Journal of Crop and Weed, 13(1) : 17-22 (2017)

To assess the scope of brown manuring in aerobic rice in central Punjab

P. K. SRAW, A. KAUR AND K. SINGH

Krishi Vigyan Kendra, Jalandhar
Punjab Agricultural University, Ludhiana, Punjab

Received : 28-03-2017 ; Revised :25-04-2017 ; Accepted:26-04-2017

ABSTRACT

A field experiment was conducted at farmer's fields to assess the scope of brown manuring in direct seeded basmati rice during the rainy (kharif) season of 2011 and 2012 in Jalandhar district, Punjab. The experiment was conducted in Randomized Block Design with four replications. The experiment consists of four treatments viz. Sole direct-seeded basmati rice (DSBR) in prepared, Sole DSBR in unprepared field, DSBR in prepared field with sesbania brown manuring (SBM) and DSBR in unprepared field with SBM. The sowing of direct-seeded basmati rice (DSBR) was done in 2nd week of June in both the years and harvested manually in 2nd fortnight of November. It was observed that Sesbania brown manuring reduced the density of broad-leaved weeds, narrow-leaved weeds, and sedges by 67.6, 43.6, and 33.6 per cent DSBR in prepared field treatment and reduced the density of broad-leaved weeds (67.2%), narrow-leaved weeds (37.1%), and sedges (64.9%) DSBR in unprepared field than the sole DSBR in prepared and unprepared field. Likewise, dry weight of the broad-leaved weeds, grassy weeds, and sedges was reduced by 77.4, 49.1 and 52 per cent, DSBR in prepared field with sesbania brown manuring treatment and 60.4 per cent, 56.7 per cent, and 52.7 per cent in DSBR in unprepared field respectively, than the sole crop of DSBR in prepared and unprepared field. DSBR in prepared field with SBM have 8.2, 9.97 and 3.8 per cent higher yield as compared to sole DSBR in prepared field, sole DSBR in unprepared field and DSBR in unprepared field with SBM. The organic carbon content at the end of the experiment ranged from 0.47-0.66 per cent across different locations. There was little or change in organic carbon content where sole direct seeded rice for cultivated, rather at some locations it decreased slightly. Highest benefit cost ratio was recorded in unprepared DSBR treatment with and without SBM which was 4.27 and 4.19 respectively. Highest net return (Rs 67.2x10^{3}ha^{-1}) was registered with DSBR in prepared field with SBM followed by DSBR in unprepared field with SBM.

Keywords : Brown manuring, DSBR, sesbania, weeds, yield

Rice–wheat is the major cropping system of the Indo-Gangetic Plains (IGP) of south Asia, where it is grown on 14 M ha and livelihoods for millions of farmers and workers. Rice is the most important staple food of more than 50 % of world population. More than 90 per cent of rice is produced and consumed in Asia with two countries China and India. The area under rice in India has increased substantially from 4 to 12.3 M ha during the last 40 years (Timsina and Connor, 2001). Rice is generally cultivated by transplanting the seedlings in puddle soil conditions. There are several major drivers of strong interest among growers in direct seeded rice (DSR). Transplanted rice has lots of energy requirement for raising nursery, uprooting of seedlings, pudding of fields and transplanting of seedlings. Moreover, under practical situation of contractually transplanted fields, it often, at cultivars' fields leads to lesser plant population, which generally varies from 16 to 21 hills m^{-2} as against the optimum of 33 hills m^{-2} Presently, in Punjab the underground water is being over-exploited by excessive pumping to meet the water need of transplanted paddy. As a consequence, it has been causing a sharp decline in water table. Rice production under current inputs and technology is likely to fail to meet the projected demand (Leeper, 2010) besides an urgent need to increase rice productivity per unit area in the world. Increasing yields in aerobic rice systems (ARSs) 'the direct-seeded rice' (DSR) can play a key role in increasing rice production globally (Prasad, 2011). The DSR also reduces the methane emission (Yadav *et al.*,2010) matures earlier than puddled transplanted flooded rice, facilitates timely sowing of wheat crop in rice – wheat traditional cropping system (Farooq *et al.*, 2008, Yadav *et al.*, 2010) and favors the growth of summer crops by improving soil physical quality (Farooq and Nawaz, 2014).

