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Effect of Paddy Residue Management Techniques on Proceeding Wheat Crop under Rice-Wheat System

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Abstract

A field experiment was conducted on wheat crop at farmer's field in district Gurdaspur, Punjab during rabi seasons (2019-20 and 2020-21) after harvesting of paddy crop. The site of experiment was located at 31.96 ^{0}N, 75.23 ^{0}E and at an altitude of 265 m. The field experiment was laid out in strip plot design having seven treatments and two varities replicated thrice. The treatments include M1: Stubble Shaver+ Burning + Zero Tillage Drill; M2: PAU cutter cum spreader + PAU happy Seeder with press wheel; M3: PAU cutter cum spreader +straw decomposer + PAU happy Seeder with press wheel; M4: PAU cutter cum spreader + incorporation with Mould Bold plough + Use of Seed drill; M5: Super Straw management system + Chopper +incorporation + Use of conventional Seed Dril; M6: Straw removal (Manual) + Zero Tillage Drill; M7: Straw removal (Manual) + through tillage + Use of conventional Seed Drill with varities HD 3086 (V1) and PBW 550 (V2). The results indicated that during 2020-21 highest plant height (95.2 cm) in variety HD 3086 was under M2; however 99.4 cm plant height was observed for variety PB550 in M4. Highest number of tillers was achieved by using the PAU cutter cum spreader + PAU happy seeder with press wheel" (M2) to cultivate wheat variety based on pooled data of both varieties. While variety wise, HD 3086 exhibited better response in when cultivated by M3 method compared to M2 in PBW 550 Unnat. Pooled data analysis of grain yield for two years under studies showed highest grain yield for M2 method of residue management followed by M3 with 48.8 and 47.5 q ha^{-1} grain yields respectively. Interaction between varieties and methods was non-significant with respect to grain yield.

***Key words** : Happy seeder, grain yield, varieties, wheat*

Introduction

Rice-wheat cropping system has been developed through the introduction of rice in the traditional wheat-growing areas and vice versa in India. However, the productivity of rice and wheat has deteriorated and declined owed to climate change and abridged soil productivity, affectation a serious threat to the sustainability of the rice-wheat cropping system (1). Low levels of soil organic matter, over mining from soil sand burning of crop residues, are some of the major reasons for declining rice-wheat productivity in the region (2). Green Revolution technologies led to the emergence of Rice-Wheat as the major production system covering an area of 29 lakh and 35 lakh hectares in Punjab respectively is called the "food bowl of India. A number of problems have cropped up in the region with the spread of the rice-wheat system for the last four decades and threatening the sustainability of the system. Interestingly, for rice establishment various methods viz., traditional transplanting, mechanical transplanting, system of rice intensification, drum seeding, wet direct seeding (broadcasting) and dry direct sowing (multi-crop planter) etc., are available in India (3). The farmers resort to burning of rice straw as the window between harvesting of paddy and sowing of wheat is of just 2-3 weeks which does not allow for time consuming operations of clearing paddy straw from the fields. The equipment and the process of cutting and ploughing back or collecting and transporting straw involves huge cost beyond the reach of small and marginal farmers. Therefore, the major challenge currently to the state is to enhance the productivity and profitability of crops while effectively handling the problem of agricultural biomass residue or crop residue burning. Besides recently released early maturing varieties of paddy (PR121, PR126 and PR127) there is also the availability of alternate technologies like happy seeder, super seeder and smart seeder to stop farmers from burning residues and which does not even increase field preparation costs or alter crop yields

Happy Seeder offers the means of drilling wheat into rice stubble without burning, eliminating air pollution and loss of nutrients and organic carbon due to burning, at the same time as maintaining or increasing the yield. Eco-friendly technology will prove a boon to the farming community and the state by providing them a tool for improving soil health and environment for sustainable agriculture (4, 5, 6). Yield trends and farmers' response showed that wheat yields were either similar or higher than the conventionally sown wheat. The residue on the soil surface reduces evaporative losses, retains the soil moisture and temperature, as well as canopy temperature

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Table-1 : Plant height and number of tillers in wheat under different treatments.

