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Original Research Article

Influence of *Rhizobium* Isolates on Nodulation and Grain Yield of Blackgram

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Keywords

Blackgram, Rhizobium, Nodulation, Yield, Biofertilizers

A B S T R A C T

The effect of different *Rhizobium* isolates against nodulation and grain yield of Black gram variety (TAU-1) were studied through a field experiment conducted at Pulses Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) during *Kharif* 2019-20. The experiment comprising of nine treatments including control and a treatment of recommended dose of chemical fertilizer with seven treatments of *Rhizobium* isolates which were procured from different agro climatic regions of India. Experiment was laid out in RBD with three replications. The carrier based culture of *Rhizobium* isolates were inoculated @ 25 g/kg of seed. Results indicated that the seed inoculation of *Rhizobium* isolate (WUR-12-1) recorded higher grain yield (533 kg/ha) and maximum number of nodulation (25.80 nodules /plant), nodule dry weight (74.09 mg/plant) and plant dry weight (4.28g/plant) among all the isolates.

Introduction

Indian population continues to grow at a rate of 1.8 to1.9% annually and has increased the demand for agricultural products. India is producing two hundred million tons of food grains per annum. It will be increased to 350-375 million tons per annum over the next 2-3 decades (Daniel, 2000). Pulses are one of the important segments of Indian agriculture after cereals and oilseeds with 33% of the world's area and 22 % of the production. Pulses occupy nearly 26.28 million hectare of land with the production around 18.09 million tones and average productivity 6.9 q/ha in India (Anonymous, 2011-12). To satisfy the demand of pulses requirement of ever increasing population, the production of pulses has to be increased only by increasing the yield/unit area/day (Anonymous, 2011).

Black gram (*Vigna mungo*) also known as Urd bean, is one of the important pulses crop, grown throughout the country and highly prized pulse for its biological protein value and rich in phosphoric acid.

It is the fourth important pulse crop in India, cultivated as a sole crop and intercrop covering an area of about 3.29 million hectares and producing 1.83 million tons (AICRP report, 2013). Increasing demand for agricultural products will lead to demand for chemical fertilizers.

These chemicals used in the field trials lead to many problems like pollution, host resistance and bio magnification (Singh, 2001). Being, a leguminous crop, black gram fulfills major part of nitrogen requirement by symbiotic nitrogen fixation with the help of

bacterium called *Rhizobia* (Pareek, 1978). *Rhizobium* involve in symbiotic biological nitrogen fixation; survival in soil, *Rhizosphere* colonization, infection and nodule development and energy transformation during Nitrogen fixation in root nodules (O, Hara *et al.,* 1988). Symbiotic nitrogen fixation is well known process exclusively driven by bacterial nitrogenase enzyme which specifically reduces atmospheric nitrogen to ammonia in the symbiotic root nodules (Leigh, 2002). Inoculation of *Rhizobium* culture in legumes increased the crop yield from 20-80% and leaving beneficial effect on the subsequent crop yield. Increased grain legume production depends on effective symbiotic di-nitrogen fixation through successful legume inoculation. Inoculants containing high numbers ($\geq 10^7$/g) of effective *Rhizobium* must withstand adverse field condition (Kremer & Peterson, 1983).

There is a good possibility and scope to increase pulse production by exploiting better colonization of the roots and rhizosphere through application of effective *Rhizobium* isolates. It has been observed that the properly screened local strains are more effective for a particular agro-climatic region than the strains imported from other places in general (Gupta *et al.,* 2000). Several workers have reported that seed inoculation with *Rhizobium* has significantly increased the growth and yield of legume crops (God *et al.,* 1999; Pathak *et al.,* 2001). The present investigation was taken up to evaluate the performance of *Rhizobium* isolates from different location with local isolate on nodulation and yield of black gram.

Materials and Methods

A field experiment was conducted during *kharif* 2019-20 at Pulses Research Unit, Dr. PDKV, Akola (M.S). The experiment was laid out in randomized block design with nine treatments. Besides uninoculated control and basal dose of inorganic N at 20 kg N ha^{-1}, there were seven treatments of different *Rhizobium* isolates obtained from AICRP Pulses centers from all over India. Seeds were inoculated with respective carrier based culture of *Rhizobium* inoculants prior to sowing using 25 g kg^{-1} of seed. Each treatment has gross plot size 3.80 X 2.40 m^2 and net plot 2.80 X 1.80 m^2 and replicated thrice with black gram variety TAU-1.

