Biological Forum – An International Journal 15(2): 15-19(2023)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Nutrient Uptake and Grain Yield of Chickpea inoculated with *Mesorhizobium* of Saline Soil

Kamble Geetanjali A.[1*], P.S. Wakte[2], S. D. Jadhao[3] and G.K. Giri[4]
[1]Ph.D. Scholar, Department of Microbiology,
D.S.M's. College, Parbhani-431401 (Maharashtra), India.
[2]Head, Department of Microbiology, D.S.M's. College, Parbhani-431401 (Maharashtra), India.
[3]Department of Soil Science, Dr. PDKV, Akola, 444 104 (Maharashtra), India.
[4]Department of Plant Pathology, Dr. PDKV, Akola, 444 104 (Maharashtra), India.

(Corresponding author: Kamble Geetanjali A.)*
(Received: 05 December 2022; Revised: 15 January 2023; Accepted: 24 January 2023; Published: 02 February 2023)
(Published by Research Trend)

ABSTRACT: Increasing and extending role of different isolate can reduce the chemical fertilizers which is costly one, also imbalanced use of chemical fertilizers resulted in adverse environmental effect and mining of soil nutrients. In view of this constraint the present the research work has been carried out to evaluate the effects of various *Mesorhizobium* isolates on nodulation and yield of Chickpea, nutrient status and uptake of chickpea (variety JAKI-9218). A field experiment was conducted during *Rabi* 2017- 18 and 2018-19 at Pulses Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.). The experiment comprising of thirty-three treatments including uninoculated control of which thirty-two treatments was of *Mesorhizobium* isolates which obtained from chickpea root nodules from different villages of saline track of Purna river of Vidarbha (M.S.). The field experiment was laid out in Randomized Block Design (RBD) with three replications. The carrier-based culture of *Mesorhizobium* isolates were inoculated @ 25 g kg^{-1} of seed. The results of present experiment results revealed that among all the isolates, seed inoculation of *Mesorhizobium* isolate (ACR-10) recorded higher grain yield (pooled mean;1641 kg/ha) and higher number of nodules i.e. 28.07 nodules plant^{-1}, nodules dry weight (100.94 mg plant^{-1} and plant dry weight (4.45g plant^{-1}). Among various seed inoculation treatments, available N (209 kg ha^{-1}) was increased significantly with the *Mesorhizobium* isolate BCR-46 (209 kg ha^{-1}) and higher N content and uptake was recorded by ACR-10 (20.76 kg ha^{-1}). The uptake of nitrogen was influenced significantly with the seed inoculation of various microbial isolates.

Keywords: *Mesorhizobium*, Biofertilizers, Chickpea, Nodulation, Yield, N-uptake.

INTRODUCTION

Fertilizers play an important role in improving soil nutrient status and plant nutrition. The fertilizer use ratio of 4:2:1 is considered optimum as this ratio supply nutrients in balanced form. Now a day the extensive use of nitrogenous fertilizers resulted unfavorable soil conditions as a result other nutrients (P and K) also causes imbalances in plant nutrition. Biological fixation of N is another aspect of N supply to crops. The use of microbial isolates play promising role in improving N status of soil as well as plants N nutrition.

Legume-*rhizobium* symbiosis depends on the specificity of plant and bacterial species because of chemical signaling that led to the formation of nodules in which the bacteria are hosted and decreased atmospheric nitrogen into ammonium (Rai and Cooper 1994; Bai *et al*., 2002). It is well known fact that world supply of organic nitrogen form is met via the symbiosis between root nodulating bacteria and leguminous host plants (Postgate, 1998).

Chickpea (*Cicer arietinum* L) due to its ability to fix atmospheric nitrogen, is considered to sustain cropping system productivity. It has highly specific symbiotic association, with a unique group of rhizobia necessary for formation of nodules and nitrogen fixation. Lack of suitable strains, less population size and relatively poor survival of rhizobia pose problems in nodules formation (Kantar *et al.,* 2007). Presence of appropriate nodule forming bacteria in the soil is important for management and utilization of atmospheric N in soil. Seed inoculation is essential before sowing nodulating crop, if crop not been sown in recent past and grown for the first time. Further, to avoid uncertainty about natural inoculation, the seed inoculation is necessary every time. The nitrogen fixation potential of chickpea genotypes can be achieved to higher extent by rhizobial inoculation. Khattak *et al.* (2006) reported that grain yield of chickpea increased considerably with rhizobial application. Chickpea yield can be improved with competitive rhizobia by inoculation and is especially economical promising to increase chickpea production

