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Improving Wheat Productivity in Rice-Wheat Cropping System through Crop Establishment Methods

Shweta* and Manu Malik

Department of Agronomy, College of Agriculture CCSHAU, Hisar

*Corresponding Author E-mail: malik.shweta54@gmail.com

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ABSTRACT

To ameliorate the ill effect of traditional rice-wheat cropping system efforts have been made to develop several resource conservation technologies. Conventional methods of wheat sowing require intensive pre-planting cultivation, which are labour, time and energy intensive. The field experiment was conducted at the experimental plot of the Crop Research Centre at Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (Udham Singh Nagar) Uttarakhand during Kharif season of 2005-06 to Rabi season of 2006-07. Maximum mean grain (4237 kg ha^{-1}) and straw (6235 kg ha^{-1}) yields of wheat were obtained from direct seeded rice plots. Nutrient uptake (NPK) by the wheat crop was highest under direct seeded rice due to rice establishment methods. Maximum mean grain (4535 kg ha^{-1}) and straw (6423 kg ha^{-1}) yields were obtained under zero till. The mean wheat grains per spikes under zero till drill wheat was 0.79, 6.93 and 4.09 per cent more than that of strip till drill, bed planted and conventional wheat, respectively. Zero till drill wheat exhibited significantly higher nutrient uptake by wheat crop than that of conventional, bed planted and strip till drill wheat.

Key words: *Rice-Wheat System, Zero Tillage, Strip Tillage, Bed Planting.*

INTRODUCTION

Rice -wheat is the most popular cropping system of India as well as of the world. In Asians sub tropic it is practiced on 24 m ha. In India the area under this rotation is about 11.0 m ha; mainly concentrated in Indo Gangatic Plains (IGP).Rice-wheat cropping system is very productive but it has fatigued natural resources resulting decline in ground water level, soil carbon stocks, and soil plant available nutrients and build up of pest and diseases[1]. Further, intensive cultivation of rice-wheat with indiscriminate use of inputs led to decline in total factor productivity, increasing energy crises and decline in farm profitability. With deteriorating resources and eroding ecological foundation, sustainability of rice-wheat system is under question. In order to ameliorate the ill effect of traditional rice-wheat cropping system efforts have been made to develop several resource conservation technologies. Zero tillage/ minimum tillage /reduced pre-planting tillage, farm irrigated raised bed system, surface seeding, drip irrigation, crop residue management are few examples of resource conservation techniques.

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Conventional methods of wheat sowing require intensive pre-planting cultivation, which are labour, time and energy intensive. To make this practice, easier and cost effective, several crop establishment methods viz ,zero till drill, roto drilling strip till drill and surface seeding wheat etc. have been developed[5]. Zero tillage with rice stables retention may improve the soil physico-chemical condition by improving the organic matter in the soil[2]. Thus keeping above points in view, the present investigation was under taken.

MATERIALS AND METHODS

The field experiment was conducted at the experimental plot of the Crop Research Centre at Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (Udham Singh Nagar) Uttarakhand during Kharif season of 2005-06 to Rabi season of 2006-07. The soil was sandy loam (sand, silt and clay contents of 50.4, 33.2 and 16.4 per cent, respectively), having pH, organic carbon and available NPK of 7.8, 0.67% and 263.4, 27.8, 246.4 kgha^{-1}, respectively. The treatment consisting of 4 rice establishment methods (direct seeding, wet sprouted rice, hand transplanting and machine transplanting) in main strip and 4 wheat establishment methods (Conventional, bed planted, strip tilll drill ad zero till drill) in sub-strip were replicated thrice in strip plot design. The rice variety Narendra-359 was sown on main strips with recommended dose of fertilizers. The wheat variety PBW-343 was sown on 20and 22 November in 2005 and 2006, respectively. Wheat crop was fertilized by 150 kg N /ha through urea, 60 kg P_2O_5 /ha through SSP and 40 kg K_2O /ha through murate of potash. Full dose of P_2O_5 and K_2O and $^1/_3$ dose of N were applied basal and remaining N was Ist top dressed after one month of sowing and II nd top dressed after one month of Ist top dressing. Need – based irrigation and plant protection measures were given.

