The Bioscan 12(1): 443-445, 2017 (Supplement on Agronomy)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

WEED DYNAMICS, SYSTEM PRODUCTIVITY AND NUTRIENT UPTAKE IN RICE-WHEAT CROPPING SYSTEM AS INFLUENCED BY TILLAGE AND CROP ESTABLISHMENT METHODS

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KEYWORDS
Crop establishment methods
Nutrient uptake
REY
System productivity

Received on :
30.12.2016

Accepted on :
04.03.2017

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ABSTRACT

An experiment was conducted in strip-plot design with four tillage and crop establishment methods in rice as horizontal strip and tillage and crop establishment methods in wheat as vertical strips. The result showed that weed population and dry weight was maximum in zero till drill sown rice followed by sowing sprouted seeds by drum seeders and minimum in manual rice transplanting. Strip till drill sown wheat recorded highest weed/m^2 at 35 DAS and being at par with zero till drill, both resulted in significantly higher number of weed than rotavator as well as conventional sowing. However, manual transplanting produced maximum REY of the system and being at par with mechanical transplanting and was significantly higher than drum seeder and zero till drill. Among wheat establishment methods, zero till drill sowing produced maximum REY and being comparable to conventional sowing. The similar results were obtained for system productivity that followed the similar trend of ZT > CT > RT > ST. It was concluded that hand/mechanical transplanting of rice followed zero-till or roatavator till wheat drilling are the best crop establishment methods in rice-wheat system of Eastern IGP.

INTRODUCTION

Rice and wheat are staple food crops of the world cultivated on an area around 370.4 million ha. The system occupies about 18 million ha in Asia, of which 13.5 million is in the Indo-Genetic Plains (IGP) of Bangladesh, India, Nepal, and Pakistan, and feeds about a billion people (20% of the world population). Rice–wheat (RW) rotation is of immense importance for both food and livelihood security in South Asia. The main emphasis would be on increasing the productivity of wheat by adopting the improved cultivation practices. In India, rice and wheat covering 44.0 and 30.47 m ha and recorded food grain production of 104.00 and 96.85 m t, respectively during 2014-15 (DAC, 2016). Quantitative traits are governed by multiple genes whose expression is greatly influenced by exposed external environment; and, thus, it results into scale or rank shift of their performance (Dia *et al.*, 2016). It has been reported that on an average wheat yield are reduced by 8% when sown after transplanted rice compared to wheat sown after direct-seeded rice (DSR) in unpuddled conditions but, weed management is most serious constraint in DSR (Kumar *et al.*, 2008). After zero-tillage, advanced technologies like strip tillage and rotavator tillage have also been developed. Strip till drill is a nine-row tractor operated rear mounted machine, which prepares 3-inch wide soil strip for placing seed and fertilizer. This machine saves energy and time in the range of 60-70 per cent in comparison to traditional sowing, where five to seven operations are required. Rotary tillage technology is different where the field is completely pulverized with simultaneous placement of seed and fertilizers using a specially designed rotary till drill. Thus proper management of all important natural resources, particularly the soil by different manipulations techniques in rice-wheat system can lead to higher productivity of both rice and wheat.

In spite of the fact that weed management is the biggest challenge in DSR, it is needed to seek an alternative system for the rice production. The new tillage technologies like zero-tillage where seed is placed directly into the soil along with fertilizer by a specially designed tractor mounted seed drill without tilling the land may help to sustain the rice and wheat yields. The effect of continuous zero and conventional tillage in wheat on soil physico-chemical properties, showed that the upper soil surface was comparatively soft, moisture content was more (up to 13.6%) in zero-tillage as compared to conventional tillage (Punia and Malik, 2004 and Singh and Khind, 2015). So the zero-till technology would be a solution for harvesting more yields with least investment and make rice wheat system, the most productive and resource-conserving system. Thus a study was conducted in order to identify best crop establishment methods in Eastern IGP for

rice-wheat system for enhancing productivity.

