EFFECTS OF PGPR (PLANT GROWTH PROMOTING RHIZOBACTERIA), SULPHUR AND MICRONUTRIENT ON MORPHOLOGICAL CHARACTERS OF LENTIL (*LENS CULINARIS*).

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Abstract : A field trial was conducted during the rabi season of 2009 at the research farm of J.V. College, Baraut, to study the role of PGPR with sulphur and micronutrients viz. Zn, Mo and Mn on the cultivar L-4076 and PL-406 of lentil (*Lens culinaris*). Application of PGPR along with S @ 60 kg/ha, Zn @ 4 kg/ha, Mn @0.5 kg/ha and Mo @ 0.1 kg/ha showed significant result in comparison of any other treatment including control in respect of Plant height, number of Branches/Plant in both variety increases with the inoculation of PGPR + S with all the micronutrients were highly significant over any other treatments. PGPR in combination with Sulphur and micronutrients attained maximum number of leaf in comparison to PGPR + S, PGPR with all the micronutrients PGPR alone and uninoculated control. Number of Pod per plant is more in both variety L-4076 and PL-406 inoculated with PGPR, S and micronutrients as compared to control. The combined application of PGPR, S and all micronutrients attained significantly higher nodules weight than any other treatments. It is concluded that use of PGPR, S and micronutrients would be an effective approach for better morphological character of lentil under natural conditions.

Keywords: PGPR, Sulphur, Zn, Mo, Mn, *Lens culinaris*, L-4076 and PL-406

INTRODUCTION

Biofertilizers are gaining importance as they are ecofriendly, non-hazardous and non-toxic (Sharma *et al;* 2007). A substantial number of bacterial species, mostly those associated with the plant rhizosphere, may exert a beneficial effect upon plant growth (Valverde *et al*., 2007). Biofertilizers can be a very good complimentary to the chemical pesticides as they not only kill the harmful insects but also the beneficial insects such as pollinators (Giri and joshi, 2010). In the last few years, the number of PGPR that have been identified has seen a great increase, mainly because the role of the rhizosphere as an ecosystem has gained importance in the functioning of the biosphere. Various species of bacteria like *Pseudomonas, Azospirillum, Azotobacter, Klebsiella, Enterobacter, Alcaligenes, Arthrobacter, Burkholderia, Bacillus* and *Serratia* have been reported to enhance the plant growth (Joseph *et al*., 2007) There are several PGPR inoculants currently commercialized that seem to promote growth through at least one mechanism; suppression of plant disease (termed Bioprotectants), improved nutrient acquisition (Biofertilizers), or phytohormone production (Biostimulants). The PGPR is known to facilitate the plant growth through nitrogen fixation; solubilization of insoluble phosphorus; production of compounds like siderophores, phytohormones, antibiotic and antifungal metabolites; and induced systemic resistance (Ashrafuzzaman, *et al.* 2009; Zaidi *et al*., 2009). Plant Growth Promoting Rhizobacteria (PGPR) are free living saprophytic bacterial micro-organisms that reside in the plant rhizosphere, colonize the root system and have been known as plant growth promoters for increasing agricultural produce and act as biocontrol agent against plant disease (Ashrafuzzaman, *et al.* 2009).

Lentil crops are able to fix atmospheric nitrogen and enrich the soil with nitrogen when include in different crop rotations practices by farmer (Shah et al., 2000 and Yadav, *et al.* 2007). India is the largest producer of pulses in the world with 25 percent share in the global production, 27 percent of consumption and 34 percent of food use India rank first with annual output of about 1.51 million hect. which is almost double the level of production during the 1980. Productivity of lentil is about 684 kg/ha compared to an average winter pulse yield of 723 Kg/ha. In India, the production is 0.95m. Tones (Dixit *et al.* 2009). This crop is valued as a high protein source and for its residues. Lentil is an important pulse crop of Indian continent. This crop is valued as a high protein source residues are used for animal feedings (Yadav, *et al.* 2007).

MATERIAL AND METHOD

Lens culinaris seeds of known varieties L-4076 and PL-406 collected from Indian Agriculture Research Institute (IARI) Pusa, New Delhi. The uniform basal dose of nitrogen in the form of urea (20 kg/ha) were applied before sowing. S, Zn, Mo, and Mn were used at the time of sowing of seed. Sulphur was used in the form of gypsum (60 kg/ha), Zn in the form of zinc sulphate (4 kg/ha), Mo as sodium molybdate (0.1 kg/ha) and Mn as manganese sulphate (0.5 kg/ha) along with basal dose of N with different combination.