(Romdhane *et al*., 2008). For improving root nodulation and yield of the crop, artificial seed inoculation of chickpea is a very useful practice in those soils lacking native effective rhizobia (Khattak *et al.*, 2006; Muhammad *et al*., 2010). Botir Khaitov *et al.* (2020) on the basis of field experiment conducted on chickpea revealed that indigenous rhizobial strain have the characteristics of broad host range, effective stimulation, higher nodulation efficiency, greater salt tolerance can be considered as a biofertilizers for enhancing chickpea productivity in saline soil of Uzbekistan. Rhizobial inoculation recorded highest N-content in chickpea straw, available N and P (Qureshi *et al*., 2009). In order to correlate the effect of *Mesorhizobium* isolates collected from saline soil tract with nodulation, grain yield, dry matter accumulation and N uptake in chickpea under field conditions, the present investigation was conducted.

MATERIAL AND METHODS

Isolation of chickpea nodulating bacteria. Healthy plants of chickpea from saline area of Vidarbha region (M.S.), India were collected by random sampling methodology and have been processed for nodule reside rhizobia isolation (Singh *et al.*, 2016). A field experiment was conducted during *Rabi* 2017-18 and 2018-19 at Pulses Research Unit, Dr. PDKV, Akola (M.S). The experiment was laid out in RBD with thirty-three treatments. Besides uninoculated control there were thirty-two different treatments of seed inoculation of *Mesorhizobium* which obtained from chickpea root nodules from different villages of saline tract of Purna river of Vidarbha region (M.S.) of India. Seeds were inoculated with respective carrier base culture of *Mesorhizobium* inoculants prior to sowing using 25 g kg^{-1} of seed. The gross plot size was $3.00 \times 2.40\ m^2$ and net plot was $2.80 \times 1.80\ m^2$ and replicated thrice with chickpea variety JAKI-9218. The data on nodulation was recorded at 45 DAS from five randomly selected plants from each plot. The roots of chickpea crop were gently washed with tap water and active nodules were counted. Seed yields were recorded after crop harvest. Data obtained through experimentation were subjected to analysis of variance (ANOVA) using Panse and Sukhatme (1967).

Soil analysis for available Nutrients. Soil samples were air-dried, ground and passed through a 2- mm sieve. Available N was determined by alkaline-potassium permanganate method (Subbaiah and Asija 1956) in which soil was mixed with excess of alkaline permanganate and distilled. Available P was determined from soil samples by Olsen's method (Olsen *et al.,* 1954). The available K was analyzed by neutral normal ammonium acetate method (Hanway and Heidel 1952). The N content in plant was estimated by Kjeldahl's method by digesting plant sample with concentrated H_2SO_4.

RESULTS AND DISCUSSION

Effect on Nodulation. Nodule numbers (12.44 $plant^{-1}$) were increased significantly with seed inoculation by *Mesorhizobium* isolates as compared to uninoculated control. The data presented in Table 1 indicated that the treatment of *Mesorhizobium* ACR-10 isolate recorded higher number of nodules and it was closely followed by *Mesorhizobium* BCR-35 and BCR-36 (27.67 & 27.60 nodules $plant^{-1}$). The variation in nodule numbers was associated with the better compatibility and efficiency of inoculated *Mesorhizobium* compared to the native rhizobia in forming effective nodules in the rhizosphere of chickpea. The inoculation with *Mesorhizobium* isolates significantly improved and increased nodulation in tested isolates. ACR-10 *Mesorhizobium ciceri* increased nodules per pant to the magnitude of 55.68% over uninoculated control. These results of nodulation are in agreement and closely resemble the earlier finding of Bhuiyan *et al.* (1998) who reported the *Rhizobium* inoculation increased nodulation and seed yield to the extent of 35% in chickpea. The effect of *Mesorhizobium* bacteria in improving nodulation in salt tolerance and salt stress soil in legumes has also been widely reported by Afrasayab *et al.* (2010) ; Mhadhbi *et al*. (2004).

Effect on grain yield. In the present investigation, seed inoculation with *Mesorhizobium ciceri* ACR-10 isolate significantly increased the grain yield (965 kg ha^{-1}) over uninoculated control. Graphical representation of grain yield of chickpea is depicted in Fig. 1), it is revealed that the seed inoculation with *Mesorhizobium ciceri* ACR-10 recorded significantly higher grain yield, higher in the extent of 41.19% and was closely followed by BCR-35 i.e. higher in the extent of 40.80% over uninoculated control. Yield advantages over uninoculated control occurred due to seed inoculation with ACR-10 and BCR-35 respectively. Increase in grain yield can be attributed to the fact that, better crop growth, better nodulation and seed inoculation with efficient and better *Mesorhizobium* isolate. Inoculation with *Mesorhizobium* isolates obviously enhanced the yield of chickpea and was found statistically significant over control. Bhuiyan *et al.* (1998) found that *Rhizobium* inoculation significantly increased seed yield upto 35% over uninoculated control. Gupta and Namdeo (1996) found that seed inoculation with *Rhizobium* significantly increased chickpea seed yield by 9.6 to 27.9%. Many researchers declared that inoculation with appropriate *Mesorhizobium* strains is effective measurers to increase N_2 fixation, improve N nutrition and increase yield in legumes (Mirza *et al.* 2007; Thomashow and Bakker 2015).