MATERIALS AND METHODS

An investigation was conducted on sandy clay loam soil and a pH of 7.5 at the Agriculture Research Farm, Institute of Agriculture Sciences, Banaras Hindu University, Varanasi (U.P.) during *kharif* and *rabi* seasons year 2010-2011. The soil was low in available N (185.6 kg N/ha) and medium in available P (14.5 kg/ha) and rich in K (178.7 kg/ha). The experiment was conducted in strip-plot design with four tillage and crop establishment methods in rice (Direct seedling by zero till drill, direct seedling of sprouted seeds by drum seeder, manual transplanting and mechanical transplanting by self propelled transplanter) as horizontal strip and tillage and crop establishment methods in wheat (Rotavator till drilling, conventional sowing, strip till drilling and zero till drilling) as vertical strips. The treatments were replicated thrice to avoid any effect of heterogeneity and the treatments were randomly allocated as per standard procedure. The rice hybrid variety 'PHB 71' was sown and transplanted at a distance of 20x15 cm, 15x15 cm and 23x15 cm between rows and plants in various crop establishments methods with a seed rate of 18 and 15 kg/ha to establishment 1-2 seedlings/till, respectively. The nutrients were applied @ 150 kg N, 75 kg P_2O_5 and 75 kg K_2O ha^{-1}. Wheat variety HD 2824 (Poorva) was sown at a distance of 20.4 cm under Rotavator till drilling, conventional sowing, strip till drilling and zero till drilling with a seed rate of 100 kg/ha respectively. The nutrients were applied @ 120 kg N +60 kg P_2O_5 + 60 kg K_2O/ha. Pre sowing application of Glyphosat 25 EC @ 4 L/ha and Pendimethylene 30 EC @ 3.3 1/ha as pre-emergence spray were applied in zero till drill sown rice. In rest of the treatment pre-emergence application of Butachlor 50 EC @ 2.5 L/ha was applied 5 days after transplanting. In wheat, application of sulfosulfuron 30 was applied after first irrigation at 35 days after sowing. One hand weeding was done at 30 days after transplanting/sowing of rice/wheat crop. Data were recorded on weed densities in rice and wheat, nutrient content in grain and yield of rice and wheat. The equivalent yield, system nutrient uptake were calculated as per the standard procedures.

RESULTS AND DISCUSSION

Weed dynamics in rice

Lucid effect of rice establishment methods was observed on weed population and the dry weight were maximum in zero till drill sown rice followed by sowing sprouted seeds by drum seeders and it was minimum in the manual transplanting of rice (Table 1). It is pertinent to mention that sowing by zero till

Table 1: Effect of crop establishment methods in rice –wheat system on fresh and dry weight (g/m²) and density (counts/m²) of weeds

Crop establishment methods	Rice (40 DAS)					Wheat (35 DAS)				
	Grasses	Sedges	Broad leaf weed	Fresh weight	Dry weight	Grasses	Sedges	Broad leaf weed	Fresh weight	Dry weight
RICE										
Direct dry seeding by zero-till drill	3.20(11.25)	7.17(52.42)	4.04(17.33)	80.58	21.74	1.39 (2.92)	7.35(55.00)	3.17(11.08)	54.94	13.85
Direct seeding of sprouted seeds by drum seeder	3.03(10.17)	6.96(49.42)	3.25(11.58)	74.23	18.23	1.40(3.00)	7.40(55.67)	3.12(10.75)	54.08	14.10
Hand Transplanting	0.82(2.67)	4.10(17.83)	1.22(2.50)	16.75	3.67	1.40(3.00)	7.40(53.42)	3.12(10.75)	55.50	13.98
Mechanical Transplanting	1.44(3.08)	4.61(22.25)	1.39(2.92)	17.02	3.99	1.39(2.92)	7.30(54.25)	3.17(11.08)	49.40	13.59
SEm±	(0.46)	(1.76)	(0.79)	0.97	0.30	0.43	2.49	0.50	2.30	2.23
L.S.D. (P=0.05)	(1.59)	(6.10)	(2.73)	3.35	1.04	NS	NS	NS	NS	NS
WHEAT										
Rotavator till drilling	2.52(7.33)	5.85(35.25)	2.81(8.92)	47.50	11.30	0.91(1.83)	6.71(46.08)	2.29(6.25)	31.18	8.45
Conventional sowing	2.43(6.92)	5.78(34.42)	2.81(8.92)	46.77	12.06	1(2.00)	6.72(46.17)	2.65(8.00)	42.21	11.00
Strip till drilling	2.33(6.42)	6.07(37.83)	2.84(9.08)	48.95	12.74	1.79(4.17)	7.98(64.67)	3.80(15.42)	75.26	19.81
Zero till drilling	2.35(6.50)	5.78(34.42)	2.53(7.42)	45.36	11.52	1.69(3.83)	7.78(61.42)	3.60(14.00)	65.28	16.25
SEm±	(0.33)	(0.76)	(0.37)	(0.69)	0.34	0.49	1.70	0.78	3.15	1.73
CD at 5%	NS	NS	NS	NS	NS	1.69	5.87	2.69	10.91	5.98