Bio-fertilizers

In this study PGPR was used as a biofertilizer. Biofertilizer was also taken from Indian Agriculture

Research Institute (IARI) Pusa; 200 g of jaggary was dissolved in 500 ml of warm water. The syrup was allowed to cool down to room temperature and 100g pack of PGPR was added to make a thick paste. Seeds will be sown in the plot with treated soil to study the morphological characters.

RESULT AND DISCUSSION

Table-1 and Table-2 data showed the morphological characters of *Lens Culinaris* by the treatment of biofertilizer PGPR (Plant Growth Promoting Rhizobacteria) Sulphur and micronutrients in different doses to L-4076 and PL-406 varieties.

Morphological characters of variety L-4076

In variety L-4076 height/plant with inoculation of Zn with PGPR and Sulphur (36.73 cm.) represent better result followed by Mn (36.69 cm.) & Mo (36.44 cm.). Number of primary Branches/plant with inoculation of PGPR + Zn + Mo (6.29) was the best combination followed by PGPR + Zn + Mn (6.17) and PGPR + Mn + Mo (5.95). Number of Leaves/plant with inoculation of PGPR in combination with Sulphur and micronutrients (69.63) attained maximum number of leaf in comparison to PGPR + S (68.79), PGPR with all the micronutrients (70.11), PGPR alone (62.57) and uninoculated control (60.99). The level of improvement in the growth attributes due to PGPR, sulphur and micronutrients was significant. Increase in plant height, branches/plant and leaves/plant due to PGPR inoculation was attributed to higher light absorption and photosynthetic activities at all the growth stage (Siddiqui *et al.* 2007). Number of Pods/plant with inoculation of Zn + Mo with PGPR and Sulphur (147.56) gave best performance than PGPR + Zn + Mn (146.41) and PGPR + Mn + Mo (144.71) because Mo increases carbohydrate metabolism in plants and activate nitrate reductase enzyme during nitrogen metabolism. Nodule dry weight/ plant with inoculation of Zn + Mo with PGPR + S (12.45g) gave better results than Zn + Mn (12.31g) and Mn + Mo (12.15g).

Morphological characters of variety PL-406

In variety PL-406 Height/plant with inoculation Zn with PGPR and Sulphur (32.99 cm.) represent better result followed by Mn (32.86 cm.) & Mo (32.79cm.) and control showed 28.35 cm. Number of primary Branches/ plant with inoculation of PGPR with S (6.43) had significantly more branches than PGPR along with all micronutrients (6.38). PGPR + S with all the micronutrients (6.75) were highly significant over any other treatments. Sulphur in the form of gypsum in increasing the height might be attributed to the readily available form of sulphate, which was easily taken up by the crop and easily metabolized, which in turn might have induced the growth. These results corroborate the finding obtained by Cimrin (2008). Number of Leaves/plant with inoculation of Zn with PGPR + S (68.21) was most effective because Zn play important role in the production of IAA, a growth hormone and tryptophan, a precursor of auxin (Remans *et al.* 2007), than PGPR + Mn (67.86) and along with PGPR + Mo (66.31) Number of Pods/plant with inoculation of Zn + Mo with PGPR and Sulphur (133.59) gave best performance than PGPR + Zn + Mn (129.68) and PGPR + Mn + Mo (126.54). Inoculation of PGPR along with Sulphur and micronutrients (12.41) in relation to nodules dry weight was better than PGPR alone (7.99) and uninoculated control (7.94).

CONCLUSION

Fig. 1 and Fig. 2 show that the morphological characters (Height/Plant, Branches/Plant, Leaves/Plant, Pods/Plant, Dry weight/Plant) are increase in L-4076 as compared to PL-406 with the increase in the concentration of PGPR, Sulphur and micronutrients.

Table 1: Different morphological characters of *Lens culinaris* variety L-4076 as influenced by the different levels of PGPR (Plant Growth Promoting Rhizobacteria) Sulphur and micronutrients.

