Indian Journal of Agricultural Sciences **93** (4): 415–419, April 2023/Article
https://doi.org/10.56093/ijas.v93i4.101263

Impact of conservation tillage practices on the growth and yield of blackgram (*Vigna mungo*) in rice (*Oryza sativa*)-blackgram cropping system

K SUBRAHMANIYAN[1]*, G SENTHILKUMAR[1] and P VEERAMANI[1]

Tamil Nadu Rice Research Institute, Tamil Nadu Agricultural University, Aduthurai, Tamil Nadu 612 101 India

Received: 17 June 2020; Accepted: 21 March 2023

ABSTRACT

A field experiment was conducted during post rainy seasons of 2015–16, 2016–17 and 2017–18 (December-March) at research farm of Tamil Nadu Rice Research Institute, Aduthurai, Tamil Nadu to study the impact of tillage practices adopted in the rice (*Oryza sativa* L.) crop on the succeeding blackgram (*Vigna mungo* L.) grown as relay cropping. The treatment comprised of 2 tillage practices (puddled and non-puddled), 3 seed priming methods (Bio-seed priming with *Rhizobium*, hydropriming and no seed priming) and 2 foliar spray (2% DAP and 2% urea). The results indicated though blackgram grown as succeeding crop in the puddled tillage registered higher values of Relative water content (RWC) (83.06 and 83.72%), Specific leaf weight content (SLW) (6.83 and 6.28 g/cm^2), Soil Plant Analysis Development chlorophyll meter values (40.88 and 39.75) at 30 and 45 DAS respectively, it was comparable with non-puddled tillage method. However, the blackgram sown as succeeding crop in non-puddled transplanted rice registered a greater number of nodules (23.67 and 17.44) and nodules dry weight (0.17 and 0.11 g) at 30 and 45 DAS respectively as compared to puddled transplanting. Similarly, the root length (6.93 and 8.62 cm) and root dry weight (0.151 and 0.174 g at 30 and 45 DAS respectively) were also higher with non-puddled tillage. The yield obtained under non-puddled tillage system was 11.8% higher than puddled method of tillage system. Bio-seed priming with *rhizobium* had higher values of growth and yield parameters, which eventually resulted in 25.0% yield increase over no seed priming. As far as foliar spray concerned, DAP 2% spray and Urea 2% spray did not differ significantly for none of the parameters except for yield.

Keywords: Blackgram, Conservation tillage, Foliar nutrients, Relay cropping, Seed priming

Traditionally, rice (*Oryza sativa* L.) is primarily grown by transplanting seedlings in puddled fields which requires a large amount of water (150 cm), energy and labour (Bhushan *et al*. 2007). In puddled soil, physical properties were adversely affected due to disturbance in the soil aggregates, impermeability in subsurface layers and formation of hard pans at shallow depths (McDonald *et al.* 2006). Hence there has been increasing trend towards conservation agriculture in many countries over the past few years (Chhokar *et al*. 2007). Research reports have indicated that non-puddled transplanted rice produced similar yields to that under conventional puddling (Rashid *et al*. 2018). The available soil water ranges from 150 to 200 mm in one meter soil profile at the time of harvest would be sufficient to raise a short-duration pulse crops under relay cropping system (Pande *et al*. 2012). Among the pulses, blackgram (*Vigna mungo* L.) is highly suited for rice fallow situation due to its better adaptability to limited moisture soils and tolerant to water logging during the early phases of crop growth as well (Raja *et al*. 2018).

