



Influence of crop establishment and microbial inoculants on profitability and nutrient concentrations of summer greengram (*Vigna radiata*)

RUXANABI NARAGUND¹, Y V SINGH², R S BANA³, A K CHOUDHARY⁴ and PRANITA JAISWAL⁵

ICAR-Indian Agricultural Research Institute, New Delhi 110 012, India

Received: 28 August 2019; Accepted: 17 October 2019

Key words: Microbial inoculants, Nutrient concentration, Residue with zero tillage, Summer greengram, Zero tillage

Greengram [*Vigna radiata* (L.) Wilczek], a short duration pulse crop is grown as catch crop during *kharif* and summer seasons. The production potential of summer greengram can be fully explored using short duration and photo insensitive varieties (Suryavanshi *et al.* 2018). Intensive tillage-based agriculture practices without recycling of organic resources deteriorate the soil quality which then reduce the overall productivity of greengram and add to production cost also. Zero-tillage has the potential to save time, energy, water and labour during crop establishment. Crop residues are important natural resource which stabilize agricultural ecosystems and can be used as mulch, improve soil biological activities, soil organic matter content and in turn helps improving soil bio-physico-chemical properties. So there is need for alternative method of crop establishment for the purpose of protecting soil degradation, increasing water use efficiency, reducing the cost of production of crops and improving crop productivity which have positive effects on the bio-physico-chemical properties of a soil. Microbial inoculants (biofertilizers) like *Rhizobium* possess unique ability to fix atmospheric nitrogen by living symbiotically, phosphate solubilising 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 plays a vital role in supplementing major plant nutrients like nitrogen, phosphorus and micro nutrients like Fe, Zn requirement of crops (Jaga and Sharma 2015). Hence a field experiment was conducted to evaluate the effects of crop establishment practices and microbial inoculation on profitability and quality of summer greengram.

A field experiment was conducted at the research farm of ICAR-IARI, New Delhi during summer 2018. The soil of the experimental field was sandy loam in texture and low in organic C, low in available N and medium in available P and medium in available K with pH of 7.6. The experiment was conducted in a split-plot design with nine

treatment combinations, keeping three methods of crop establishments *viz.* conventional tillage (CT), zero tillage (ZT) and zero tillage with chickpea residue (ZT+R) in main plots and three microbial inoculant treatments, *viz.* dual inoculation of *Rhizobium*+ Phosphate Solubilizing Bacteria (PSB), the combined inoculation of *Rhizobium*+ PSB + Arbuscular Mycorrhizal (AM) Fungi and control where no seed inoculation was done. Seeds of test variety 'Pusa Vishal' were treated with *Rhizobium* and PSB biofertilizers whereas AM Fungi was applied in soil before sowing. Nitrogen, phosphorus and potassium were uniformly applied as basal at the rate of 20, 40 and 20 kg/ha, respectively to all plots. The observations on yield, macro nutrient (N, P, K) and micro nutrients (Zn, Fe, Mn, Cu) in grain and stover and economics were assessed using standard procedures. The data obtained were statistically analyzed as per the standard procedure.

Results revealed that among the method of crop establishments, grain yield (968.6 kg/ha) and stover yield (2415.3 kg/ha) were highest in zero tillage with residue and lowest in zero tillage (Fig. 1). Similar results were recorded by Khan *et al.* (2016). 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 (Rajkumar *et al.* 2014). Among the microbial inoculant treatments, combined inoculation of *Rhizobium*+PSB+AM recorded significantly higher grain yield (940.7 kg/ha) and stover yield (2387.2 kg/ha) as compared to other treatments (Fig 1). This could be ascribed to the higher availability and uptake of nitrogen and phosphorus due 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. Significantly higher yield due to biofertilizer application could be due to effective nutrients utilization which were absorbed by extensive root system and prolific shoot development (Yadav *et al.* 2017). Similar results were reported by Dongare *et*

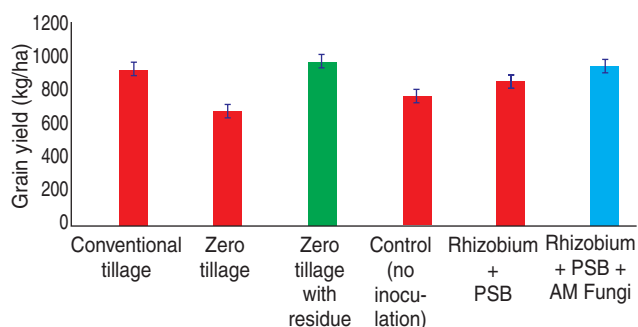


Fig 1 Effect of crop establishment and microbial inoculations on grain yield of greengram.

al. (2016) in greengram and Shekhawat *et al.* (2018) in blackgram.