Treatments	Height/Plant	Branches/Plant	Leaves/Plant	No. Of Pods	Nodules Dry Weight
	90 DAS	90 DAS	90 DAS	90 DAS	90 DAS
Control	31.99	5.73	60.99	131.88	10.09
PGPR	32.45	5.89	62.57	132.99	10.19
PGPR + Mn + Mo	33.11	5.95	63.21	134.21	10.53
PGPR + Zn + Mn	34.19	6.17	65.31	135.41	10.82
PGPR + Zn + Mo	35.74	6.29	66.65	136.54	11.06
PGPR+ Mn + Zn + Mo	35.96	6.49	68.11	137.15	11.35
PGPR + S	36.09	6.62	68.79	138.76	11.57
PGPR + S + Mo	36.44	6.89	69.05	140.51	11.77
PGPR + S + Mn	36.69	6.96	69.81	142.59	11.95
PGPR + S + Zn	36.73	6.99	70.04	143.75	12.09

PGPR +S + Mo + Mn	36.79	7.05	70.11	144.71	12.15
PGPR + S + Zn + Mn	36.83	7.09	70.15	146.41	12.31
PGPR + S + Mo + Zn	36.89	7.15	70.19	147.56	12.45
PGPR + S + Mo + Mn + Zn	36.91	7.19	70.21	148.66	12.81

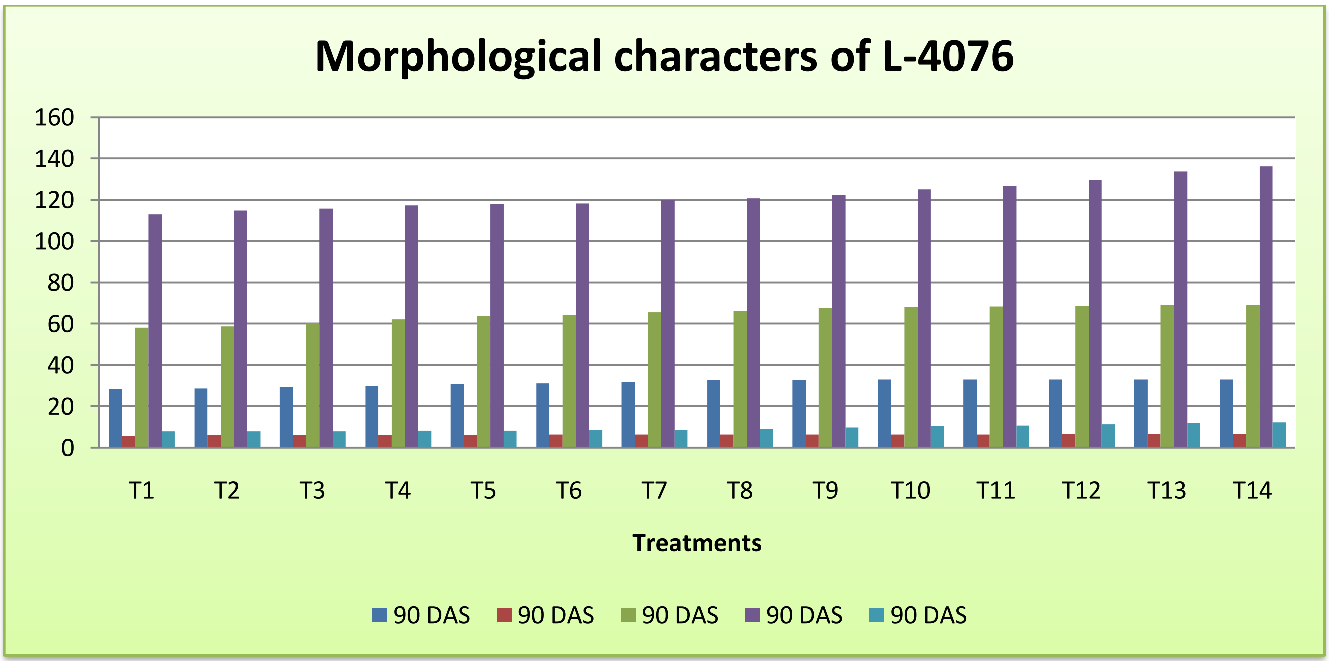

Fig. 1. Different morphological characters of *Lens culinaris* variety L-4076 as influenced by the different levels of PGPR Sulphur and micronutrients.

