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INFLUENCE OF VARIOUS CROP ESTABLISHMENT METHODS ON YIELD AND NUTRIENT UPTAKE OF WHEAT (*TRITICUM AESTIVUM* L.) IN RICE-WHEAT CROPPING SYSTEM

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Abstract

A field experiment was conducted to find out the effect of different crop establishment methods on wheat in rice-wheat cropping system. Conventional till rice (Puddled transplanted) followed by Zero-till wheat recorded highest value of nutrient content, nutrient removal, grain and straw yield. So zero till wheat after conventional till puddle transplanted rice can be more efficient and profitable alternatives to current practice.

In India rice-wheat is the most commonly employed cropping system on around 13.5 million ha of land extending across the Indo-Gangetic Plain (IGP). The major challenge facing the rice-wheat cropping system is to sustain long-term productivity.

This system has immense importance in the food security and livelihoods of millions of farmers and workers of populous countries such as India. However, sowing of wheat particularly in rice-wheat system is often delayed due to late harvesting of rice and long turn-around time for wheat sowing.

Under this critical situation, it becomes obligatory to focus on aim oriented research to lift the rice and wheat yields to fulfil large gaps between biologically and climatically achievable potential yield. In this context several resource-conserving technologies (RCTs) such as zero tillage (ZT), reduced tillage (RT) and unpuddled transplanting have been found to be beneficial in terms of improving soil health, water use, crop productivity and farmer's income (Gupta and Seth 2007, Singh *et al*. 2009). Due to rising cost of labour, escalating fuel prices and excessive water use in puddling for transplanting rice in the irrigated eco-systems, DSR is gaining popularity in south-east Asia (Balasubramanian and Hill 2002). Combining precision land-levelling, ZT and drill seeding wheat leaving crop residues on the soil surface quadrupled farmers' income, mainly due to higher yields resulting from timely planting and reduced tillage cost (Jat *et al*. 2011). Thus, the experiment was conducted with the objectives to evaluate eco-friendly, energy-effective and economic rice-wheat establishment options for long-term production sustainability.

The field experiment was carried out during *kharif* and *rabi* season of 2013-2014 at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India.

The experiment was laid out in a randomized complete block design consisting of 8 treatments replicated thrice: Conventional tilled rice (puddled transplanted) in *kharif* **-** conventional tilled wheat (broadcasted-tilled) (CE_1), conventional tilled rice (puddled transplanted) in *kharif* **-** reduced till wheat (sown by seed cum fertilizer drill after two tillage by

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cultivator followed by planting) in *rabi* (CE_2), conventional till rice (Puddled transplanted) in *kharif* **-** zero-till wheat (sown by single pass of tractor attached with zero till and seed cum fertilizer drill) in *rabi* (CE_3), reduced till direct seeded rice (sowing was done by zero-till-drill machine after two tillage operation by cultivator) in *kharif* **-** reduced till wheat in *rabi* (CE_4), reduced till direct seeded rice in *kharif* **-** zero-till wheat in *rabi* (CE_5), zero-till direct seeded rice (primary tillage is completely avoided and sowing was done by zero-till- seed cum-fertilizer drill) in *kharif* **-** reduced till wheat in *rabi* (CE_6), zero-till direct seeded rice in *kharif* **-** zero-till wheat (without residue) in *rabi* (CE_7), zero-till direct seeded rice in *kharif* **-** zero-till wheat (with residue) in *rabi* (CE_8). Rice was harvested manually after leaving 30 cm anchored crop stubbles in all plots except treatment CE_7 and wheat sowing was done in standing rice stubbles. The nutrients were applied at 150 kg N, 60 kg P_2O_5 and 60 kg K_2O/ha in rice and 150 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha in wheat. Half of nitrogen and full doses of phosphorus and potassium were applied as basal at the time of sowing/transplanting. Remaining nitrogen was applied in two equal splits as top dressing at tillering and panicle initiation stage in rice and at CRI and ear emergence stages in wheat. Other crop management practices followed as per the recommendation of area. Five plants of each experimental plot were selected randomly and tagged from sampling area. Crop response to the treatments was measured in terms of various qualitative and quantitative indices. The plant samples (grain and straw) ware collected per treatment at harvest. Samples were ground after drying in an oven at 65 ± 5^{o}C for 48 hrs. The ground plant material was passed through a 30 mesh sieve and used for determination N, P and K concentration.

