Indian Journal of Agronomy **64** (4): 541–544 (December 2019)

Research Communication

Influence of crop-establishment practices and microbial inoculants on growth and productivity of summer greengram (*Vigna radiata*)

RUXANABI NARAGUND[1], Y.V. SINGH[2], R.S. BANA[3], A.K. CHOUDHARY[4] AND PRANITA JAISWAL[5]

ICAR–Indian Agricultural Research Institute, New Delhi 110 012

Received: August 2019; Revised accepted: December 2019

ABSTRACT

A field experiment was carried out during the summer season in 2018 at the ICAR–Indian Agricultural Research Institute, New Delhi, to study the effect of crop-establishment practices and microbial inoculation on crop growth and productivity of summer greengram [*Vigna radiata* (L.) R. Wilczek]. The experiment was laid out in split-plot design and treatments were replicated thrice. The experiment included 9 treatment combinations including 3 crop-establishment practices, viz. conventional tillage, zero tillage and zero tillage with chickpea (*Cicer arietinum* L.) residue @ 2.5 t/ha in main plots, and 3 microbial inoculation treatment, viz. control (no inoculation), dual inoculation of *Rhizobium* + phosphate solubilizing bacteria (PSB) and combined inoculation of *Rhizobium* + phosphate solubilizing bacteria (PSB) + arbuscular mycorrhizal (AM) Fungi in sub plots. Results showed that zero tillage with residue produced significantly higher growth parameters of greengram, viz. plant height, plants/m^2, dry-matter accumulation, leaf-area index, branches/plant, root nodules/plant and root nodule weight/plant at 45 days after sowing (DAS). The same treatment showed significantly superior yield attributes at maturity, viz. plants/m^2, pods/plant, pod length, grains/pod and 1,000-grain weight, and yields over other 2 treatments. Seed inoculation with *Rhizobium* + PSB + AM fungi was significantly superior to other 2 treatments with regard to plant growth parameters, yield attributes and grain yield.

Key words **:** Growth, Microbial inoculants, Residue and zero tillage, Summer green gram, Yield, Zero tillage

Pulses play a significant role in providing nutritionally balanced diet and improvement in soil fertility (Narayan and Kumar, 2015). Greengram, a short duration pulse crop, can be grown as catch crop during rainy season (*kharif*) and summer seasons. Use of excessive and unnecessary tillage operations are harmful to soil and add to production cost. Intensive tillage-based agriculture practices without recycling of organic resources deteriorate the soil quality, which then reduce the overall productivity of greengram. Crop establishment with zero-tillage is used widely for many crops around the world. It has the potential to save time, energy, water and labour during crop establishment. Crop residues are important natural resource in the stability of agricultural ecosystems which can be used as mulch and play an important role in improving soil biological activities, soil organic matter content and in turn helps improve physical, chemical and biological soil properties (Singh *et al*., 2002). Integration of crop residue with minimum tillage helps to improve soil health, nutrient-use efficiency and finally crop productivity (Singh *et al*., 2019). Adoption of zero tillage and residue retention/ incorporation may be a viable alternative for better resource conservation and to overcome the imposed constraints of the climate change and high input costs (Negi *et al*., 2018). Microbial inoculants are organic products containing a specific micro-organism which are derived from the nodules of plant or from soil of root zone (rhizosphere). They offer important technology to Indian agriculture, holding a promise to balance many of the shortcomings of conventional chemical based technologies. Biofertilizers (microbial inoculants) have major role in nitrogen assimilation and phosphorus solubilization/mobilization and thereby bringing sustainability in soil fertility and pulse production. Some microbial inoculants like *Rhizobium* possess unique ability to fix atmospheric nitrogen by living symbiotically

Based on a part of M.Sc. thesis of the first author, submitted to ICAR-Indian Agricultural Research Institute, New Delhi, in 2019 (unpublished)

[2]**Corresponding author's e-mail:** yvsingh63@yahoo.co.in
[1]M.Sc. Scholar, Division of Agronomy; [2]Principal Scientist (Agronomy), CCUBGA; [3]Scientist, [4]Senior Scientist, Division of Agronomy; [5]Principal Scientist (Microbiology), ICAR–Indian Agricultural Research Institute, New Delhi 110 012.

and phosphate-solubilizing bacteria (PSB) plays a vital role in solubilization of various inorganic and organic phosphates added to the soil (Bhavya *et al*., 2018). Arbuscular mycorrhiza (AM) fungi are recommended as the universal compensators needed to accomplish the mission of sustainable agriculture. Considering these facts, a field experiment was conducted to evaluate the effects of crop establishment practices and microbial inoculation on growth and productivity of summer greengram.