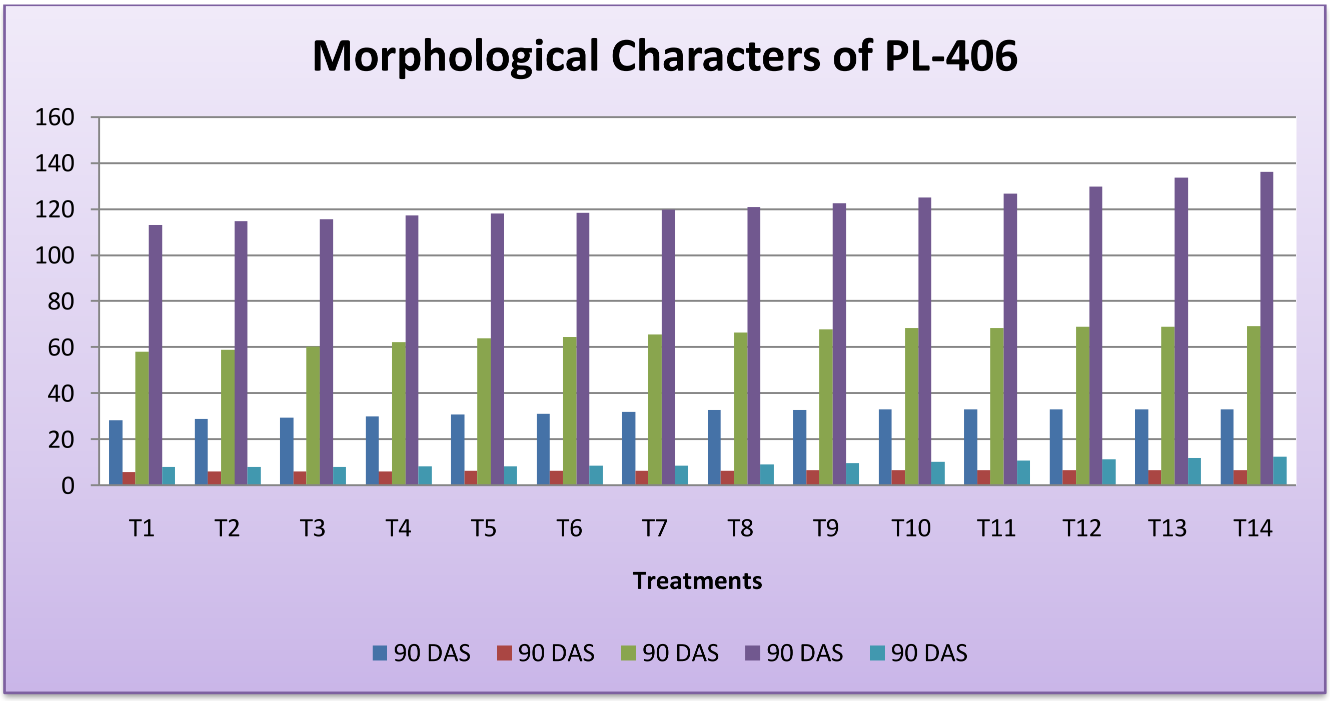

Fig. 2. Different morphological characters of *Lens culinaris* variety PL-406 as influenced by the different levels of PGPR Sulphur and micronutrients.

Table 2: Different morphological characters of *Lens culinaris* variety PL-406 as influenced by the different levels of PGPR (Plant Growth Promoting Rhizobacteria) Sulphur and micronutrients.

Treatments	Height/Plant	Branches/Plant	Leaves/Plant	No. Of Pods	Nodules Dry Weight
	90 DAS	90 DAS	90 DAS	90 DAS	90 DAS
Control	28.35	5.94	58.14	113.11	7.94
PGPR	28.91	6.07	58.84	114.73	7.99
PGPR + Mn + Mo	29.41	6.13	60.36	115.66	8.17
PGPR + Zn + Mn	30.09	6.23	62.11	117.18	8.26
PGPR + Zn + Mo	30.85	6.29	63.89	117.96	8.38
PGPR+ Mn + Zn + Mo	31.21	6.38	64.35	118.31	8.55
PGPR + S	32.01	6.43	65.62	119.76	8.75
PGPR + S + Mo	32.79	6.51	66.31	120.74	9.19
PGPR + S + Mn	32.86	6.54	67.86	122.39	9.86
PGPR + S + Zn	32.99	6.59	68.21	124.92	10.37
PGPR +S + Mo + Mn	33.06	6.62	68.35	126.54	10.89
PGPR + S + Zn + Mn	33.09	6.66	68.75	129.68	11.51
PGPR + S + Mo + Zn	33.12	6.69	68.99	133.59	11.93
PGPR + S + Mo + Mn + Zn	33.17	6.75	69.05	136.04	12.41

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