Table 1: Effect of prominent *Mesorhizobium* isolates on nodulation, grain yield, N content and N uptake of Chickpea (Pooled data of two years 2017-18 & 2018-19).

Isolates	No. of Nodules/ plant	Grain Yield Kg/ha	Available Nutrients (kg ha^{-1})			Nitrogen Content (%)	Nitrogen Uptake (kg ha^{-1})
			Available N	Available P	Available K		
ACR-10	28.07	1641	205.0	15.72	375.50	1.27	20.76
ACR-20	26.67	1582	204.5	15.26	375.93	1.27	20.02
BCR-34	26.04	1553	208.0	16.11	371.67	1.25	19.41
BCR-35	27.67	1630	206.5	15.97	373.73	1.27	20.62
BCR-36	27.60	1606	207.0	15.81	377.08	1.27	20.40
BCR-40	26.77	1593	206.0	16.03	374.06	1.26	20.07
BCR-46	25.40	1545	209.0	15.83	371.73	1.26	19.39
Control	12.44	965	216.5	18.47	374.95	1.14	11.05
S.E.(m)±	1.03	59	2.45	0.54	3.25	0.011	0.766
P=0.05	3.02	174	6.87	1.47	8.25	0.033	2.17

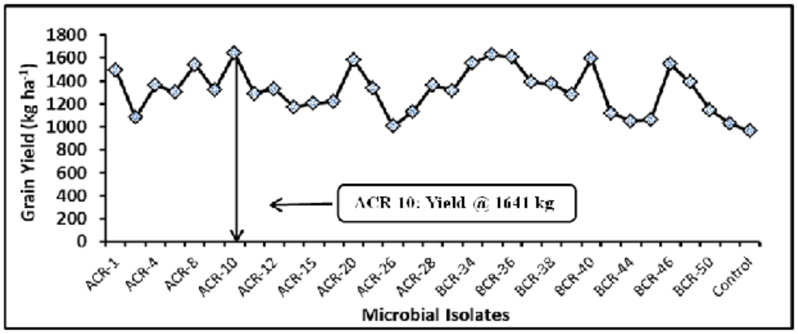

Fig. 1. Effect of seed treatment with *Mesorhizobium* isolates on grain yield of chickpea.

Effect on dry matter accumulation. The effect of *Mesohizobium* isolates on nodules and plant dry weight was significant graphically represented in Fig. 2. The higher nodules dry weight (100.94 mg plant^{-1}) which was 68.28% higher and plant dry weight (4.45 g plant^{-1}) which was 27.41% higher was recorded in *Mesohizobium ciceri* ACR-10 followed by BCR-35 (99.71 mg plant^{-1} and 4.42 g plant^{-1}) *i.e.* 67.90% and 26.92% higher over uninoculated control. The increased root, shoot and nodule dry weight of chickpea owing to *Mesorhizobium* isolates over control in saline soil and *Mesorhizobium* inoculation increased the dry matter of nine chickpea genotypes by 3.3 to 33.9% relative to the control has also been reported earlier by Botir Khaitov *et al*. (2020).

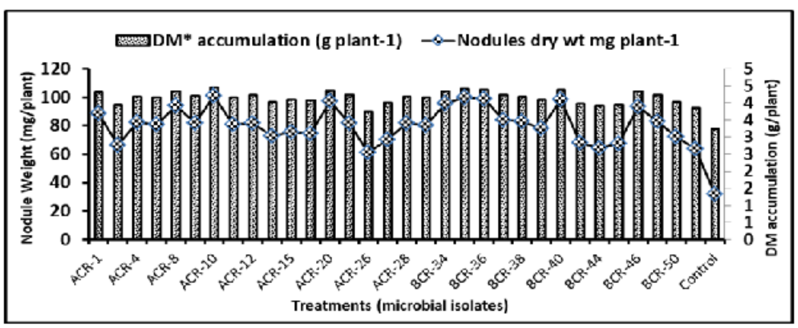

Fig. 2. Effect of seed treatment with *Mesorhizobium* isolates on dry matter accumulation.