Timsina and Connor (2001) reported that the yield of post-rice - wheat can be enhanced with reduction in the cost of production by just avoiding the puddling operation. Therefore, DSR offers the advantage of faster and easier planting, ensure proper plant population, reduce labour and hence less drudgery, 10-12 days earlier crop maturity, more efficient water use and higher tolerance to water deficit, and often high profit in areas with assured water supply. To make the rice cultivation cost-effective, to ensure the rational use of water and to get rice best fit in different cropping systems on account of early maturity, cultivation of DSR seems to be the best option.

There are many other problems which are associated with aerobic rice that needs to be addressed but major constrain is less yield in DSR due to more weeds

Email: pahulparam78@pau.edu

infestation. In direct seeded rice, weeds germinate simultaneously with crop, as there is no puddling and standing water to suppress growth of weeds (Fukai,2002). Direct seeded rice is infested with more than 50 weed species, causing major losses to rice production worldwide (Rao *et al.,* 2007). Weeds are a serious problem in DSR which can cause grain yield losses from 50 to 90 per cent (Chauhan and Johnson, 2011) enhances the cost of production and reduces grain quality. So, to address this problem present investigation was planned to assess the scope of brown manuring in aerobic rice.

MATERIALS AND METHODS

A field experiment was conducted at farmer's fields to assess the scope of brown manuring in direct seeded basmati rice during the rainy (*kharif*) season of 2011 and 2012 in Jalandhar district, Punjab. Jalandhar is geographically situated at 31°19'N latitude, 35°18' E longitude and at an altitude of about 228 m above mean sea level. The climate of Jalandhar district is humid subtropical with cool winters and long hot summers. Summers last from April to June and winters from November to February. The mean maximum and minimum temperature show considerable fluctuations during summer and winter. The average annual rainfall is 769 mm and greater portion of total (about 75%) is received as southwest monsoon during July and August. The average annual temperature is 23.9 °C. The soil analysis done prior to the start of the experiment at all the locations. The soil samples from 0–15 profile layer were taken from the selected sites and analysised. The soil of the experimental sites was sandy loam to loam in texture, with normal soil reaction (8.2), medium in organic carbon (0.48% to 0.58 %), low in available N (249 - 251 kg ha^{-1}), high in available P (23.2 - 32.8 kg ha^{-1}) and K (348 - 368 kg ha^{-1}).Initial bulk density of different locations ranged from 1.15-1.34 gcm^{-3} for 0-5 cm soil layer and 1.32-1.4u gcm^{-3} for 5-10 cm soil layer (Table1).The experiment was conducted in Randomized Block Design with four replications. The experiment consist of four treatments viz. sole direct-seeded basmati rice (DSBR) in prepared and DSBR in unprepared field, DSBR in prepared with sesbania brown manuring (SBM) and DSBR in unprepared field with SBM. The sowing of direct-seeded basmati rice (DSBR) was done in 2nd week of June in both the years and harvested manually in 2nd fortnight of November. For sowing of DSBR in prepared field, the field was prepared with two ploughings with a disc harrow followed by one planking and seed at 50 kg/ha was direct seeded in rows at 20 cm spacing. For sowing DSBR in unprepared field, the sowing of seeds (50kg ha^{-1}) was directly done in unprepared field by opening the furrows at 20 cm spacing. For brown manuring, *Sesbania* seeds @ 50 kg ha^{-1} was uniformly broadcasted after sowing rice crop and knocking down by spraying 2, 4-D @ 1 kg ha^{-1} when *Sesbania* crop is 45 Days old. The colour of *Sesbania* residue became brown and it was allowed to lie and decompose in situ on field. The wheat crop in all these four treatments was grown conventionally by following recommendations of Punjab Agricultural University, Ludhiana.