[1]Tamil Nadu Rice Research Institute, Tamil Nadu Agricultural University, Aduthurai, Tamil Nadu. *Corresponding author email: subrah_arul@yahoo.com

Crop establishment is very vital in relay cropping system as the yield is determined by the plant population per unit urea. Since, the seeds are sown under residual moisture condition, proper seed treatment would promote germination, establishment and development of crop. Inoculation of legumes with bacteria enhances seed germination (Sarkar *et al*. 2021), increases biological nitrogen fixation in agriculture (Neo *et al*. 2012) and acts as a bio-control agent/inoculum (Deshmukh *et al*. 2020). Application of nutrients elements through foliar at appropriate stages of growth become important for their efficient utilization and better performance of the crop (Ganapathy *et al*. 2008). Application of DAP (2%) is recommended to increase the yield of rice fallow blackgram (CPG 2020). Das and Jana (2015) reported that the yield of blackgram obtained with 2% urea spray was 5.8% higher than yield obtained with DAP. Therefore, an experiment was conducted to study the impact of tillage practices adopted in the rice crop along with bio-priming and foliar spray on the succeeding blackgram grown as relay cropping.

MATERIALS AND METHODS

A field experiment was conducted for 3 years during

the post rainy season of 2015–16, 2016–17 and 2017–18 (December-March) at research farm of Tamil Nadu Rice Research Institute, Aduthurai (11^0 01' N, 79^0 48' E, 19.5 m altitude), Tamil Nadu. The experimental area is characterized by a tropical climate with distinct wet and dry seasons with annual rainfall more than 1200 mm. The experiment was laid out in split plot design (SPD) with 2 tillage systems (Puddled and non-puddled transplanting) and 2 seed priming methods (bio-seed priming, hydropriming and no priming) in main plots and 2 foliar spray of nutrients (DAP 2% spray and Urea 2% spray) in sub plots. The study commenced with transplanting of rice variety (CR 1009) in puddled and non-puddled condition during *Samba* season (August-December). In non-puddled condition, minimum tillage of dry ploughing with cultivator followed by rotavator was done. Subsequently after a simple wetting of soil with 50 mm of irrigation water, transplanting was done with paddy transplanter. The blackgram cultivar ADT-3 was sown 7–10 days prior to harvest of paddy crop by adopting a seed rate of 30 kg/ha. Bio-seed priming with *Rhizobium* and hydropriming for 2 h and No priming (control) was done prior to sowing. Foliar application of DAP 2% spray and 2% urea was done at flowering and 15 days after. The treatments were replicated thrice. Soil of the experimental site was clayey soil with a *p*H 7.6, low in organic carbon (0.20%) and medium in available nitrogen (278 kg/ha), high in available phosphorus (30 kg/ha) and medium in available potassium (308 kg/ha).

Germination count was taken on 15 days of after sowing (DAS). The SPAD-502 chlorophyll meter (SPAD-502 Minolta Camera Co., Ltd., Japan), a rapid, non-destructive and hand-held spectral device was used for estimating leaf chlorophyll content. SPAD values of the 4 fully expanded uppermost leaves were determined on 30 and 45 DAS and the results are reported as SPAD units. Ten randomly selected plants from each plot were measured in the field. The total number of effective nodules and dry weight of nodules were measured in all the treatments and mean value was arrived (Khan *et al*. 2006). The relative water content (RWC) expresses the water content in per cent at a given time as related to the water content at full turgor and describes the degree of water saturation in plant leaves. Specific Leaf Weight (SLW) is one of the few morphological characteristics of plants that shows large changes over the course of a single day and was measured by the formula suggested by Gonzalez and González-Vilar (2001). Specific leaf weight (SLW) was calculated by using the formula of Amanullah (2015) and expressed as mg/cm^2. The data on growth and yield attributes were observed at the time of harvest randomly from 10 plants from the same 5 plants in each treatment. The seed yields were measured as total yield per plot and transformed to kg/ha. The crop was harvested on 65 DAS. Analysis of variance (ANOVA) was used to detect the significance of treatment effects on different parameters studied. Least significant difference (LSD) was used to separate the mean whenever the treatment means were significantly different. The statistical analysis was done as per the method suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Root length (cm) and root dry weight (g): Higher root length of blackgram was observed in non-puddled method of tillage practice at 30 and 45 DAS (Table 1). Puddling operations would have been resulted in destruction of soil aggregates, break in capillary pores and dispersion of clay particles. Further puddling would have also created an impermeable clayey layer on the surface of coarse-textured soil and a plough pan that impedes root penetration for the succeeding crop. This might be reason for poor root growth in puddled soil as compared to non-puddled soil. Earlier Haque *et al.* (2016) reported similar findings. With regard to seed priming, bio-seed priming had the highest root length of (6.94 and 8.59 cm) and root dry weight (0.174 and 0.190 g) at 30 and 45 DAS respectively. Vishwas *et al.* (2017) also