Regarding plant nutrient acquisition, zero tillage with residue exhibited significantly highest N, P, K in grain and stover and crude protein content in grain (%) and lowest in zero tillage (Table 1). The results were in accordance with findings of Raghvendra *et al.* (2017) who found highest K uptake in zero tillage with residue because of the reason that crop residues returned more K concentration to the field than under conventional tillage and high K concentration in cereal straw (1.2–1.7%) usually has higher potassium content than other straws. Combined inoculation of *Rhizobium*+PSB+AM Fungi contributed significantly higher N, P and K content in grain and stover and crude protein content in grain (%) as compared to other two treatments and lowest was recorded in control. Yadav *et al.* (2017) documented that in black

gram the combined inoculation with PSB+VAM significantly increased the N, P and K concentration of grain and stover and protein content of grain over control. It occurred due to increased solubilization and mineralization of organic phosphorus and availability of nitrogen and phosphorus. Higher crude protein content and protein yield in grain under zero tillage with treatment having residue might be due the fact that crop residue retention increased the availability of N, P, K and other micronutrient concentration in soil and improved the aeration, root activity and thereby increased the absorption and assimilation of N by plants (Harper and Paulsen 1969) and encouraged the translocation of N from vegetative parts to grain which indirectly affected protein concentration and amino acid content.

Concentrations of Fe, Zn, Mn and Cu in grain and stover were significantly influenced due to methods of crop establishment and microbial inoculants. Among methods of crop establishment, zero tillage with residue treatment contributed highest Fe Zn, Mn and Cu concentration in grain and stover (Table 2). Higher micronutrient concentrations in grain and stover were due to increased concentration of these nutrients in soil and enhanced growth of crop roots under zero tillage with residue. Combined inoculation of *Rhizobium*+PSB+AM Fungi showed higher concentration of Fe, Zn, Mn and Cu and lowest was recorded in control. Significantly higher interactions in Fe and Zn concentrations in grain and stover was observed under zero tillage with residue combined with inoculation of *Rhizobium*+PSB+AM Fungi and lowest in plot where conventional tillage was

Table 1 Influence of crop establishment and microbial inoculation on nutrient concentration in grain and stover and crude protein content in grain of summer greengram

Treatment		Nutrient concentration (%)						Crude protein content in grain (%)
		N		P		K		
		Grain	Stover	Grain	Stover	Grain	Stover	
<i>Method of crop establishment (ME)</i>								
Conventional tillage		3.45	1.85	0.53	0.34	1.43	1.73	21.5
Zero tillage		3.31	1.71	0.44	0.30	1.41	1.71	20.7
Zero tillage with residue		3.68	2.08	0.56	0.36	1.55	1.85	22.9
SEm±		0.05	0.03	0.004	0.003	0.01	0.01	0.3
LSD (P=0.05)		0.19	0.12	0.016	0.010	0.04	0.04	1.2
<i>Microbial inoculation (MI)</i>								
Control (no inoculation)		3.31	1.71	0.48	0.31	1.33	1.63	20.7
<i>Rhizobium</i> + PSB		3.50	1.90	0.52	0.34	1.51	1.80	21.8
<i>Rhizobium</i> + PSB + AM Fungi		3.63	2.03	0.54	0.35	1.55	1.85	22.7
SEm±		0.04	0.04	0.004	0.002	0.01	0.01	0.25
LSD(P=0.5)		0.12	0.12	0.012	0.008	0.04	0.04	0.77
<i>Interaction (ME x MI)</i>								
Factor (B) at same level of A	S E m ±	0.08	0.08	0.007	0.004	0.03	0.02	0.52
LSD (P=0.05)		NS	NS	NS	NS	NS	NS	NS
Factor (A) at same level of B	S E m ±	0.07	0.07	0.007	0.005	0.05	0.02	0.46
LSD (P=0.05)		NS	NS	NS	NS	NS	NS	NS

Table 2 Influence of crop establishment methods and microbial inoculation on micro nutrient concentration in grain and stover of summer greengram