For control of weeds, Pendimethalin @ 0.75 kg ha^{-1} was sprayed with knapsack immediately after sowing in all the treatments. The crop was raised under irrigated conditions with recommended package of practices. As per requirement of the crop irrigations were applied without maintaining flooded conditions. The scheduled irrigation was skipped if there is rainfall. Nitrogen (120 kg ha^{-1}) was applied through urea in three equal splits ,1/3rd as basal, 1/3rd N 45 days after sowing, and 1/3rd 65 days after sowing Weed density (no. m^{-2}) and dry matter(g m^{-2}) was taken at 35 DAS , 75 and at harvest with 50 x 50 cm quadrate by placing randomly at three places in each treatment. Operational cost and prevailing price of inputs in market were used to calculate the economics. After harvest of rice, soil samples were collected for 0-15 cm soil and analysed at laboratory of Krishi Vigyan Kendra for analysis of soil organic carbon and analysed with Walkley and Black's rapid titration method. For determination of the bulk density, undisturbed soil cores are collected from 0-5 cm and 5-10 cm depths with the help of cylindrical iron rings and dried in an oven at 105^{o}C for 24 hours. The mean data of 5 different locations was pooled for two years and the statistical analysis was performed using CPCS-1 Software.

RESULTS AND DISCUSSION:

Weed dynamics

The weed flora was assessed after 4 weeks after sowing and the dominating weed species found in experimental fields were *Echinocloa crusgalli*, *Echinocloa colona*, *Dactylotenum, aegypticum* among grasses, *Cyperus rotundus*, *Cyperus iria* in sedges, and *Euphorbia hirta , Eclipta prostrata, , Ammania spp and Trianthema portulacastrum* in broad leaf weeds. *Echinocloa colona, Digitaria sanguinalis and Trianthema portulacastrum* were the most prominent weeds present in direct seeded rice crop. The result indicated that the total weed density and dry matter accumulated by weeds varied significantly with increase in the age of the crop. The proportion of density of grasses was higher (43.1 % of total density) than for other weeds. The sesbania brown manuring reduced the density and dry biomass of weeds significantly (Table 2.) Sesbania brown manuring reduced the density

Table 1: Initial status of soil organic carbon and bulk density of different locations

Locations	Texture	Initial organic carbon (%)	Bulk density gcm^{-3}(0-5 cm)	Bulk density gcm^{-3}(5-10 cm)
Location 1	Sandy loam	0.48	1.32	1.43
Location 2	Sandy loam	0.52	1.26	1.42
Location 3	loam	0.58	1.15	1.32
Location 4	Sandy loam	0.57	1.34	1.48
Location 5	Sandy loam	0.54	1.30	1.42

Table 2: Effect of different treatments on total weed density and dry weight at 30, 75 and at harvest (pooled data 2 years)

Treatments	Total weed density (no m^{-2})			Total weed dry matter (g m^{-2})		
	30 DAS	75 DAS	At harvest	30 DAS	75 DAS	At harvest
T_1-DSR in prepared field	189.8	240.1	219.0	45.5	225.7	254.3
T_2-DSR in unprepared field	148.0	215.6	207.3	38.6	218.1	251.4
T_3- DSR in prepared field + SBM	109.3	128.8	129.3	13.5	45.3	61.5
T_4- DSR in unprepared field + SBM	85.1	100.9	93.7	11.2	41.8	58.9
SEm(±)	**4.48**	**4.98**	**3.89**	**1.94**	**4.92**	**4.57**
LSD(0.05)	**17.9**	**19.1**	**15.5**	**6.7**	**17.0**	**15.8**

Table 3: Effect of different treatments on total weed density and dry weight of individual weed species at harvest (pooled data 2 years)

Treatments	Total weed density (no m^{-2})			Total weed dry matter (g m^{-2})		
	Grassy weeds	Sedges	Broad leaf weeds	Grassy weeds	Sedges	Broad leaf weeds
T_1-DSR in prepared field	335.7	200.4	127.8	179.4	82.5	49.2
T_2-DSR in unprepared field	291.1	175.6	103.1	111.9	68.7	24.8
T_3- DSR in prepared field + SBM	221.8	113.0	41.4	91.2	38.9	11.1
T_4- DSR in unprepared field + SBM	198.6	61.6	33.8	49.2	32.5	9.8
SEm(±)	**2.91**	**3.98**	**4.17**	**5.31**	**2.91**	**2.53**
LSD(0.05)	**8.6**	**12.2**	**12.5**	**18.6**	**8.1**	**8.0**

