeds and bacterial culture. Coriander cultivar 'Ajmer Coriander-1' was taken for the study. These four treatments were replicated by five times in Randomized Block Design. Diseases and pests were controlled by use of neem based organic pesticides i.e. neem oil (2% v/v). Irrigation and hoeing was done as and when required during the experimentation period. Observations pertaining to growth and yield characters were recorded as per technical programme. Total protein and carotenoids content was estimated by nitrogen fraction and DMSO methods, respectively. The obtained data were poold and analyzed statistically for differences in treatment mean.

RESULTS AND DISCUSSION

Growth parameters

Plants were taller at 30, 60, 90 DAS and at harvest with combine use of PSB and *Azotobactor* than control (Table 1). However, plant height was at par with *Azotobactor* and control. Days to germination were also remained at par with all the treatments. Number of primary branches was more either with *Azotobactor* or in combination with PSB. However, secondary branches were higher with combine inoculation of PSB and *Azotobacter.* DAS to 50% and complete flowering did not influence with individual or combine inoculations. This is because of biofertilizers produce metabolites such as plant growth regulators that directly promote growth and facilitate nutrient uptake by plants (Kucey *et al.,* 11). The highest plant height and dry matter accumulation was also recorded by application of recommended fertilizers and seed inoculation with *Azotobacter* sp (Mehta *et al*., 16).

Yield and yield attributes

Number of umbellate/umble were more only with combine inoculation and umbels per plant were not influence by use of inoculations either individual or in combination of PSB and *Azotobacter* (Table 2). Test weight and harvest index were remand at par. In case of seed yield, straw, and biological yield were highest with the combine use of biofertilizers, which was at par with individual inoculation of PSB and *Azotobacter*. Per cent seed yield increased with the use of *Azotobacter*, PSB and their combination was 8.8, 11.6 and 18.5, respectively, as compared to control. It is obvious that availability of P improved by PSB, N taped from atmosphere by *Azotobactor* and soil was already have sufficient amount of K leads to balance supply of major nutrients and ultimately contributed into higher yield and yield attributing characters. These results are in agreement with those reported by Belimov *et al.* (3), who stated that, the inoculation with bacterial mixtures provided a more nutrition for the plants and the improvement in root uptake of both nitrogen and phosphorus as a balance result of mechanism of interaction between nitrogen fixing and phosphate solubilising bacteria. Moreover, El-Komy (8) demonstrated the beneficial influence of co-inoculation of *Azospirillum lipoferum* and *Bacillus megaterium* for providing balanced nitrogen and phosphorus nutrition of wheat plants**.** However, Ali *et al.* (1) showed that the effect of N-fertilisation on growth of coriander depends not only on the absolute quantity of N-application but also on soil type. Kumar *et al.* (12) studied the effect of N fertilizer (0, 30, 60, or 90 kg ha^{-1}) and biofertilizer (i.e. *Azotobacter*, *Azospirillum*, and *Azotobacter* + *Azospirillum*) on the yield and quality of coriander (cv. RCr-435). They found a positive response up to 60 kg N ha^{-1} and with the use biofertilizers.

Carotenoid and protein content

Carotenoids are naturally occurring tetraterpenoid organic pigments present in the chloroplasts and chromoplasts of plants and some other photosynthetic organisms like algae, some bacteria, and some types of fungus. Carotenoids can be synthesized fats and other basic organic metabolic building blocks by all these organisms. Carotenoids generally cannot be manufactured by species in the animal kingdom (although one species of aphid is known to have acquired the genes for synthesis of the carotenoid torulene from fungi by horizontal gene transfer (Nancy and Tyler, 18).