RESULTS AND DISCUSSIONS

Effect of rice establishment method on wheat:

Growth and Yield attributes: Direct seeded rice produced significantly higher spike length compared to wet seeded rice, hand transplanted and machine transplanted rice and grain per spikes than to hand transplanted and machine transplanted rice during 2006-07. However, different rice establishment methods remained statically at par in growth and yield attributing characters (Table 1). The better growth parameters and yield attributes of wheat on plots following direct seeded rice were attributed to its effect on providing ideal seed bed for wheat sowing, which resulted in better growth of crop. Similar results were also reported by Singh *et al*[3].

Yield: Different rice establishment methods adopted in preceding rice did not affect wheat yield in any year. However, maximum mean grain (4237 kg ha^{-1}) and straw (6235 kg ha^{-1}) yields of wheat were obtained from direct seeded rice plots (Table2). This was mainly due to more effective ears m^{-2} and 1000- grain weight. Tripathi *et al*[4]., also reported similar results.

Nutrient uptake: Nutrient uptake (NPK) by the wheat crop was highest under direct seeded rice due to rice establishment methods. During 2005-06, uptake of N and P by grain was statistically at par in each establishment methods. However, K uptake significantly higher under direct seeded rice. During 2006-07, nutrient (NPK) uptake by grain was significantly higher in direct seeded rice than that of other methods. Nitrogen and phosphorus uptake by wheat straw due to rice establishment methods were significant only during 2005-06 and potassium uptake was non- significant during both years. Nitrogen and phosphorus uptake by wheat straw after direct seeded rice being at par with wet sprouted rice exhibited significantly higher than that of hand and machine transplanted rice.

Effect of wheat establishment methods on wheat:

Growth and yield attributes: The zero till drilling being produced significantly longer spikes and higher 1000- grain weight than that of other wheat establishment methods. The variations in spike length under conventional and bed planting wheat were non- significant. However, wheat establishment methods did not significantly affect number of spikes m^{-2}

and number of grains per spikes during both years. The mean wheat grains per spikes under zero till drill wheat was 0.79, 6.93 and 4.09 per cent more than that of strip till drill, bed planted and conventional wheat, respectively. The average thousand grain weight was 3.84, 9.34 and 5.35 per cent higher in zero till drill wheat (Table 1). The better crop growth under zero till wheat might be due to favorable soil condition viz. soil bulk density, infiltration rate and deeper root system than conventional system. The higher yield attributes in zero till drill wheat may be due to the fact that zero till wheat crop removed more nutrient uptake. These results collaborates the findings of Singh *et al*[3]., who also noted yield attributes higher in zero till wheat crop.

Yield: The yield of wheat was influenced significantly due to different wheat establishment methods during both years. Maximum mean grain (4535 kg ha^{-1}) and straw (6423 kg ha^{-1}) yields were obtained under zero till drilling that were significantly higher than that the rest of methods. The quantum increase in zero till drill wheat was 12.24, 25.97 and 15.98 per cent over strip till drill, bed planted and conventional wheat during 2005-06, respectively. The respective increase during 2006-07, was 10.09, 13.49 and 11.51 per cent (Table 2). The marked increase in grain yield in above treatment may be owing to over all improvement in yield attributes.

Nutrient uptake: Nitrogen uptake by wheat was influenced significantly due to different wheat establishment methods during both years. Zero till drill wheat exhibited significantly higher nitrogen uptake by wheat grain than that of other methods. During 2005-06 nitrogen uptake by wheat straw was significantly higher in zero till drill wheat than other methods (Table 3). However, during 2006-07 nitrogen uptake by wheat straw was significantly more under conventional wheat than that of other methods. Phosphorus uptake by wheat was influenced significantly during 2005-06 only. Phosphorus uptake by wheat grain was significantly higher under zero till drill than bed planted wheat, being at par with strip till drill and conventional wheat. During 2006-07 potassium uptake by wheat grain was affected significantly and under conventional wheat significantly higher potassium uptake than that of bed planted, strip till drill and zero till drill wheat. However, potassium uptake by straw during both years was non-significant.