Table 4: Effect of different treatments on yield and yield attributing characters in direct-seeded basmati rice (pooled data 2 years)

Treatments	Plant height (cm)	Effective tillers m^{-2}	Grains panicle^{-1} (No.)	1000 grain weight (g)	Straw yield (t ha^{-1})	Grain yield (t ha^{-1})
T_1-DSR in prepared field	108.6	252.7	134.7	20.4	8.28	3.13
T_2-DSR in unprepared field	104.3	241.7	121.3	20.1	7.89	3.07
T_3- DSR in prepared field + SBM	111.1	258.3	136.0	20.8	8.46	3.41
T_4- DSR in unprepared field + SBM	106.2	247.0	125.0	20.7	8.18	3.28
SEm(±)	**1.41**	**2.60**	**2.40**	**0.33**	**0.29**	**0.10**
LSD(0.05)	**4.0**	**7.6**	**6.4**	**NS**	**NS**	**0.21**

Table 5: Effect of different treatments on soil organic carbon (%) after harvest of rice 2012

Treatments	Loc* 1	Loc 2	Loc3	Loc 4	Loc 5
T_1-DSR in prepared field	0.47	0.52	0.58	0.56	0.54
T_2-DSR in unprepared field	0.48	0.54	0.61	0.58	0.54
T_3- DSR in prepared field + SBM	0.50	0.57	0.65	0.62	0.60
T_4- DSR in unprepared field + SBM	0.52	0.58	0.66	0.64	0.61

Loc* = Location

Table 6: Effect of different treatments on soil bulk density (0-5cm) after harvest of rice 2012

Treatments	Loc 1	Loc 2	Loc 3	Loc 4	Loc 5
T_1-DSR in prepared field	1.30	1.26	1.15	1.34	1.29
T_2-DSR in unprepared field	1.29	1.26	1.12	1.32	1.28
T_3- DSR in prepared field + SBM	1.28	1.23	1.10	1.30	1.26
T_4- DSR in unprepared field + SBM	1.28	1.22	1.10	1.29	1.24

Table7 : Effect of different treatments on soil bulk density (5 -10cm) after harvest of rice 2012

Treatments	Loc 1	Loc 2	Loc 3	Loc 4	Loc 5
T_1-DSR in prepared field	1.43	1.42	1.32	1.48	1.42
T_2-DSR in unprepared field	1.43	1.42	1.32	1.47	1.40
T_3- DSR in prepared field + SBM	1.42	1.39	1.30	1.46	1.40
T_4- DSR in unprepared field + SBM	1.42	1.39	1.30	1.46	1.40

Table 8: Economic analysis of different treatments (pooled data of 2 years)

Treatments	Total expenses (Rs ha^{-1})	Net return (Rs ha^{-1})	Benefit cost ratio
T_1-DSR in prepared field	16800	61450	3.66
T_2-DSR in unprepared field	14550	62200	4.27
T_3- DSR in prepared field + SBM	18050	67200	3.72
T_4- DSR in unprepared field + SBM	15800	66200	4.19