A field experiment was conducted at the research farm of the ICAR–Indian Agricultural Research Institute, New Delhi, during summer 2018 season. The soil of the experimental field was sandy loam in texture with 61.23% sand, 15.59% silt and 23.25% clay. The soil was low in organic C, low in available N and medium in available P and medium in available K, with *p*H of 7.6. The experiment was conducted in a split-plot design with 9 treatment combinations, keeping 3 methods of crop establishment, viz. conventional tillage (CT), zero tillage (ZT) and zero tillage with residue (ZT + R) in main plots and 3 microbial inoculants treatments, viz. *Rhizobium* + phosphate solubilizing bacteria (PSB), *Rhizobium*+ PSB + soil application of Arbuscular Mycorrhiza (AM) fungi and control (no inoculation). Seeds were treated with *Rhizobium* and PSB and AM Fungi before sowing. Nitrogen, phosphorus and potassium were uniformly applied basal at the rate of 20, 40 and 20 kg/ha, respectively, to all plots. Other agronomic practices were followed as per the standard packages of practices to raise the greengram crop. Five plants at physiological maturity were randomly selected in each plot for measuring plant height, branches/plant. For dry-matter computation 5 plants at 50 days after sowing (DAS) were collected and used for calculating leaf area; the same plants were later air-dried and then oven-dried and finally dry matter was recorded. Yield attributes like plants/m^2, pods/plant, pod length, grains/pod from 5 random plants were recorded at maturity according treatments. At harvesting grain and stover yields were recorded separately for each plot and reported at 12% moisture. The data obtained from the experiment were statistically analyzed using the F-test as per the standard procedure to determine the significance of difference between treatment means.

Results showed that plant growth parameters of green gram increased steadily with the progress of crop growth stages starting from 20 days after sowing (DAS) and peaked at the time of maturity. Dry-matter accumulation and leaf-area index at 50 DAS, root nodules/plant and root nodule weight/plant at 45 DAS were significantly higher in zero tillage with residue treatment as compared to other 2 methods of crop establishment (Table 1). Plant height and branches/plant at maturity did not differ significantly due to methods of crop establishment. The positive changes in soil parameters due to zero tillage and residue retention might have caused higher leaf growth and consequently higher dry-matter accumulation in residue retention plots (Ram *et al*., 2012). Among the microbial inoculation treat-

Table 1. Influence of crop-establishment methods and microbial inoculation on growth parameters of summer greengram

Treatment		Plant height (cm)	Dry-matter accumulation (g/plant)	Leaf-area index	Branches/ plant	Nodules/ plant 45 DAS	Nodule weight (mg/plant) 45 DAS
Method of crop establishment (ME)							
Conventional tillage		35.1	10.3	2.82	5.23	21.5	18.5
Zero tillage		33.9	9.89	2.59	4.90	18.7	17.2
Zero tillage with residue		36.6	11.2	3.02	5.22	23.0	20.4
SEm±		0.98	0.15	0.03	0.14	0.22	0.15
CD (*P*=0.05)		NS	0.75	0.10	NS	0.85	0.60
Microbial inoculants (MI)							
Control (no inoculation)		33.1	10.0	2.67	4.86	19.9	17.9
Rhizobium + PSB		35.0	10.5	2.86	5.20	20.8	18.6
Rhizobium + PSB + AM Fungi		37.4	10.9	2.91	5.30	22.5	19.6
SEm±		0.99	0.14	0.04	0.13	0.37	0.15
CD (*P*=0.05)		NS	0.53	0.13	NS	1.15	0.47
Interaction (ME × MI)							
Factor (B) at same level of A	SEm±	1.1	0.20	0.04	0.24	0.37	0.18
	CD (*P*=0.05)	NS	NS	NS	NS	NS	0.76
Factor (A) at same level of B	SEm±	1.2	0.23	0.07	0.23	0.57	0.21
	CD (*P*=0.05)	NS	NS	NS	NS	NS	0.71

DAS, Days after sowing; PSB, phosphate-solubilizing bacteria; AM, arbuscular-mycorrhiza.

ments, dry-matter accumulation and leaf-area index, root nodules/plant and root nodule weight/plant at 45 DAS were significantly higher in combined inoculation of *Rhizobium* + PSB + AM fungi over the other 2 treatments. The results are in accordance with findings of Dongare *et al*. (2016).