The data on nodulation was recorded at 35 DAS from five randomly selected plants from each plot. The roots of uprooted plants were gently washed with water and counted the pink colour active nodules only and after drying the nodules, weight of dried nodules were recorded. Seed yields were also recorded after crop harvest. The data collected during this study was subjected to statistical analysis variance (ANOVA) to compare the difference among all the treatments.

Results and Discussion

Effect on Nodulation

The treatments of application of seed inoculation with *Rhizobium* increased the nodules number significantly in the range of 19.60 to 25.80 nodules per plant as compared to uninoculated control (11.40 nodules $plant^{-1}$). The data indicated that the *Rhizobium* isolate WUR-12-1 recorded the highest nodule number (25.80 $plant^{-1}$) and was followed by *Rhizobium* BMBS-47 (24.33 $plant^{-1}$) and PUR-34 (24.00 $plant^{-1}$). The variation in nodule number was due to better compatibility and efficiency of inoculated *Rhizobium* compared to the native rhizobia in forming effective nodules in rhizosphere of black gram. Ahmed *et al.,* (2006) reported the application of inoculation treatment

significantly affected number of nodules and the treatments significantly differed from each other as compared to the control.

The present results are also confirmatory with the findings of Chandra *et al.,* (2002), Kumar *et al.,* (2017) and Abirami *et al.,* (2018).

Effect on Nodule and plan dry weight

Nodules dry weight and plant dry weight differences among all the *Rhizobium* inoculation were significant. Among the inoculated treatments, highest nodules dry weight (74.09 mg/plant) and plant dry weight (4.28 g/plant) were observed in the seed inoculation with *Rhizobium* WUR-12-1 while least nodules dry weight (25.34 mg/plant) and plant dry weight (3.25 g/plant) was recorded in the uninoculated control. These results are in the agreement with the findings of Saleh *et al.,* (2013). Similar results was observed by Waseem Raza *et al.,* (2004) who reported that dry weight of nodules and plant biomass was increased with *Rhizobium* inoculation over control without inoculation

Effect on grain yield

Rhizobium isolates significantly increased the grain yield by 16.32 to 38.08% over uninoculated control (386 kg ha^{-1}). The seed inoculation with *Rhizobium* isolate WUR-12-1 recorded the highest grain yield of 533 kg ha^{-1} followed by *Rhizobium* isolate BMBS-47 (518 kg ha^{-1}) and PUR-34 (509 kg ha^{-1}).

Yield advantages over uninoculated control occurred due to seed inoculation of *Rhizobium* WUR-12-1, BMBS-47 and PUR-34 by 38.08, 34.19 and 31.86% respectively. KY963966 Accession number has been received from NCBI for *Rhizobium* isolate WUR-12-1.

Table.1 Effect of different *Rhizobium* isolates on nodulation and grain yield of black gram

Sr. No.	*Rhizobium* isolates	No. of Nodules / plant	Nodule dry wt / plant (mg)	Plant dry wt./plant (gm)	Grain yield (kg/ha)
1	BMBS 47	24.33	66.34	4.18	518
2	GUR-5	22.47	61.10	4.09	491
3	GUR-8	19.87	50.42	3.85	455
4	VUC	19.60	50.13	3.82	449
5	P 7	21.07	55.78	3.96	479
6	PUR-34	24.00	66.13	4.14	509
7	WUR-12-1	25.80	74.09	4.28	533
8	20 Kg N/ha	15.93	37.58	4.79	621
9	Uninoculated Control	11.40	25.34	3.25	386
	S.E. $\pm$ (m)	0.73	1.80	0.12	39
	C.D. P = 0.05	2.17	5.36	0.35	114

Fig.1 Nodulation due to seed inoculation of *Rhizobium* (WUR-12-1)

Fig.2 Effect of seed inoculation with different *Rhizobium* isolates on nodulation of Black gram

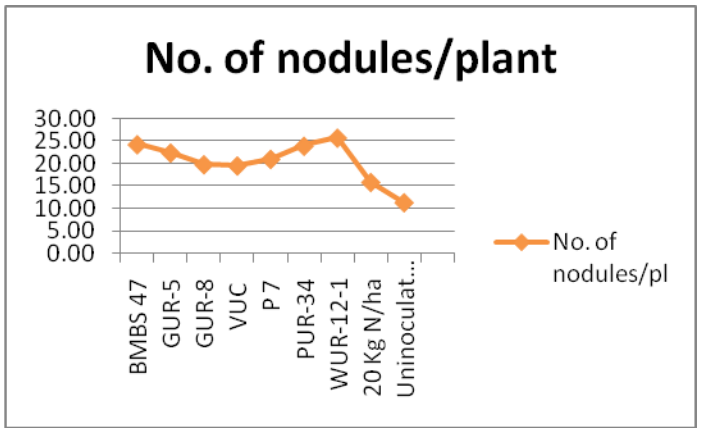


Fig.3 Effect of seed inoculation with different *Rhizobium* isolates on grain yield of Black gram