Table 1 Effect of different treatments on root length (cm) and root dry weight (g), nodule count and nodule dry weight (g) of blackgram

Treatment	Root length (cm)		Root dry weight (g)		Nodules count		Nodules dry weight (g)	
	30 DAS	45 DAS	30 DAS	45 DAS	30 DAS	45 DAS	30 DAS	45 DAS
Tillage practices								
Puddled TP	5.96	7.52	0.151	0.176	24.26	15.68	0.173	0.093
Unpuddled TP	6.93	8.72	0.177	0.192	24.63	18.18	0.183	0.124
CD (P=0.05)	0.42	0.51	0.008	0.004	0.12	0.14	0.006	0.001
Seed priming								
Biopriming	6.94	8.62	0.174	0.19	24.86	19.05	0.186	0.128
Hydropriming	6.38	8.03	0.165	0.185	24.41	16.53	0.178	0.108
Control	6.05	7.76	0.158	0.181	24.08	15.21	0.17	0.09
CD (P=0.05)	0.14	0.12	0.006	0.012	0.15	0.11	0.004	0.004
Foliar spray								
DAP 2%	6.43	8.12	0.162	0.184	24.43	16.78	0.176	0.106
Urea 2%	6.46	8.14	0.169	0.187	24.47	17.08	0.180	0.111
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

indicated that improved root length in bio-seed priming were attributed to growth promotional effect of bio-seed primers that produced growth regulatory substances (hormones) upon seed imbibition. The root parameters were not significantly altered by the application of foliar nutrients.

Nodule count and dry weight (g): Similar to the root parameters, number of root nodules and root dry weight were also highly influenced by tillage practices (Table 1). Non puddled method of tillage registered more number of nodules and nodules dry weight both at 30 and 45 DAS as compared to puddled method of tillage. Soil compaction created due to puddling in the rice soils by decreasing the volume of transmission pores would have resulted in lesser nodule count and dry weight. This might be the reasons for a greater number of nodules per plant and nodule dry weight as well under non-puddled tillage practices. Bio-seed priming with *Rhizobium* registered more number of nodules (24.72 and 18.34) and the nodules dry weight (0.17 and 0.12 g) at 30 and 45 DAS respectively as compared to other seed priming methods. Similarly, Patel *et al.* (2016) reported that bio- seed priming with *Rhizobium* significantly increased the nodulation and nitrogenase activity and thus improved the soil fertility and sustainability through its ability to fix atmospheric nitrogen in the soil through root nodules. Similar to root parameters, foliar application of macro nutrients did not improve the number of root nodules/ plant and root dry weight as well.

Physiological parameters: Unlike root parameters, puddled method of tillage registered numerically higher level of RWC (83.06 and 83.72%), SLW (6.83 and 6.28 g/ cm^2) and SPAD meter values (40.88 and 39.75 at 30 and 45 DAS respectively) (Table 2). However, it was comparable with the values obtained with non-puddled tillage method. The results clearly indicated the tillage practices adopted in rice cultivation did not influence the growth parameters of blackgram which was evidently seen in the physiological parameters observed. Kumar *et al*. (2022) also reported that zero tillage did not differ from conventional tillage with respect to crop growth rate. Among different seed priming methods, bio-seed priming with *Rhizobium* registered higher values of RWC, SLW and chlorophyll content irrespective of the stages of observation when compared to other methods. Bio-seed priming would have enhanced the N-fixation from atmosphere and resulted in better growth and development of plant which was reflected in specific leaf weight and SPAD values. Similarly, bio-seed priming with a microbial consortium consisting of *Bradyrhizobium* has been reported to enhance the levels of chlorophyll, total carotenoids and net photosynthetic rate (Moretti *et al*. 2021). In case of foliar nutrient application, urea @2% at flowering and pod development stage registered higher values of RWC, SLW and SPAD values (chlorophyll content) at both the stages of observation. However, the values were comparable with DAP 2% spray. The foliar application of nitrogen was already reported to have beneficial effect on physiological growth of lentil (Das and Jana 2015).