Significantly highest content and uptake of nutrients in the wheat grain and straw was recorded with zero till wheat after conventional tilled puddle transplanted rice (CE_3). However, it remained statistically at par with zero till wheat after reduced till DSR (CE_5). It is also evident from data that zero till drill sown wheat (without residue) after zero till DSR (CE_7) recorded minimum content and uptake of nutrients (Table 1). Nutrient uptake/removal by plants is dynamic in nature and is affected by different factors like climate, soil properties, amount and method of fertilizer application and cultural practices adopted (De Datta 1981). In CE_3 system, more root proliferation in upper soil profile enhanced the removal of N, P, and K from soil for further translocation and utilization by plants which led to increased concentration of these elements in grain and straw of the crop.

Table 1. Effect of different treatments on total nutrient content (%) and its removal (kg/ha) by wheat.

Treatments	Nitrogen	Phosphorus	Potassium
CE_1	73.87	14.54	73.91
CE_2	75.05	14.80	74.63
CE_3	80.82	16.06	78.75
CE_4	67.90	13.25	69.62
CE_5	76.75	15.12	76.86
CE_6	72.00	14.13	72.97
CE_7	62.87	12.26	64.65
CE_8	70.82	13.83	72.03
SEm±	0.98	0.21	1.46
C.D.(P=0.05)	2.88	0.61	4.27

Significantly highest earhead length (cm), earhead weight (g) and number of grains /earhead were recorded with zero till wheat after conventional tilled puddle transplanted rice (CE_3) followed by zero till wheat after reduced till DSR (CE_5) but remained statistically at par with reduced till wheat after conventional tilled puddle transplanted rice (CE_2) (Table 2). Yield attributes are the resultant effect of the vegetative development of the plant. Adequate availability and translocation of nutrients under zero tillage produces healthy plants with higher earhead length and more spikelets and grains per earhead (Tripathi and Chauhan 2001).

Table 2. Effect of crop establishment on yield and yield attributes of wheat.

Treatments	Earhead length (cm)	Earhead weight (g)	Number of grains/ earhead	Test weight (g)	Grain yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)	Harvest index (%)
CE_1	12.49	3.09	47.78	42.93	33.63	47.71	81.34	41.36
CE_2	13.42	3.16	48.10	43.07	34.00	48.09	82.10	41.40
CE_3	16.27	3.33	51.47	43.30	36.47	53.67	90.13	40.49
CE_4	11.09	2.92	44.10	42.18	31.09	45.49	76.58	40.60
CE_5	13.52	3.23	49.00	43.28	34.31	49.72	84.03	40.82
CE_6	11.85	2.98	47.32	42.70	32.76	47.42	80.18	40.89
CE_7	10.48	2.89	43.12	42.17	28.95	42.29	71.24	40.66
CE_8)	11.21	2.97	46.17	43.68	32.40	46.85	79.25	40.92
SEm±	0.66	0.02	0.63	0.46	0.62	1.21	1.21	0.82
C.D. (p = 0.05)	1.93	0.07	1.85	NS	1.81	3.55	3.54	NS

Marked variation in the grain, straw and biological yield of wheat was observed due to different crop establishment methods. Significantly highest grain yield (36.47 q/ha), straw yield (53.67 q/ha) and biological yield (90.13 q/ha) was recorded in zero till drill sown wheat after conventional tilled puddle transplanted rice (CE_3) followed by zero till direct seeded rice in *kharif* **-** zero-till wheat in *rabi* (CE_5) (Table 2). The lowest grain yield (28.95 q/ha) was observed in zero till wheat (without residue) after zero till DSR (CE_7).

Crop establishment methods fail to cause any significant variation in harvest index. CE_3 registered 25.98% higher grain yield over CE_7. The higher yield under CE_3 could be attributed to better performance of the crop through optimum utilization of resources which had direct bearing on the production of grain. Poor performance under zero till wheat (without residue) after zero till DSR (CE_7) was due to poor plant stand and excessively higher competition with weeds.

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