of broad-leaved weeds, narrow-leaved weeds, and sedges by 67.6 per cent, 43.6 per cent, and 33.6 per cent DSBR in prepared field treatment and reduced the density of broad-leaved weeds (67.2%), narrow-leaved weeds (37.1%), and sedges (64.9%), DSBR in unprepared field than the sole crop of DSR in prepared and unprepared field. The density of broad leave weeds decreased significantly at 75 DAS in sesbania brown manuring treatment as compared to sole DSBR because 2, 4-D sprayed on sesbania to knock down it, also affect the population of broad leaf weeds. Likewise, dry weight of the broad-leaved weeds, grassy weeds, and sedges was reduced by 77.4 per cent, 49.1 per cent and 52 per cent, DSBR in prepared field with sesbania brown manuring treatment and 60.4 per cent, 56.7 per cent and 52.7 per cent in DSR in unprepared field respectively, than the sole crop of DSBR in prepared and unprepared field (Table 3) . The lowest density of *Echinocloa Colona* was also observed under DSBR in prepared field with sesbania brown manuring. These results are in agreement with Mukherjee and Maity, 2011, Gill and Walia, (2013) and Nawaz *et al.* (2016b).This might be due to smothering effect of brown manuring on diverse weed flora, decreased availability of sunlight to the germinating weed seeds and weed plants, which inhibited the germination of weed seeds and photosynthesis in weeds (Chauhan and Mahajan, 2014; Hazbavi and Sadeghi, 2016). Sesbania is a legume crop, so is more efficient in utilizing limited resources than are weeds. Lower weed growth under sesbania plots at later stages of growth was observed because sesbania was killed by broad-leaf herbicide, and its residue formed mulch on soil surface, thus restricted the weed emergence by restricting sunlight to soil surface and causing physical barrier (Chauhan and Mahajan, 2014)

Yield attributes and yield

Plant height is one of the most important physiological parameter for determining the growth and development of the crop. The plant height indicates the vigour, strength and adaptability of the crop to the existing agro climatic conditions. Significant difference in plant height was recorded in DSBR in prepared field in comparison to DSBR in unprepared field. Data presented in Table 4, revealed that the highest plant height (111.1 cm) was registered in DSBR in prepared field with SBM followed by sole DSBR in prepared field (108.6 cm) which was at par with DSBR in unprepared field without SBM. Numbers of effective tillers m^{-2} which are main grain yield determining factor were significantly higher in sole DSBR in prepared field as compared to sole DSBR in unprepared field. Highest effective tillers m^{-2} was registered with DSBR in prepared field with SBM followed by sole DSBR in prepared field while least was recorded in sole DSBR in unprepared field which was stastically at par with DSBR in unprepared field with SBM. Significantly higher number of grains $panicle^{-1}$ was observed in DSBR in prepared field with SBM followed by sole DSBR in unprepared field which was stastically at par with each other but significantly higher than sole DSBR in prepared field and DSBR in unprepared field with SBM. Test weight is a function of various production factors, gives an indication of grain development and filling patterns influenced by various factors, was non significant under various treatment but highest test weight was observed under DSBR in prepared field with SBM (20.9). Grain yield is the main criteria for judging the efficiency of various treatments. The data on grain yield presented in table 3, revealed that DSBR in prepared field with SBM gave higher grain yield (3.41) as compared to other treatments but was stastically at par with DSBR in unprepared field. Similar results were also observed by (Dhyani *et al.* 2009). DSBR in prepared field with SBM have 8.2, 9.97 and 3.8 per cent higher yield as compared to sole DSBR in prepared field, sole DSBR in unprepared field and DSBR in unprepared field with SBM. The straw yield is a function of biomass accumulated by crop during growth period. The data straw yield presented in Table 3 showed that the various treatments have non significant effect on straw yield but highest straw yield was registered with DSBR in prepared field with SBM which was 2.1, 6.7 and 3.3 per cent higher with respect to sole DSBR in prepared field, sole DSBR in unprepared field and DSBR in unprepared field with SBM.

Soil properties

Soil samples were taken from 0-15 cm soil layer after harvesting of rice season in the year 2012. It has been observed that amongst different treatments, organic carbon content increased from its initial content in the treatments, where sesbania has been used as brown manure at all the locations. The organic carbon content at the end of the experiment ranged from 0.47-0.66 per cent across different locations (Table 5) There was little or change in organic carbon content where sole direct seeded rice for cultivated, rather at some locations it decreased slightly. This may be due to the fact that lower amount of root biomass is provided to soils as compared to conventionally tilled rice. Similarly, Different treatments had also shown an effect on soil bulk density. It decreased almost in all the four treatments at 0-5 cm depth, this decrease in bulk density was highest in the treatment where sesbania has been use as brown manure crop. This reduction is comparatively less at 5-10 cm depth. (Table.7)

Economics analysis

The gross return obtained by yield of crop varied greatly due to different treatments which are presented in table 8. The grain yields of different treatments were comparable but due to less input cost involved, highest benefit cost ratio was recorded in unprepared DSBR treatment with and without SBM which was 4.27 and 4.19 respectively. Highest net return (Rs 67.2×10^3/ha) was registered with DSBR in prepared field with SBM followed by DSBR in unprepared field with SBM.

