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Enhancement of Plant Growth, Nodulation and Yield of Mungbean (*Vigna radiate* L.) by Microbial Preparations

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A B S T R A C T

A field experiment was conducted to study the effect of *Rhizobium* and PlantaStim preparations on plant growth, nodulation and yield of mungbean (*Vigna radiate* L.). Experimental treatments included of uninoculation control, inoculation with *Rhizobium* 3, *Rhizobium* 9 and PlantaStim preparations. The *Rhizobium* 3 and *Rhizobium* 9 preparations showed better results over control and PlantaStim. The results showed that *Rhizobium* 9 preparation inoculation rose plant height by 27%, root length by 77% and root dry weight by 78%. Inoculation with *Rhizobium* 3 preparation significantly increased the plant height, root length, shoot dry weight, root dry weight, pods length, number of nodules, number of pods per plant, number of seed per plant, number of seed per pod and 1000 seed weight of mungbean compared to control. PlantaStim preparation inoculation increased the number of pods per plant by 25%, number of seed per plant by 28% and weight of seed per plant by 34 % compared to control. It is concluded that a significant positive effect of inoculation with *Rhizobium* 3 and *Rhizobium* 9 on growth, nodulation and yield of mungbean plants compared to control and PlantaStim.

Introduction

Mungbean (*Vigna radiate* L.) is an important legume for human nutrition and a major protein (1). Seeds contain 60-65% carbohydrates, fat (1-1.5%) and 3.5-4.5% fibre. It plays also in enhancing the soil fertility by fixing the atmospheric nitrogen (2). Symbiotic relationships of the rhizobia also play a key role in improving the quality and productivity of the soil. *Rhizobial* species such as *Rhizobium*, *Bradyrhizobium*, *Sinorhizobium* and *Mesorhizobium* are commonly used as inoculants in various parts of the world for improving the yield of legumes. When seed inoculation with *Rhizobium*, colonize plant roots, increase plant growth, development, noduation and yield of legume crops by multifarious mechanisms, such as control of soil borne and systemic pathogens, beneficial activities in terms of nutrients availability and production of enzymes and plant growth regulators (3-9). Environmentally, the use of specific

rhizobium may be preferable to the use of nonspecific chemical fertilizers and pesticides because of cost, time effectiveness, and contributions to sustainable agricultural systems.

There are many reports on the positive effects of inoculation of legumes with *Rhizobium* spp. Several studies have shown that rhizobial inoculants increased in nodulation, N_2 fixation and nitrogenize activity of nodulated legumes (10-12). The inoculation with *Rhizobium spp*. had enhanced nodulation and nitrogen fixation, plant biomass and grain yield in various leguminous species including mungbean, chickpea, bean and soybean (13-16). Daramola *et al.,* (17) reported that increased nodule number, nodule weight, nitrogen fixation, dry matter and nitrogen yield of soybean when inoculated with *Brudyrhizobium japonicum* strain.

Microbial preparations to mungbean for better plant height, root length, dry biomass, nodulation and yield components of mungbean was investigated in field conditions. The aim of this field research was to study the possibility of cultivation of mungbean by applying seed inoculation with selected highly effective microbial preparation.

Materials and Methods

Mungbean (*Vigna radiate* L.) seed cultivar Zilola was used for field experiments. *Rhizobium* 3 and *Rhizobium* 9 preparations were obtained from the culture collection of the Department of Microbiology and Biotechnology, National University of Uzbekistan. PlantaStim (*trichodermin*) was obtained from private company of AnGuzal Agroservis, Uzbekistan.