Grain yield: The grain yield of blackgram (Table 3) varied significantly between the two tillage systems due to the variations in the number of pods/plant. The grain yield observed with non-puddled method of rice cultivation was 11.1% higher than puddled rice. Puddling in rice would have weakened the soil structure and the development of sub-surface hard pans and increased risk of water-logging. Haque *et al*. (2016) observed that puddling operation in transplanted rice had adverse effects on soil physical properties and destruction of soil structure and also required more energy to obtain fine tilth for succeeding crops. Furthermore, Rashid *et al*. (2018) reported similar grain rice yield in puddled transplanted and non-puddled rice cultivation. Samejima *et al*. (2020) also reported that non-puddled rice cultivation

Table 2 Effect of different treatments on physiological parameters of blackgram

Treatment	RWC (%)		SLW (g/cm^2)		Chlorophyll content (SPAD values)	
	30 DAS	45 DAS	30 DAS	45 DAS	30 DAS	45 DAS
Tillage practices						
Puddled TP	85.11	83.47	6.61	5.96	43.07	38.77
Unpuddled TP	84.97	83.25	6.55	5.67	42.84	38.40
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Seed priming						
Bio-seed priming	85.51	84.41	6.89	5.98	43.16	39.54
Hydropriming	85.17	83.41	6.47	5.84	42.99	38.43
Control	84.44	82.97	6.35	5.62	42.72	37.79
CD (P=0.05)	0.21	0.25	0.08	0.06	0.14	0.19
Foliar spray						
DAP 2%	84.99	83.38	6.49	5.67	42.83	37.97
Urea 2%	85.09	83.81	6.65	5.96	43.08	39.21
CD (P=0.05)	0.03	0.13	0.02	0.03	0.08	0.13

RWC, Relative water content; SLW, Specific leaf weight content.

Table 3 Effect of different treatments on growth, yield parameters and yield of blackgram

Treatment	Plant density/ m^2	Plant height at harvest (cm)	Pods/ plant	seeds/ pod	100-seed weight (g)	Yield (kg/ha)
Tillage practices						
Puddled TP	27	27.3	24	6.2	4.70	544
Unpuddled TP	25	26.4	27	6.2	4.63	608
CD (P=0.05)	0.1	NS	0.8	NS	NS	10
Seed priming						
Bio priming	27	27.0	30	6.7	4.86	644
Hydropriming	25	27.2	24	6.2	4.64	569
Control	23	26.3	22	5.7	4.50	515
CD (P=0.05)	0.4	0.2	0.4	0.1	0.16	20
Foliar spray						
DAP 2%	24	26.0	24	6.06	4.62	551
Urea 2%	27	27.7	27	6.42	4.71	601
CD (P=0.05)	0.3	0.2	0.2	0.04	0.11	6

increased subsequent soybean yield to a tune of 16.8%. Due to favourable growth and yield parameters, bio-seed priming resulted in 13.2 and 25.0% increased grain yield over hydro-priming and no seed priming respectively. Bio-priming with PGPR has been reported to enhance the seed germination, increase the branches in root hair, enhance earlier nodule formation, increase in leaf area index, uptake of nutrients and water by crop, increase in dry matter production and thereby crop yield (Mahmood *et al.* 2016). Umair *et al*. (2011) also observed that bio-seed priming increased the seed yield of greengram considerably through significant increase in nodulation, nitrogen fixation and nutrient uptake. Between the two foliar spray of macro nutrients, urea 2% increased the grain yield by 9.07% over DAP 2%, though it was on par with DAP 2% for yield parameters. The foliar nutrients might have supplemented the nutrient demand of the crop at the critical stage, resulting in better growth and development of the crop and ultimately the yield attributing characters and enhanced positive source-sink gradient of photosynthates translocation guaranteeing seed formation and better grain-filling (Mohan Raj *et al.* 2018). Foliar nutrient application would have resulted in effective utilization of nutrients where the soil conditions were not conducive for soil application of nutrients under residual moisture condition. Similarly, Qadri *et al.* (2015) also reported that foliar application of urea was more beneficial as it depends less on soil conditions and in saline or dry soils when root nitrogen uptake is impaired, plants can easily take nitrogen from foliar application. Urea is considered to be most suitable source of foliar N due to its neutrally charged nature, high solubility and rapidly absorption through stomatal and hence effectively utilized by the plants without any leaching losses and fixation in the soil similar to that of any N sources for foliar application. The foliar application of urea @2% was reported to improve the seed yield as that of enhanced efficient fertilizers (Cassim *et al*. 2020).