Zero tillage with residue recorded significantly superior yield attributes, viz. plants/m^2, pods/plant, pod length and grains/pod compared to other 2 methods of crop establishments however, test weight in this treatment was at par with conventional tillage (Table 2). Other researchers also reported higher values of yield attributes under zero tillage supplemented by residue retention, since residue application maintained good and favourable soil moisture, moderate soil temperature, and improved soil water and nutrient conditions (Ram *et al*., 2012; Kothyari *et al*., 2017). Significantly higher yield attributes of greengram were found in zero-tilled greengram with mustard residue may be ascribed owing to the favourable crop growth and enhanced utilization of resources (Suryavanshi *et al*., 2018). Among the microbial inoculant treatments, combined inoculation of *Rhizobium* + PSB + AM fungi recorded significantly higher no. of plants/m^2, pods/plant, pod length and grains/pod than dual inoculation and the control however, test weight in this treatment did vary significantly with dual inoculation. Tagore *et al*. (2013) also reported higher growth and yield attributes under *Rhizobium* + PSB inoculation mainly owing to higher availability of N, P, K and S in the soil for chickpea plants. Moreover, growth-promoting substances (phytohormones) were produced by these organisms which further promoted plant growth.

Among the method of crop establishments, grain yield (968.6 kg/ha), stover yield (2,415.3 kg/ha), harvest index (HI) were the highest in zero tillage with residue and the lowest in zero tillage; however, HI of zero tillage with residue was at par with conventional tillage (Table 2). Similar results were recorded by Khan *et al*. (2016) in greengram that was sown under zero tillage and adequate vegetative mulch on the soil surface gave higher yield comparable with or even higher than those obtained under conventional tillage. Highest yield under zero tillage with residue was reported in maize and wheat crops by Raghvendra *et al.* (2017). This might be owing to the fact that well-managed soil under zero till condition with crop-residue application could support sustainable crop production through improved soil quality with higher soil organic carbon and available nutrients. Regular and appropriate addition of crop residue have essential roles in improving the enzymatic activity of soil that are important for nutrient cycling, as well as increasing crop productivity (Rajkumara *et al*., 2014). Among the microbial inoculants treatments, combined inoculation of *Rhizobium* + PSB + AM fungi recorded significantly higher grain yield (940.7 kg/ha), stover yield (2,387.2 kg/ha) and HI as compared to other 2 seed inoculation treatments. This could be ascribed to the larger availability and uptake of nitrogen and phosphorus owing to additive effect of biofertilizers in improving nutritional environment which enhanced the growth through higher branches and dry matter, photosynthetic area, production of assimilates and their translocation to reproductive parts, thereby amplified the yield attributes and ultimately the crop yield. The significantly higher straw yield owing to biofertilizer application could be attributed to higher vegetative growth as a result of effective nutrients utilization which were absorbed by extensive root-system and prolific shoot development on account of improved nourishment (Yadav *et al*., 2017). Similar results were reported by Dongare *et al*. (2016) in greengram and Shekhawat *et al*. (2018) in blackgram.

It was concluded from the study that, combined inocu-

Table 2. Influence of establishment methods and microbial inoculation on yield attributes of summer greengram

Treatment	Plants/m^2	Pods/plant	Pod length (cm)	Grains/pod	1,000-grain weight (g)	Grain yield (kg/ha)	Stover yield (kg/ha)	Harvest index
Method of crop establishment (ME)								
Conventional tillage	27.4	14.8	9.09	8.80	39.1	920.6	2,305.5	28.5
Zero tillage	25.8	12.4	7.84	7.92	31.6	674.7	2,098.5	24.3
Zero tillage with residue	28.6	16.5	9.71	9.02	39.3	968.6	2,415.3	28.6
SEm±	0.10	0.45	0.12	0.04	0.65	11.70	24.10	0.08
CD (P=0.05)	0.41	1.69	0.60	0.20	2.53	40.20	94.02	0.30
Microbial inoculants (MI)								
Control (no inoculation)	26.9	13.1	8.31	8.31	33.4	762.9	2,226.0	25.5
Rhizobium + PSB	27.6	14.7	8.87	8.58	35.8	851.7	2,306.2	27.0
Rhizobium + PSB + AM Fungi	28.1	15.9	9.29	8.86	36.8	940.7	2,387.2	28.3
SEm±	0.09	0.34	0.14	0.03	0.65	10.50	23.80	0.06
CD (P=0.05)	0.28	1.06	0.40	0.08	2.00	33.70	73.30	0.21

lation of *Rhizobium* + PSB + AM fungi may be used in summer greengram crop established through zero tillage method of crop establishment with @ 2.5 t/ha crop residue for better crop growth and productivity. So farmers may use combination of biofertilizers and crop residue in zero-tilled summer greengram for higher crop productivity.