Effect on soil nutrient status. The seed inoculation with various microbial isolates significantly increased the available nutrient status. Among various seed inoculation treatments, the higher N status of soil was recorded with the seed inoculation with BCR-46 which is closely followed by seed inoculation with BCR-34 to BCR-36. The higher available N in control treatment may be due to comparatively lesser uptake as a result of the variation in crop growth among various seed inoculation treatments.

The available P status increased significantly with among various seed inoculation treatments, the higher available P was recorded with the seed inoculation with BCR-34 followed by seed inoculation with BCR-40. The higher available P in control treatment may be due to lesser uptake as a result of the variation in crop growth due to seed inoculation. Similar trend of available K status was observed with the seed inoculation with various *Mesorhizobium* isolates. Dhakal *et al*. (2016) demonstrated improvement in available nutrient status with the application of nutrient through 75% RDF + 2.5 t/ha vermicompost + *Rhizobium* + phosphate solubilizing bacteria as compared to other combinations and control.

Content and uptake of Nitrogen. The content and uptake of N by chickpea differed among seed inoculation with various *Mesorhizobium* isolates. The data from the Table 1 indicated that the higher content of N in chickpea plant was recorded with seed inoculation of ACR 10, ACR 20, BCR-35 and BCR-36 (1.27%). As a result, the uptake of N was influenced significantly with the seed inoculation of various microbial isolates. However, the significantly highest N uptake was noted with the microbial isolates ACR 10 (20.76 kg ha^{-1}).

Correlation between yield and nitrogen uptake. The correlation between yield and nitrogen uptake is depicted in Fig. 3. There exist significant and positive correlation between yield of chickpea and nitrogen uptake by chickpea as indicated by higher value coefficients of determination (R^2 = 0.96**) (p=0.05). The higher value of coefficients of determination suggests synergistic effect of *Mesorhizobium* isolates for getting higher yield with higher nitrogen content. The magnitude of nutrient uptake is depends on the yield and yield attributing parameters.

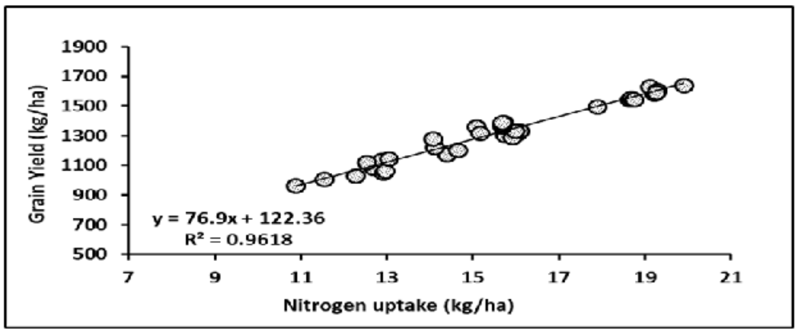

Fig. 3. Correlation between grain yield and Nitrogen uptake in chickpea.

CONCLUSION

From the two years study, it can inferred that, seed inoculation with *Mesohizobium ciceri* (ACR-10) was found most effective isolate for getting higher yield and yield attributes of Chickpea. The soil nutrient status was slightly changes due to inoculation of various microbial isolates. There is no significant difference in nitrogen concentration of chickpea plants among various microbial inoculants. However, the nitrogen uptake in chickpea was significantly increased with the *Mesohizobium ciceri* (ACR-10). The significant and positive correlation exists among the yield and nitrogen uptake in chickpea.

Acknowledgement. The research work carried out at Pulses Research Unit, Dr. PDKV., Akola in collaboration with DSM., College, Parbhani is duly acknowledge by the authors.
Conflict of Interest. None.

REFERENCES

Afrasayab, S., Faisal, M. and Hasnain, S. (2010). Comparative study of wild and transformed salt tolerant bacterial strains on *Triticum aestivum* growth under salt stress. *Brazilian Journal of Microbiology, 41*(4), 946-955.

Bai, B. P., Charles, T. C., Trevor, C. and Smith, D. L. (2002). Co-inoculation dose and root zone temperature for plant growth promoting rhizobacteria on soybean (*Glycin max* L.) growth in soil-less media. *Soil. Biol. Biochem., 34*, 1953-1957.

Bhuiyan, M. A. H., Khanam, D., Khatun, M. R. and Hassan, M. S. (1998). Effect of molybdenum, boron and *Rhizobium* on nodulation, growth and yield of chickpea. *Bull. Inst. Trop. Agric., Kyushu Univ., 21*, 1-7.