Treatment	Micro nutrient concentration (mg/kg)							
	Fe		Zn		Mn		Cu	
	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover
<i>Method of crop establishment (ME)</i>								
Conventional tillage	45.3	40.7	17.5	19.3	7.94	9.94	5.06	4.51
Zero tillage	42.9	38.6	17.3	19.6	7.59	9.59	5.05	4.00
Zero tillage with residue	46.4	41.7	17.6	19.6	8.24	10.2	5.09	4.58
SEm±	0.24	0.57	0.02	0.02	0.05	0.04	0.01	0.40
LSD (0.05)	0.90	2.04	0.07	0.07	NS	NS	NS	NS
<i>Microbial inoculants (MI)</i>								
Control (no inoculation)	44.4	39.9	17.4	19.3	7.76	9.76	4.99	4.34
<i>Rhizobium</i> + PSB	45.1	40.4	17.5	19.5	7.93	9.93	5.03	4.53
<i>Rhizobium</i> + PSB + AM Fungi	45.2	40.8	17.6	19.6	8.09	10.1	5.19	4.66
SEm ±	0.14	0.39	0.01	0.01	0.04	0.03	0.02	0.40
LSD (P=0.05)	0.42	1.14	0.04	0.04	NS	NS	NS	NS
<i>Interaction (ME x MI)</i>								
Factor (B) at same level of A SEm±	0.15	1.03	0.02	0.03	0.06	0.06	0.011	0.42
LSD (P=0.05)	0.46	3.17	0.07	0.08	NS	NS	NS	NS
Factor (A) at same level of B SEm±	0.14	1.04	0.02	0.02	0.05	0.05	0.020	0.43
LSD (P=0.05)	0.48	3.32	0.10	0.08	NS	NS	NS	NS

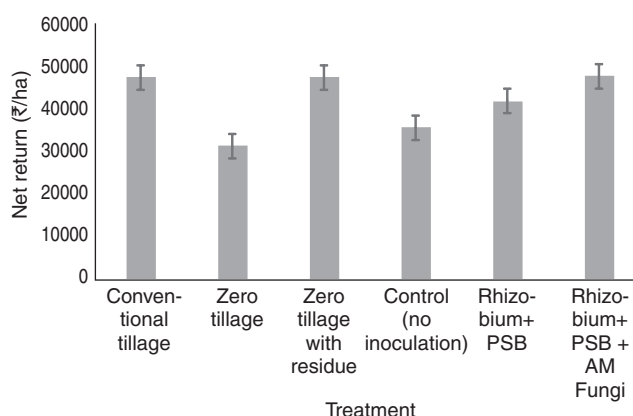


Fig 2 Effect of crop establishment and microbial inoculations on net return from greengram.

followed and no inoculation was done with microbial preparation. PSB and VAM enhanced supply of macro as well as micronutrients during entire growing season which led to higher assimilation of food and its subsequent partitioning in sink (Kumar *et al.* 2017). AM fungi increased the uptake of relatively immobile nutrients like P, Cu, Zn, Fe etc. by plants by mobilizing them in soil which increases the availability in soils (Jaga and Sharma 2015).

Net return of greengram varied due to the effect of method of crop establishment and microbial inoculants treatments. Greengram gave highest gross return (₹ 75083.8) and net returns (₹ 47432.5) under zero tillage with residue. Among microbial inoculation treatment highest gross returns, net returns and net benefit cost (B: C) were

recorded in combined inoculation of *Rhizobium*+PSB+AM Fungi (Fig 2). Residue addition augmented in generating higher income might be due to better soil fertility which improved the yield and returns, even if the part of returns was reduced by the cost of crop residue (Jaga and Sharma 2015; Shekhawat *et al.* 2017).

SUMMARY

It was concluded that zero tillage with 2.5 t/ha residue of chickpea crop and combined inoculation of *Rhizobium* + PSB + AM Fungi gave higher productivity and profitability as well as enhanced macro and micro nutrients in grain and stover of summer greengram over the other methods of crop establishment, viz. conventional and zero tillage without microbial inoculation. Thus farmers may inoculate with combination of *Rhizobium*+ PSB + AM Fungi in summer greengram and sow the crop through zero tillage with 2.5 t/ha crop residue to get higher productivity, profitability and nutrient concentration in grain.

REFERENCES

- Bhavya G, Chandra Shaker K, Jayasree G and Malla Reddy 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.
- Harper J E and Paulsen G M. 1969. Nitrate reductase activity

- in corm seedlings as affected by light and nitrate content in nutrient media. *Plant Physiology* **35**: 700–708.
- 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.
- Jaga P K and Sharma S. 2015. Effect of bio-fertilizer and fertilizers on productivity of soybean. *Annals of Plant and Soil Research* **17**(2): 171–174
- Kumar S, Yadav S S, Tripura P, Jinger D and Balwan. 2017. Interaction effect of phosphorus and bio-organics for increasing productivity and profitability of mungbean (*Vigna radiata* L. Wilczek). *Annals of Agriculture Research* **38**(1):67–72.
- 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): 855–61
- Rajkumar 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): 43–8.
- 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 black gram (*Vigna mungo* L.). *International Journal of Chemical Studies* **6**(2): 3518–3521
- 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* **1**: 2022–2026.
- Yadav V K, Singh D P, Sharma S K and Kishor K. 2017. Use of phosphorus for maximization of summer mungbean [*Vigna radiata* (L.) Wilszeck] productivity under sub-humid condition of Rajasthan. *Indian Journal of Pharmacognosy and Phytochemistry* **6**(4):01–03.