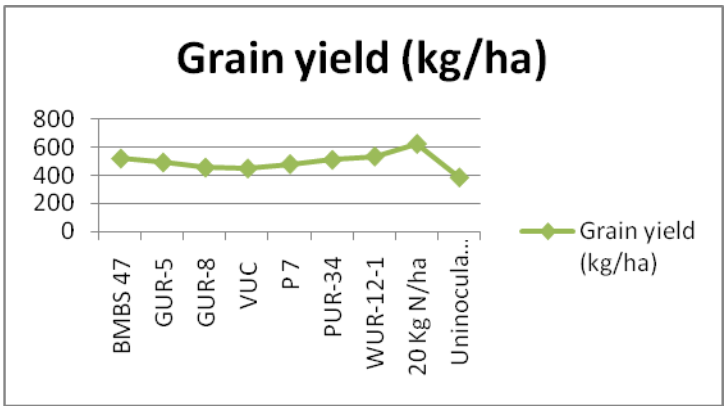
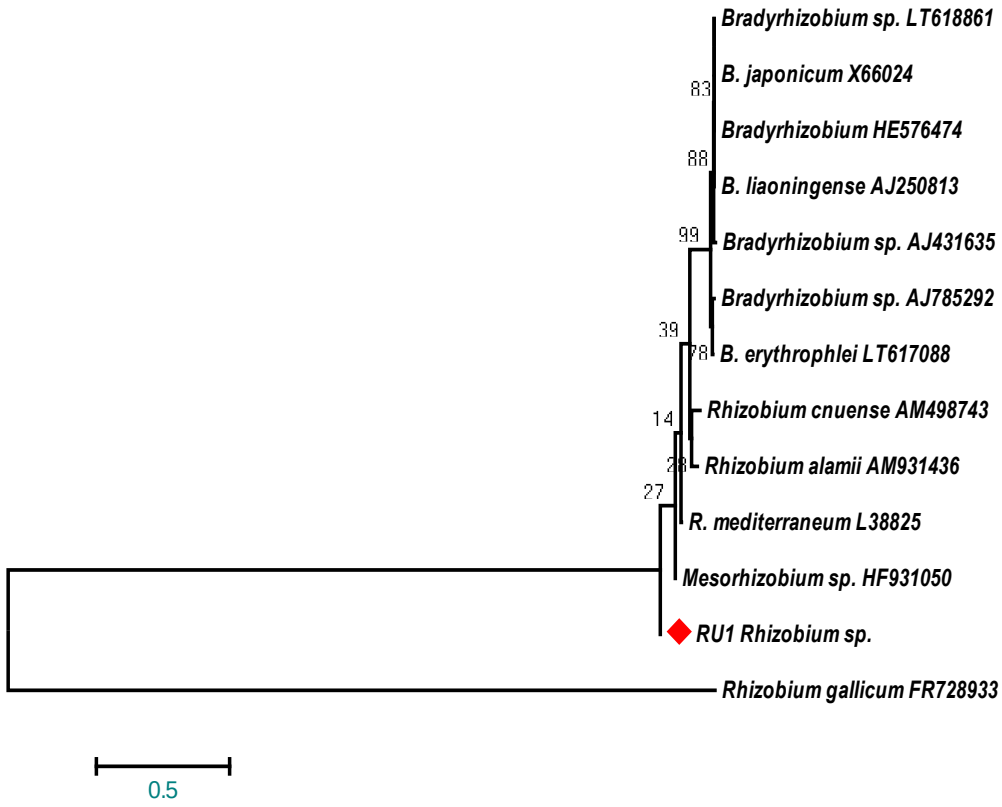


Fig.4 Dendrogram showing genetic similarity among different *Rhizobium* isolates KY963966 Accession number for nucleotide sequence of WUR-12-1



The better nodulation and improvement of yield attributes due to seed inoculation with efficient *Rhizobium* isolates. The results of increased grain yield due to efficient isolates of *Rhizobium* reported earlier by Saini and Khanna (2012).

The similar findings have also been recorded by Biswas and Bhowmick (2009). *Rhizobium* isolates are good candidates to be developed as biofertilizers for N_2 fixation, growth promotion and yield enhancement in green gram was reported by Kallimath and Patil **(**2018).

It is concluded that seed inoculation with *Rhizobium* isolate WUR-12-1was found most effective in terms of nodulation and yield parameters of black gram.

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