Treatments	Plant height (cm)		Tillers m^{-2}	
	2019-20	2020-21	2019-20	2020-21
Stubble Shaver+Burning (M1) + Zero Tillage Drill	95.6	87.1	375.5	362.7
PAU cutter cum spreader (M2) + PAU happy Seeder with press wheel	94.2	96.0	434.5	440.9
PAU cutter cum spreader + straw decomposer (M3)+ PAU happy Seeder with press wheal	93.7	95.0	447.0	407.8
PAU cutter cum spreader + incorporation with Mould Bold plough(M4) + Use of Seed drill	95.3	95.9	387.3	382.5
Super Straw management system + Chopper + incorporation (M5) + Use of conventional Seed Drill	95.3	93.3	401.3	351.5
Straw removal (Manual) (M6) + Zero Tillage Drill	94.4	90.0	360.6	350.7
Straw removal (Manual) + thorough tillage (M7) + Use of conventional drill	94.3	90.8	377.9	374.7
CD at 5%	NS	2.6	14.4	19.9

Table-2 : Wheat yield and yield contributing characters under different treatments.

Treatments	Grains $spike^{-1}$		Test weight (g)		Grain yield (q ha^{-1})	
	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
Stubble Shaver+Burning (M1) + Zero Tillage Drill	15.6	15.9	38.7	34.2	44.8	44.7
PAU cutter cum spreader (M2) + PAU happy Seeder with press wheel	17.6	19.1	44.2	43.3	48.2	48.8
PAU cutter cum spreader + straw decomposer(M3)+ PAU happy Seeder with press wheal	17.2	16.8	44.8	44.7	47.3	47.5
PAU cutter cum spreader + incorporation with Mould Bold plough(M4) + Use of Seed drill	16.4	15.1	43.0	39.5	46.5	44.8
Super Straw management system + Chopper + incorporation (M5) + Use of conventional Seed Drill	16.0	15.8	41.2	35.0	44.2	43.7
Straw removal(Manual) (M6) + Zero Tillage Drill	14.7	14.6	34.7	38.7	42.0	43.3
Straw removal (Manual) + thorough tillage (M7) + Use of conventional drill	14.9	15.7	36.8	39.7	42.3	42.2
CD at 5%	0.8	1.1	2.1	3.3	2.6	2.4

(7). Comparative economics were better when wheat was sown with Happy Seeder as HST brought about improvement in physical condition of soil and improvement. Use of HST also reduced the terminal heat stress and saved on pre-sowing irrigation leading to reduction in time taken for first and second irrigation (6). Findings reveal that, sowing of wheat with Happy Seeder could save time 4.31 hrs and 2250 ha^{-1} over the rotavator and, fuel 16.03 liters diesel, time 5.38 hrs and `3250 ha^{-1} over the farmers? practice (8). Use of happy seeder also reduced the terminal heat stress and saved on pre-sowing irrigation leading to reduction in time taken for first and second irrigation. The average wheat yield was 4.58 and 4.46 t ha^{-1} for Happy Seeder and conventional wheat plots, respectively (9). The results of study show revealed that this technology could save about 1000-1060 ha^{-1} (or USD 23) on average in field preparation costs compared to plots that were conventionally tilled. Study also pointed out that farmers enjoy substantial time savings because the Happy Seeder could be brought into the field immediately after the rice harvest (10). Comparative economics were better when wheat was sown with Happy Seeder as HST brought about improvement in physical condition of soil and improvement. Use of HST also reduced the terminal heat stress and saved on pre-sowing irrigation leading to reduction in time taken for first and second irrigation. Happy Seeder was the most efficient method to reduce the cost of production and manages the combine harvested paddy straw and ultimately improves the soil productivity. Comparative economics were better when wheat was sown with Happy Seeder brought about improvement in physical condition of soil and improvement.