REFERENCES

Bhavya, G., Chandra, S.K., Jayasree, G. and Reddy, M.M. 2018. Nutrient uptake and yield of greengram (*Vigna radiata* L.) as influenced by phosphorus fertilization, organic manures and biofertilizers. *International Journal of Chemical Studies* **6**(3): 32–35.

Dongare, D.M., Pawar, G.R., Murumkar, S.B. and Chavan, D.A. 2016. To study the effect of different fertilizer and biofertilizer levels on growth and yield of summer greengram. *International Journal of Agricultural Sciences* **12**(2): 151–157.

Khan, Imran, Inam, I. and Ahmad, F. 2016. Yield and yield attributes of mungbean (*Vigna radiata* L.) cultivars as affected by phosphorous levels under different tillage systems. *Cogent Food and Agriculture* **2**(1): 115–129.

Kothyari, H., Singh, K.Y., Jat, R. and Chand, G.P. 2017. Influence of biofertilizers on plant growth and seed yield of pea (*Pisum sativum* L.). *International Journal of Current Microbiology and Applied Sciences* **6**(11): 1,810–1,817.

Narayan, P. and Kumar, S. 2015. Constraints of growth in area production and productivity of pulses in India: An analytical approach to major pulses. *Indian Journal of Agricultural Research* **49**(2): 114–124.

Negi, S.C., Rana, S.S. and Kumar, S. 2018. Effects of resource conservation technologies on productivity, nutrient acquisition, employment generation and energetics of maize (*Zea mays*)-based cropping systems in North-Western Himalayan region. *Indian Journal of Agronomy* **63**(3): 285–292.

Raghavendra, M., Singh, Y.V., Das, T.K. and Meena, M.C. 2017. Effect of crop residue and potassium management practices on productivity and economics of conservation agriculture based maize (*Zea mays*)–wheat (*Triticum aestivum*) cropping system. *Indian Journal of Agricultural Sciences* **87**(7): 855–861.

Rajkumara, S.S, Gundlur, S., Neelakanth, J.K. and Ashoka, P. 2014. Impact of irrigation and crop residue management on maize (*Zea mays*)–chickpea (*Cicer arietinum*) sequence under no tillage conditions. *Indian Journal of Agricultural Sciences* **84**(1): 43–48.

Ram, H.S., Yadvinder, Saini, K.S., Kler, D.S., Timsina, J. and Humphreys, E.J. 2012. Agronomic and economic evaluation of permanent raised beds, no tillage and straw mulching for an irrigated maize–wheat system in northwest India. *Experimental Agriculture* **48**(1): 21–38.

Shekhawat, A.S., Purohit, Jat, H.S., Meena, R. and Regar, M.K. 2018. Efficacy of phosphorus, vermicompost and biofertilizers on soil health and nutrient content and uptake of blackgram (*Vigna mungo* L.). *International Journal of Chemical Studies* **6**(2): 3,518–3,521.

Singh, N, Pandey, D.K. and Dikshit, H.K. 2002. Status of germplasm, its management and cultivation in pulse crop. *Farmer's Forum* **2**: 23–27.

Singh, R., Rai, A.K., Kumari, R., Sharma, D.K., Kumar, S., Joshi, P.K. and Singh, A. 2019. Long term effect of crop residue and tillage on carbon sequestration, soil aggregation and crop productivity in rice (*Oryza sativa*)–wheat (*Triticum aestivum*) cropping system under partially reclaimed sodic soils. *Indian Journal of Agronomy* **64**(1): 11–17.

Suryavanshi, T., Sharma, A.R., Nandeha, K.L., Lal, S. and Porte, S.S. 2018. Effect of tillage, residue and weed management on soil properties, and crop productivity in greengram (*Vigna radiata* L.) under conservation agriculture. *Journal of Pharmacognosy and Phytochemistry* 2,022–2,026.

Tagore, G.S., Namdeo, S.L., Sharma, S.K. and Kumar, N. 2013. Effect of *Rhizobium* and phosphate solubilizing bacterial inoculants on symbiotic traits, nodule leghemoglobin and yield of chickpea genotypes. *International Journal of Agronomy* **3**(2): 12–16.

Yadav, V.K., Singh, D.P., Sharma, S.K. and Kishor, K. 2017. Use of phosphorus for maximization of summer mungbean [*Vigna radiata* (L.) Wilezeck] productivity under sub-humid condition of Rajasthan. *Indian Journal of Pharmacognosy and Phytochemistry* **6**(4): 01–03.