Botir Khaitov**,** Aziz Karimov, Anvar Abdiev, Jabborov Farrukh and Kee Woong Park (2020). Beneficial effect of *Rhizobium* inoculation on growth and yield of chickpea (*Cicer arietinum* L.) in saline soils. *Bulgarian Journal of Agricultural Science, 26*(1) 96-104.

Dhakal, Y., Meena, R. S. and Kumar, S. (2016). Effect of INM on nodulation, yield, quality and available nutrient status in soil after harvest of green gram. *Legume Research, 39*(4), 590-594.

Gupta, S. C. and Namdeo, S. L. (1996). Effect of *Rhizobium* strains on symbiotic traits and grain yield of chickpea. *Indian J. Pulses Res*., *9*(1), 94-95.

Hanway, J. J. and Heidel, H. (1952). Soil Analysis Methods, as used in Iowa State. *College Soil Testing Laboratory, Iowa, Agriculture, 57*, 1-31.

Kantar, F., Hafeez, F. Y., Shivakumar, B. G., Sundaram, S. P., Tejera, N. Aslam, A., Bano, A. and Raja, P. (2007). Chickpea: *Rhizobium* management and nitrogen fixation. Chickpea Breed. Mgt. pp. 179-192.

Khattak, S., Khan, D. F., Shah, S.H., Mdani, M. S. and Khan, T. (2006). Role of Rhizobial inoculation in the production of chickpea crop. *Soil and Environ., 25*(2), 143-145.

Mhadhbi, H., Jebara. M., Limam, F. and Aouani, M. E. (2004). Rhizobial strain involvement in plant growth, nodule protein composition and antioxidant enzyme activities of chickpea-rhizobia symbioses: modulation by salt stress. *Plant Physiology and Biochemistry, 42*(9), 717-722.

Mirza, B. S., Mirza, M. S., Bano, A. and Malik, K. A. (2007). Co-inoculation of chickpea with Rhizobium isolates from roots and nodules and phytohormone-producing Enterobacter strains. *Australian Journal of Experimental Agriculture, 47*(8), 1008- 1015.

Muhammad Aslam (2010). Nodulation, grain yield and grain protein contents as affected by *Rhizobium* inoculation and fertilizer placement in chickpea cultivar Bittle-98. Sarhad *J. Agric. Res., 26*(4), 467-474.

Olsen, S. R., Cole, C. V., Wanatabe, F. S. and Dean, L. A. (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate, Washington DC: U.S. Department of agriculture circular 939, USDA.

Panse, V. G. and Sukhtme, P. V. (1967). Statistical methods for agricultural workers. ICAR New Delhi, *2nd Edn.* pp. 381.

Postgate, J. (1998). Nitrogen Fixation. Cambridge University Press, Cambridge, UK.

Qureshi, M. A., Shakir, M. A., Naveed, M. and Ahmad, M. J. (2009). Growth and yield response of chickpea to co-inoculation with *Mesorhizobium ciceri* and *Bacillus megaaterium. J. Animal and plant Sciences, 19*(4), 205-2011.

Rai, J. R. and Cooper, J. E. (1994). Rhizobia catabolize gene-inducing flavonoid via C-ring fission mechanisms. *J. Bacteriol., 176*, 5409-5413.

Romdhane, S. B., Aouani, M. E., Trabelsi M., deLajudie, P. and Mhamdi. R. (2008). Selection of High Nitrogen-Fixing Rhizobia Nodulating Chickpea (*Cicer arietinum*) for Semi-Arid Tunisia. *J. Agron. and Crop Sci., 194*(6), 413-420.

Singh, R. P., Manchanda, G., Singh, R. N., Srivastava, A. K. and Dubey, R. C. (2016). Selection of alkalotolerant and symbiotically efficient chickpea nodulating rhizobia from North-West Indo Gangetic Plains. *Journal of basic microbiology, 56*(1), 14-25.

Subbaiah, B. V. and Asija, G. L. (1956). A rapid procedure for the determination of available nitrogen in soil. *Current Science, 25,* 259–260.

Thomashow, L. and Bakker, P. A. (2015). Microbial Control of Root-Pathogenic Fungi and Oomycetes. In: *Principles of Plant-Microbe Interactions,* Lugtenberg, B. (ed.), 165–173. Cham: Springer International Publishing.

How to cite this article: Kamble Geetanjali A., P.S. Wakte, S.D. Jadhao and G.K. Giri (2023). Nutrient Uptake and Grain Yield of Chickpea inoculated with *Mesorhizobium* of Saline Soil. *Biological Forum – An International Journal, 15*(2): 15-19.