Table 1: Effect of rice and wheat establishment methods on yield attributes of wheat crop in rice-wheat cropping system

Establishment Methods	Tiller m^{-2}		Spike length		No of spike/m^2		No of grain/spike		1000-grain wt.	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Rice										
Direct seeded rice	432	426	8.6	9.8	421	617	49.9	52.2	43.0	43.6
Sprouted rice	417	416	8.5	9.6	407	616	49.3	51.1	40.5	42.5
Hand transplanting	412	407	8.4	9.6	400	601	47.3	50.2	39.9	41.6
Machine transplanting	385	400	8.3	9.2	375	587	45.6	49.6	38.8	41.2
S.Em±	41	24	0.26	0.04	40	34	1.32	0.40	1.8	0.3
C.D. (5%)	NS	NS	NS	0.15	NS	NS	NS	1.4	NS	0.9
Wheat										
Conventional	401	397	8.67	9.3	392	589	47.3	50.4	40.5	39.8
Bed planting	393	389	8.28	9.0	380	572	45.9	49.3	39.4	41.6
Strip till drill	402	418	8.71	9.6	395	626	49.4	51.5	40.6	42.7
Zero till drill	450	445	8.73	10.1	438	637	49.9	51.9	41.6	45.0
S.Em±	18	29	0.20	0.13	18.7	23.1	1.40	0.84	1.3	0.5
C.D. (5%)	NS	NS	NS	0.45	NS	NS	NS	NS	NS	1.6

Table 2: Effect of rice and wheat establishment methods on grain yield, and straw yield of wheat crop in rice-wheat cropping system

Establishment methods	Grain Yield			Straw yield		
	2005-06	2006-07	Mean	2005-06	2006-07	Mean
Rice						
Direct seeded rice	3408	5065	**4237**	5075	7394	**6235**
Sprouted rice	3384	4979	**4182**	4875	7202	**6039**
Hand transplanting	3375	4885	**4130**	4816	6888	**5852**
Machine transplanting	3154	4576	**3865**	4650	6589	**5620**
S.Em±	91	125	-	114	187	-
C.D. (5%)	NS	NS	-	NS	NS	-
Wheat						
Conventional	3175	4745	**3960**	4650	6817	**5733**
Bed planting	3000	4662	**3831**	4467	6692	**5580**
Strip till drill	3367	4806	**4087**	4992	7026	**6009**
Zero till drill	3779	5291	**4535**	5308	7538	**6423**
S.Em±	109	62.0	-	114	117	-
C.D. (5%)	381	217	-	499	405	-

Table 3: Nutrient uptake (Kg/ha) under different rice- wheat establishment methods after each cycle of a rice-wheat cropping system

Establishment Methods	Grain						Straw					
	2005-06			2006-07			2005-06			2006-07		
	N	P_2O_5	K_2o	N	P_2O_5	K_2o	N	P_2O_5	K_2o	N	P_2O_5	K_2o
Rice												
Direct seeded rice	66.8	9.4	20.9	93.3	15.8	29.1	20.6	3.1	81.2	27.8	3.9	120.2
Sprouted rice	66.3	9.3	20.4	91.04	14.3	27.9	19.8	2.9	77.9	26.1	3.6	116.9
Hand transplanting	65.7	9.1	20.0	88.5	13.8	27.1	19.2	2.7	76.7	24.7	3.1	111.6
Machine transplanting	61.1	8.4	18.5	82.8	12.8	25.2	18.2	2.5	73.9	25.1	4.8	106.3
S.Em.±	1.8	0.2	0.5	2.1	0.6	0.68	0.4	0.1	1.80	0.8	1.0	3.0
C.D. (5%)	NS	NS	1.7	7.4	1.9	2.33	1.6	0.3	NS	NS	NS	NS
Wheat												
Conventional	65.1	9.2	21.0	91.0	14.7	29.7	20.3	3.1	76.7	29.2	3.9	113.0
Bed planting	57.8	8.2	18.6	84.6	13.5	26.8	17.6	2.8	73.4	23.5	3.2	109.8
Strip till drill	64.6	9.0	19.5	86.0	13.6	26.6	19.5	2.7	78.1	24.8	3.1	113.9
Zero till drill	72.3	9.8	20.7	99.3	14.9	26.1	22.4	2.6	81.4	26.1	5.1	118.4
S.Em.±	2.2	0.3	0.7	1.3	0.7	0.4	0 .5	0.1	2.2	0.5	1.0	2.0
C.D. (5%)	7.5	1.0	NS	4.4	NS	1.43	1.7	0.3	NS	1.8	NS	NS

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