It is concluded that use of sesbania as brown manuring in DSBR, suppressed the weeds, enhanced grain yield and profitability of DSAR. Decrease in weed density and dry biomass, attributed to adaptation of DSBR. So, farmers can get higher productivity and profitability by adopting sesbania brown manuring in DSBR.

REFERENCES

Timsina, J. and Connor, D. J. 2001. Productivity and management of rice–wheat cropping systems: issues and challenges. *Field Crops Res.* **69**: 93–132.

Rao, A. N., Johnson, D. E., Sivaprasad, B., Ladha, J. K. and Mortimer, A. M. 2007. Weed management in direct seeded rice. *Adv Agron.* **93**: 153–255.

Singh, S. K., Bharadwaj, V., Thakur, T. C., Pachauri, S.P., Singh, P.P. and Mishra, A. K. 2009. Influence of crop establishment methods on methane emission from rice fields. *Curr. Sci*. **97**: 84-89.

Fukai, S. 2002. *Rice Cultivar Requirements for Direct Seeding in Rainfed Lowlands*. In: Pandey S, Mortimer M, Wade L, Tuong TP, Lopes K, Hardy B (eds.) Direct Seeding: Research Strategies and Opportunities. International Rice Research Institute, Los Banos, Philippines, pp 257– 69.

Gill, J. S. and Walia, S. S. 2013. Effect of establishment methods and nitrogen levels on basmati rice (*Oryza sativa*) *Indian J. Agron*. **58** : 506-11.

Nawaz, A., Farooq, M., Ahmad, R., Basra, S. M. A. and Lal, R. 2016a. Seed priming improves stand establishment and productivity of no-till wheat grown after direct seeded aerobic and transplanted flooded rice. *Euro. J. Agron.* **76**: 130-37.

Nawaz, A., Farooq, M., Lal, R., Rehman, A., Hussain, T. and Nadeem, A. 2016b. Influence of sesbania brown manuring and rice residue mulch on soil health, weeds and system productivity of conservation rice–wheat systems *Land Degrad. Develop*. DOI: 10.1002/ldr.2578.

Mahajan, G., Chauhan, B. S. and Johnson, D. E. 2009. Weed management in aerobic rice in northwestern indo-gangetic plains. *J. Crop Improvement*, **23**: 366-82.

Chauhan, B. S. and Mahajan, G. 2014. *Recent Advances in Weed Management*. Springer-Verlag New York: USA. DOI: 10. 1007/978-1-4939-1019-9

Leeper, J. R. 2010. Back to basics in improving yield by controlling weeds. *Rice Today*, **9** :12–14.

Farooq, M., Basra, S.M.A. and Asad, S.A. 2008. Comparison of conventional puddling and dry tillage in rice–wheat system. *Paddy Water Env.*, **6**: 397-404.

Dhyani, V.C., Singh, V. P., Singh, S.P., Kumar, A. and Tripathi, N. 2009. Impact of Sesbania brown manuring on weeds and performance of direct seeded rice. *Indian J. Weed Sci.* **41** : 157-59.

Maity, S. K and Mukherjee, P. K. 2011. Effect of brown manuring on grain yield and nutrient use efficiency in dry direct seeded *kharif* rice *(Oryza sativa L.) Indian J. Weed Sci.* **43** : 61-66.

Farooq, M. and Nawaz, A. 2014. Weed dynamics and productivity of wheat in conventional and conservation rice-based cropping systems. *Soil and Tillage Res.* **141**: 1-9.