Carotenoid content at 60 DAS was more with PSB inoculation. However, it was marginally higher with

Table 1. Effect of different bio-fertilizer on germination and growth parameter of coriander

Treatment	Days to Germination	Plant height (cm)				No of branches		Day to flowering	
		30 DAS	60 DAS	90 DAS	At harvest	Primary	Secondary	50 %	Complete
Control	7.8	4.3	11.0	41.0	59.0	7.0	15.4	74.0	81.0
Azotobacter	8.5	4.4	12.0	45.0	60.0	8.2	15.7	74.2	90.0
PSB	8.5	4.9	22.0	44.0	66.0	7.9	13.9	71.8	91.0
PSB+Azotoba	8.5	4.5	14.0	49.0	70.0	9.8	18.3	73.8	90.0
S.Em±	0.3	0.1	1.6	2.4	2.6	0.5	1.0	0.9	5.9
CD(*P=0.05*)	0.7	0.2	3.6	5.3	5.7	1.0	2.2	2.0	12.9
CV (%)	6.1	3.1	17.3	8.6	6.5	9.2	10.4	2.0	10.6

Table 2. Effect of different bio-fertilizer on yield and yield attributes of coriander

Treatment	No of umbels plant^{-1}	No of umblet umbels^{-1}	Test weight (g)	Harvesting index	Yield (q ha^{-1})		
					Seed	Straw	Biological
Control	15.8	74.2	4.2	29.6	10.6	26.1	31.7
Azotobacter	16.7	88.3	4.5	29.8	12.0	28.4	40.5
PSB	16.5	76.2	4.5	30.0	12.4	28.8	41.2
PSB+Azotoba	18.1	95.2	4.6	31.1	13.5	29.9	43.4
S.Em±	1.1	7.2	0.4	1.6	0.9	1.0	1.4
CD(*P=0.05*)	2.4	15.7	0.8	3.5	1.9	2.2	3.05
CV (%)	10.5	13.7	12.9	8.5	11.7	5.7	5.46

Azotobacter at 90 DAS (Fig. 1). The overall carotinoids content was about to half at 90 DAS than the 60 DAS. This might be due to rise in temperature leads to decrease in carotenoids content in plant. It explains that rise in air temperature brings the forced flowering in coriander as carotenoids contents decreases with rise in air temperature. Which is an active sites for converting radiant energy into chemical energy and their frequently use of carotenoids molecule as a sink, or hole, in their photo-dissociation (Calvin and Platt, 4, Anderson and Robertson, 2) proved the role of colored carotenoids in plants is the protection of chlorophyll from photo-destruction which vary from plant to plant Mark *et al.* (15) also reported that Lutein and α-carotene concentration increased linearly with the increase in air temperatures for kale (*Brassica oleracea* L), but the same pigments showed linear decrease in concentration for increasing a temperature for spinach (*Spinacia oleracea* L).

Protein content in straw was enhanced either with individual and combine use of inoculations, whereas no statistical variation was observed in seed (Fig 2). This might be due to protein was not properly transferred from

Fig 1. Carotenoid content (mg g^{-1}) in coriander leaves at 60 and 90 days after sowing