A field experiment was conducted to study effect of *Rhizobium* 3, *Rhizobium* 9 and PlantaStim on plant growth, nodulation and yield of Mungbean (*Vigna radiate* L.). The experiment were carried out in randomized block design with three replications a field experiments at the Institute of Genetics and Plant Experimental Biology, Kibray, Tashkent region, Uzbekistan. Experimental treatments included of uninoculation control, inoculation with *Rhizobium* 3, *Rhizobium* 9 and PlantaStim. Seeds were sown on 13 and 14 April for the year of 2018. A plot size of 10 m^2 with row spacing 30 cm and plant spacing of 10 cm were used. Harvesting was performed on 18 and 19 July 2018. After 94 and 95 days plant height, length of roots and pods, dry weight of roots, dry weight of stems, dry weight of pods, dry weight of grains, number of pods and grains per plant, number of grains per pod, 1000 grains weight were determined.

Experimental data were analysed with the StatView Software using ANOVA. The signifi cance of the effect of treatment was determined by the magnitude of the F value ($P < 0.05$).

Results and Discussion

An effect of inoculation of mungbean seed either with *Rhizobium* 3, *Rhizobium* 9 and PlantaStim preparations on plant growth, nodulation and yield of mungbean were conducted in field conditions. The results showed that PlantaStim preparation inoculation increased dry weight of root by 15% and dry weight of shoot by 57% compared to control (Table 1). The *Rhizobium* 3 and *Rhizobium* 9 showed better results over to control and PlantaStim. Data in Table 1 indicated that *Rhizobium* 9 inoculation increased plant height by 27%, root length by 77% and root dry weight by 78%, compared to uninoculated control. When inoculation with *Rhizobium* 3 preparation significantly increased the plant height by 33%, root length

by 77%, shoot dry weight by 32%, root dry weight by 78%.

Inoculation with *Rhizobium* preparations indicated increase in the height of plant, length of root, dry weight of root and dry weight of shoot of mungbean compared to control. There are many studies which showed that seed inoculation with *Rhizobium* bacteria increase the height of plant, length of root, dry weight of root and dry weight of shoot of legume crops (18-21). Similar results were obtained by Youseif *et al*., (22) in soybean. Delic *et al.*, (23) reported that inoculation with *bradyrhizobial* strains increased shoot dry weight by 26-33% compared to control. Dhami and Prasad (24) confirmed that inoculation of effective *B. japonicum* strains significantly increased the plant biomass of soybean. According to the results of some authors, under field conditions, growth of faba bean and mungbean increased significantly in response to inoculation with the most effective rhizobial strains (25, 26).

Number of nodules of mungbean increased in both the *Rhizobium* 3 and *Rhizobium* 9 inoculation. *Rhizobium* 3 had a positive significant effect on the number of nodules per plant that the maximum the number of nodules per plant was obtained from inoculation with *Rhizobium* 3 treatment by 52 nodules that the number of nodules per plant increased by 8% as compared with *Rhizobium* 9 treatment (Figure).

Table.1 Effect of microbial preparations on plant height, root length and plant weight of mungbean in field conditions

Treatments	Plant height (cm)	Root length (cm)	Shoot dry weight (g)	Root dry weight (g)
Control	41.20±1.57	12.40±2.29	6.72±0.42	0.38±0.02
PlantaStim	42.00±2.02	12.60±1.00	10.61±0.46*	0.44±0.05
Rhizobium 3	55.80±1.69*	22.00±1.86*	15.64±0.69*	0.68±0.08*
Rhizobium 9	52.40±2.02*	22.60±2.20*	15.14±0.66*	0.57±0.05*

Level of significance, *(P <0.05).

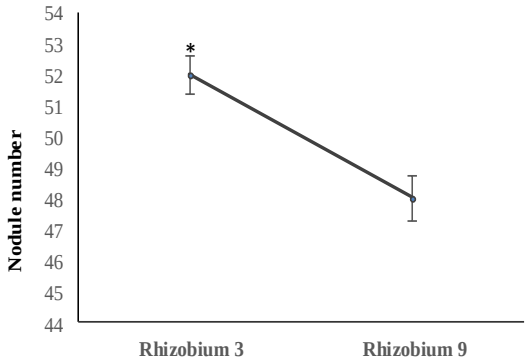
Table.2 Effect of microbial preparations on number of pod per plant, length of pod and weight of pod per plant of mungbean in feild conditions