Table 2: Effect of crop establishment methods in rice-wheat system on rice equivalent yield, system productivity and system nutrient uptake of system

Crop establishment methods	REY (q/ha)	System productivity (kg/ha/day)	System nutrient uptake (kg/ha)		
			Nitrogen	Phosphors	Potassium
Rice					
Direct dry seeding by zero-till drill	93.13	25.51	129.88	21.96	142.54
Direct seeding of sprouted seeds by drum seeder	111.74	30.61	153.55	26.18	161.93
Hand Transplanting	132.26	36.24	173.02	29.34	181.30
Mechanical Transplanting	130.11	35.65	174.53	30.58	187.37
SEm±	2.45	0.67	1.48	0.67	1.43
L.S.D. (P=0.05)	8.47	2.32	5.13	2.32	4.96
Wheat					
Rotavator till drilling	115.87	31.74	160.75	27.14	172.43
Conventional sowing	117.90	32.30	160.18	27.74	173.91
Strip till drilling	113.36	31.06	149.21	25.73	167.99
Zero till drilling	120.12	32.91	160.84	27.44	158.81
SEm±	1.84	0.50	3.44	0.84	4.43
CD at 5%	6.37	1.75	NS	NS	NS

drill was accompanied with the knocked down herbicidal treatment of glyphosate and pre-emergence application of pendimethalin and a pre-emergence spray of butachlor in drum seeding. The sowing of rice by zero till drill and drum seeder the effect was not very obvious because major flush of weeds during kharif comes after the onset of monsoon in mid July. Where as in manual and mechanical transplanting, most of the weeds were killed due to puddling operation, which was done after the onset of monsoon around mid July and the butachlor applied after the transplanting was effective in controlling the germinating grassy weeds. Similarly, the weed count was also significantly higher in zero till drill sown rice than other methods of rice establishment. A similar finding was also reported by Singh *et al*. (2006). Across all planting methods, sedge were the major and predominant weed species in the experimental plot followed by broad leaf and grass (Table 1). The population of all these weeds were maximum in zero till drill sown rice followed by drum seeding and the least in manual transplanting. The population of sedge weeds were particularly high in zero till drill sowing while the puddling operation seems to have destroyed the nuts of this weed. These results are in close conformity with the finding of Bhol and Singh (1987).

Weed dynamics in wheat

Strip till drill sown wheat recorded the highest number of weed/m^2 at 35 DAS and being at par with zero till drill, both resulted in significantly higher number of weed than rotavator as well as convention sowing at both the stage of observation (Table 1). Rotavator till drill sowing of wheat though produced less number of weed/m^2 than conventional method but the differences did not turn significant at 35 days stage. The weed infestation pattern is similar to that of rice with the highest number of weeds observed are sedge followed by broad leaf and grass weeds. The population of all the weeds together were not significantly different in any of the planting method under wheat (Table 1). The population of sedge weeds were particularly high in strip till drill sowing. Similar finding were reported by Bhardwaj *et al*. (1984).

Rice equivalent yield (REY) and system productivity

Among different methods of rice establishment, hand transplanting produced maximum of REY of the system and being at par with transplanting. The REY in hand and mechanical transplanting was significantly higher than drum seeder and zero till drill (Table. 2). Rice sowing by drum seeder also proved significantly superior to zero till drill with respect to REY. The results obtained with respect to REY do differ for system productivity. Among the different wheat establishment methods, zero till drill sowing produced maximum REY and being comparable to conventional sowing and rotovator till drill proved significantly superior to strip till drilling. The similar results were obtained for system productivity that followed the similar trend ZT > CT > RT > ST. These results are in conformity with the findings of Bohra and Kumar (2015), Sharma *et al*. (2006) and Brar *et al*. (2011).

Nutrient uptake (kg/ha) in rice-wheat cropping system

Mechanical transplanting of rice recorded maximum uptake of nitrogen, phosphorus and potassium followed by hand transplanting and sowing of rice by drum seeder; being at paramount themselves, they registered significantly higher NPK uptake than zero till drill sown rice (Table 2). Rice grown under puddle condition obtained higher grain and straw yields, accompanied with better NP content in grain and straw this resulted into higher NPK uptake compared with unpuddled condition. These results are agreement with the findings of Saini *et al*. (2011) and Singh and Khind (2015). In the case of wheat, the zero till drill sowing recorded maximum nitrogen uptake followed rotavator drill, conventional sowing and least by strip till drill sown wheat. Conventional sowing wheat recorded maximum uptake of phosphorus and potassium than other establishment methods. However, the differences failed to touch the level of significance.

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