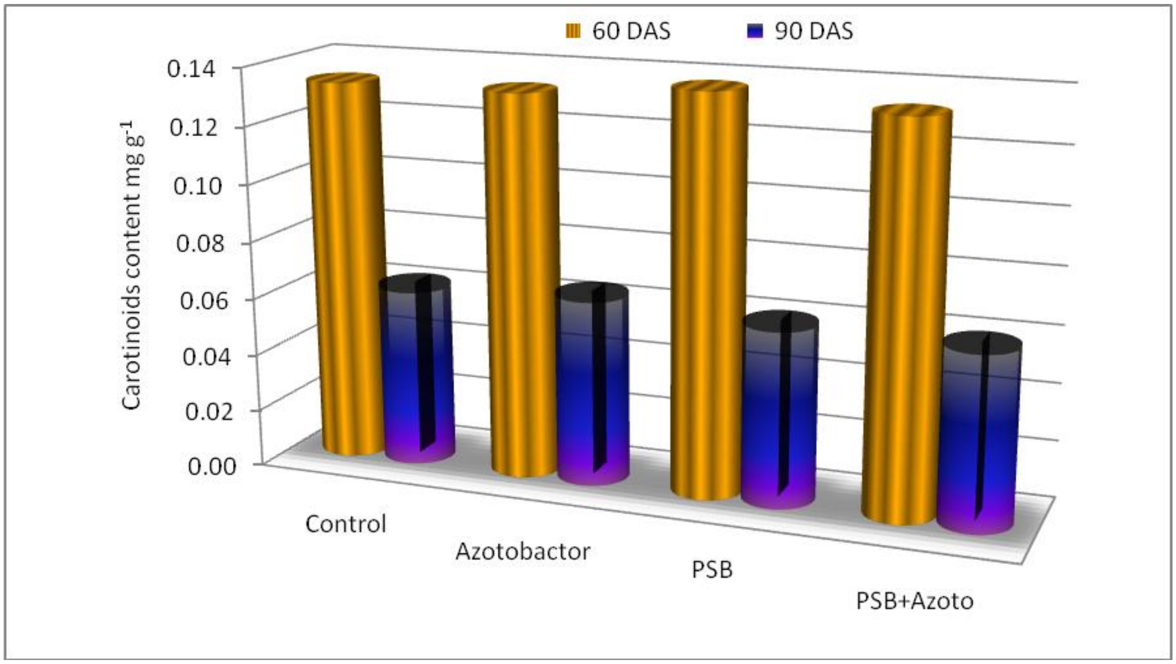
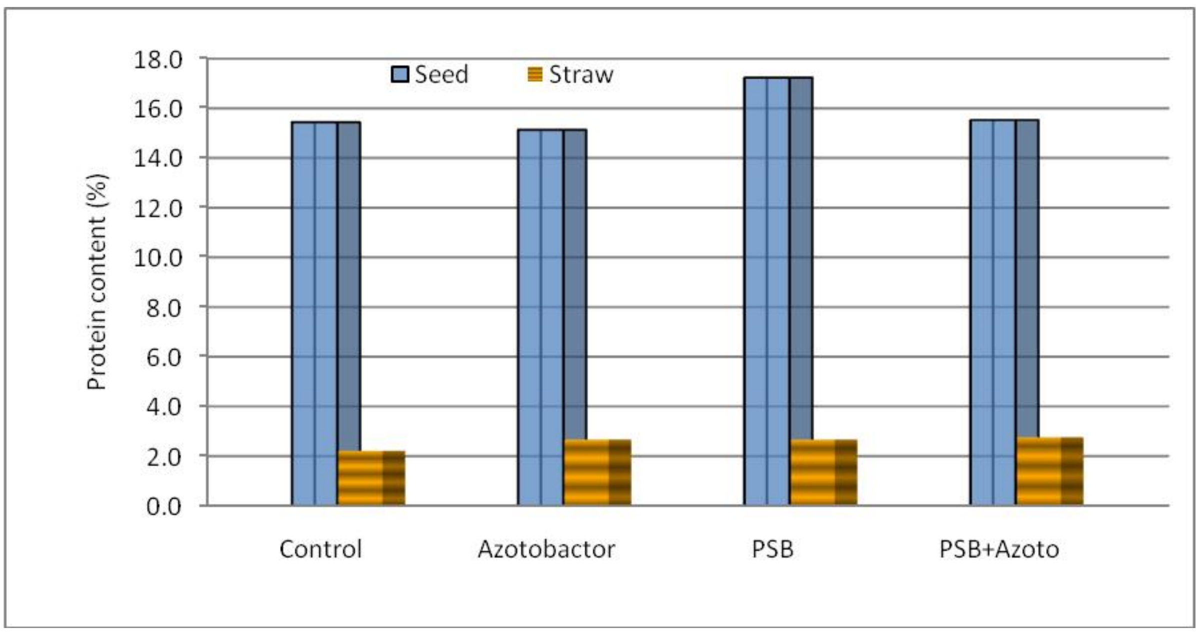


Fig 2. Protein content percent in seed and straw of coriander



source to sink. This is obvious that N supply increases the protein content in plant, Shehata and El-Khawas (13) also reported higher nitrogen compound and protein profiles in sunflower with use of individual and combine application of biofertilizers.

CONCLUSION

It can be concluded that, coriander crop positively responded to biofertilization, especially dual inoculation of PSB and *Azotobacter.*

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