From the three years field investigation, results confirmed that *Rhizobium* bio-seed priming of blackgram sown in the non-puddled transplanted rice followed by urea 2% spray enhanced the crop yield of blackgram hence it could be concluded that adoption of non-puddled transplanted rice system would improve the yield of succeeding blackgram sown as relay cropping in the rice-blackgram cropping system besides improving the soil physical properties.

REFERENCES

Amanullah. 2015. Specific leaf area and specific leaf weight in small grain crops wheat, rye, barley, and oats differ at various growth stages and NPK source. *Journal of Plant Nutrition* **38**: 1694–1708.

Bhushan L, Ladha J K, Gupta R K, Singh S, Tirol-Padre A, Saharawat Y S, Gathala M and Pathak H. 2007. Saving of water and labour in rice-wheat systems with no-tillage and direct seeding technologies. *Agronomy Journal* **99**: 1288–96.

Cassim B M A R, Machado A P M, Fortune D, Moreira F R, Zampar É J D O and Batista M A. 2020. Effects of foliar application of urea and urea-formaldehyde/triazone on soybean and corn crops. *Agronomy* **10**(10): 1549. https://doi.org/10.3390/agronomy10101549

Chhokar R S, Sharma R K, Jat G R, Pundir A K and Gathala M K. 2007. Effect of tillage and herbicides on weeds and productivity of wheat under rice-wheat growing system. *Crop Protection* **26**: 1689–96.

CPG. 2020. *Crop Production Guide,* pp. 127–28. Department of Agriculture, Govt. of Tamil Nadu, Chennai and Tamil Nadu Agricultural University, Coimbatore.

Das S K and Jana K. 2015. Effect of foliar spray of water-soluble fertilizer at pre flowering stage on yield of pulses. *Agricultural Science Digest* **35**(4): 275–79.

Deshmukh A J, Jaiman R S, Bambharolia R P and Patil V A. 2020. Seed biopriming–A review. *International Journal of Economic Plants* **7**(1): 038–043.

Ganapathy M, Baradhan G and Ramesh N. 2008. Effect of foliar nutrition on reproductive efficiency and grain yield of rice fallow pulses. *Legume Research* **31**(2): 142–44.

Gomez K A and Gomez A A. 1984. *Statistical Procedure for Agricultural Research*. John Wiley and Sons, New York.

Gonzalez L and Gonzalez-Vilar M. 2001. Determination of relative water content. *Handbook of Plant Ecophysiology Techniques*. Reigosa Roger M J (Ed). Springer, Dordrecht. https://doiorg/101007/0-306-48057-3_14

Haque M E, Bell R W, Islam M A and Rahman M A. 2016. Minimum tillage unpuddled transplanting: An alternative crop establishment strategy for rice in conservation agriculture cropping systems. *Field Crops Research* **185**: 31–39.

Khan M S, Zaidi A and Wani P A. 2006. Role of phosphate solubilizing microorganisms in sustainable agriculture-A review. *Agronomy for Sustainable Development* **26**: 1–15.