Treatments	Pod plant^{-1}(no.)	Pod length (cm)	Pods weight plant^{-1}(g)
Control	11.80±0.84	7.98±1.62	5.60±0.40
PlantaStim	14.80±1.42	8.76±1.31	7.87±0.73
Rhizobium 3	23.00±0.62*	10.58±0.67*	17.97±2.01*
Rhizobium 9	24.60±3.31	10.57±0.53	18.45±2.03

Table.3 Effect of microbial preparations on number of seed per plant, number of seed per pod, weight of seed per plant and weight of 1000 seed of mungbean in feild conditions

Treatments	Seed plant^{-1}(no.)	Seed pod^{-1}(no.)	Seed weight plant^{-1}(g)	1000 seed weight (g)
Control	90±7.72	7.60±0.82	4.89±0.45	54.40±2.20
PlantaStim	116±11,17*	7.79±1.11	6.57±0.22*	57.00±3.92
Rhizobium 3	210±14.09*	9.11±0.35*	14.91±1.98*	71.20±3.89*
Rhizobium 9	234±10.41*	9.70±0.56	16.31±1.24*	69.70±3.79*

Fig.1 Effect of rhizobial preparations inoculation on number of nodules of mungbean



The rhizobial inoculation with its considerable positive effects showed increases the number of nodules per plant. Similar findings were reported for bean (27), soybean (16), munbean (28) and chickpea (29). According to the results of some authors, *B. japonicum* strains improved soybean nodulation, and increased nitrogen fixation (17, 30). Dhami and Prasad (24) reported that inoculation of soybean plants with *B. japonicum* increased nodule number. Raza *et al.*, (19) reported on mungbean when inoculated with *Rhizobium* strain increased the number of nodules of mungbean.

PlantaStim preparation inoculation increased the number of pods per plant by 25%, weight of pods per plant by 40%, number of seed per plant by 28% and weight of seed per plant by 34 % compared to control (Table 2, 3). The results showed that *Rhizobium* 3 and *Rhizobium* 9 had a positive significant effect on the number of pods per plant that the maximum the number of pods per plant was obtained from inoculation with Rhizobium 9 treatment by 24.60 pods that the number of pods per plant increased by 108% as compared with control treatment (Table 2). *Rhizobium* 9 inoculation significantly increased the length of pod by 32%, seed per pod by 27% and 1000 seed weight by 28% compared to control. Inoculation with *Rhizobium* 3 significantly increased the length of pod and 1000 seed weight compared other

treatments. The maximum 1000 seed weight was obtained from inoculation with *Rhizobium* 3 treatment of by 71.20 seed weight by 30% compared to control treatment.

Rhizobium 3 and *Rhizobium* 9 preparations used in this study have improved yield compounds of mungbean in field conditions. Similar results were reported by Dhami and Prasad (24). *Rhizobium* sp. improved the number of pods, the number of grains, the weight of pods, the weight of grains, 100 and 1000 grains weight of several legumes such as soybean (12,24,20,6,16), chickpea (31) and mungbean (32,15,18). Raza *et al.,* (19) reported that *Rhizobium* inoculation increased seed weight per plant by 64% compared to uninoculated control. Delic *et al*. (23) observed that the *B. japonicum strain* 542 inoculation increased the grain yield of mungbean in field conditions.

In conclusion, our work demonstrated that inoculation with *Rhizobium* 3 and *Rhizobium* 9 preparations could enhance formation of nodules on mungbean grown in field conditions. In summary, a significant positive effect of inoculation with *Rhizobium* 3 and *Rhizobium* 9 preparations, on plant growth, nodulation and yield of mungbean in field conditions. The *Rhizobial* preparations could be the most suitable inoculant preparations for mungbean cultivation practices.

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