Kumar, M, Singh, S S, Singh Y, Nath, C P, Palsaniya D R, Prasad M and Bhinda N K. 2022. Effect of tillage and bioregulators on physiological parameters and yield of rainfed chickpea (*Cicer arietinum* L.). *The Pharma Innovation Journal* **SP-11**(6): 2005–08.

Mahmood A, Turgay O C, Farooq M and Hayat R. 2016. Seed biopriming with plant growth promoting rhizobacteria: A review. *FEMS microbiology ecology* **92**(8): fiw112.

Mcdonald A, Riha S, Duxbury J, Steenhuis T and Lauren J. 2006. Soil physical responses to novel rice cultural practices in the rice–wheat system: comparative evidence from a swelling soil in Nepal. *Soil and Tillage Research* **86**: 163–75.

Mohan Raj N, Subrahmaniyan K, Umamageswari C and Vanitha K. 2018. Growth and yield of irrigated blackgram as influenced by different land configurations and foliar nutrients in cauvery delta zone of Tamil Nadu. *Research Journal of Agricultural Sciences* **9**(5): 1107–09.

Moretti L G, Costa C A, Crusciol, Bossolani J W, Calonego J C, Moreira A, Garcia A, Momesso L, Kuramae E E and Hungria M. 2021. Beneficial microbial species and metabolites alleviate soybean oxidative damage and increase grain yield during short dry spells. *European Journal of Agronomy* **127**: 126293. https://doi.org/10.1016/j.eja.2021.126293

Neo S, Vintila D, Vintila T, Dragomirescu M and Nicula M. 2012. Multiplication and viability of some Rhizobium strains to be used as inoculants for agricultural biomass production. *Scientific Papers Animal Science and Biotechnologies* **45**: 335–40.

Pande S, Sharma M, Ghosh R, Rao S K, Sharma R N and Jha A K. 2012. *Opportunities for Chickpea Production in Rain-fed Rice Fallows of India–Baseline Survey Report*. Grain Legumes Program Report No. 1. International Crops Research Institute for the Semi-Arid Tropics, Patancheru 502324, Andhra Pradesh, India, pp. 56.

Patel A R, Patel D D, Patel T U and Patel H M. 2016. Nutrient management in summer greengram (*Vigna radiata*). *International Journal of Applied and Pure Science and Agriculture* **2**(2): 133–42.

Qadri R, Khan I, Jahangir M, Ashraf U, Samin G, Anwer A, Adnan M and Bashir M. 2015. Phosphorous and foliar applied nitrogen improved productivity and quality of potato. *American Journal of Plant Sciences* **6**: 144–49.

Raja K and Sathish. 2018. Seed treatments for vigorous seedling establishment and improved seed yield of blackgram under rice fallow condition. *Legume Research* **41**(1): 120–25.

Rashid M, Goswami H P C, Hossain M H, Mahalder D, Rony M K I, Shirazy B J and Russell T D. 2018. Mechanised non-puddled transplanting of boro rice following mustard conserves resources and enhances productivity. *Field Crops Research* **225**(1): 83–91.

Samejima H, Chonan Y, Yamane T, Ohashi Y, Morimoto S, Ohtomo R, Oka N and Nakamura T. 2020. Non-puddling rice cultivation increases subsequent soybean yield in rice-soybean rotation system. *Plant Production Science* **24**(2): 180.

Sarkar D, Rakshit A I, Al-Turki R Z and Sayyed R D. 2021. Connecting bio-priming approach with integrated nutrient management for improved nutrient use efficiency in crop species. *Agriculture* **11**(4): 372

Umair A, Safdar A, Rifat H, Muhammad A and Muhammad J T. 2011. Evaluation of seed priming in mung bean (*Vigna radiata*) for yield, nodulation and biological nitrogen fixation under rainfed conditions. *African Journal of Biotechnology* **10**(79): 18122–29.

Vishwas S, Chaurasia A K, Bineeta M B, Ashim D, Neeraj Nath P, Brunda K and Rahul Si. 2017. Effect of priming on germination and seedling establishment of chickpea (*Cicer arietinum* L.) seeds. *Journal of Pharmacognosy and Phytochemistry* **6**(4): 72–74.