Materials and Methods

A field experiment was conducted on wheat crop at farmer's field in district Gurdaspur, Punjab during rabi seasons (2019-20 and 2020-21) after harvesting of paddy crop. The site of experiment was located at 31.96 ^{0}N, 75.23 ^{0}E and at an altitude of 265 m. The field experiment was laid out in strip plot design having seven treatments and two varieties replicated thrice. The treatments include M1: Stubble Shaver + Burning + Zero Tillage Drill; M2: PAU cutter cum spreader+PAU happy Seeder with press wheel; M3: PAU cutter cum spreader + straw decomposer + PAU happy Seeder with press wheel; M4: PAU cutter cum spreader +incorporation with Mould Bold plough + Use of Seed drill; M5: Super Straw management system +

Table-3 : Wheat yield and B:C ratio.

Treatments	Grain yield (q/ha)	MSP (Rs.)	Gross return	Net return	B:C
Stubble Shaver + Burning (M1) + Zero Tillage Drill	44.7	1975	88283	34813	1.54
PAU cutter cum spreader (M2) + PAU happy Seeder with press wheel	48.5	1975	95788	35250	1.72
PAU cutter cum spreader + straw decomposer(M3) + PAU happy Seeder with press wheal	47.4	1975	93615	35063	1.67
PAU cutter cum spreader + incorporation with Mould Bold plough(M4) + Use of Seed drill	45.7	1975	90258	42813	1.11
Super Straw management system + Chopper + incorporation (M5) + Use of conventional Seed Drill	43.9	1975	86703	41563	1.09
Straw removal (Manual) (M6) + Zero Tillage Drill	42.7	1975	84333	37313	1.26
Straw removal (Manual) + thorough tillage (M7) + Use of conventional drill	42.2	1975	83345	41813	0.99

Chopper + incorporation + Use of conventional Seed Dril; M6: Straw removal (Manual) + Zero Tillage Drill; M7: Straw removal (Manual) + through tillage + Use of conventional Seed Drill with varities HD 3086 (V1) and PBW 550 (V2).

Results and Discussion

Plant **height :** Plant height (96 cm) was the highest for M2 and also statistically at par with M3 and M4. The least plant height (87.1 cm) was observed in M1 during 2020-21 (Table-1). In 2019-20 there was no significant difference found among the treatments. Similar results were also reported (11) that plant height of wheat did not vary due to planting methods.

Tillers per meter square : M2 and M3 were statistically at par with with respect to tillers followed by all other treatments during the year 2020-21. Highest number of tillers per square meter (440.4) was recorded followed by M3 with 407.78 tillers. However lowest tiller number was recorded in M1 for both year. It was found that highest number of tillers was recoreded by happy seeder zero tillage (213 and 282.36 m^{-2}) as compared to conventional method i.e. an average yield increase of about 10% from sowing with the HS compared with farmer practice (12).

Pooled data analysis of grain yield for two years under studies showed highest grain yield in M2 method of residue management followed by M3 with 48.8 and 47.5 q ha^{-1} yields respectively. Interaction between varieties and methods was non-significant with respect to grain yield. Similar results were also reported by (13) found an average yield increase of about 10% from sowing with the happy seeder compared with farmer practice.

Spikelets per spike : Higher number of grains per spike could be achieved by using the methodology PAU cutter cum spreader + PAU happy Seeder with press wheal (M2) followed by PAU cutter cum spreader + straw decomposer (M3) + PAU happy Seeder with press wheal to cultivate wheat variety based on pooled data of both varieties HD 3086 and PBW 550 Unnat.

Test Weight : During both years (2019-20 and 2020-21), varieties showed statistically similar test weight under pooled data of all the methods of residue management with no significant differences variety wise (Table-2). Similar results were also reported by (12, 14) that 1000 grain weight was higher with happy seeder than the other methods of wheat sowing i.e. 43 g.

Grain yield q/ha : Pooled data analysis of grain yield for two years under studies showed highest grain yield in M2 method of residue management followed by M3 with 48.8 and 47.5 q ha^{-1} yields respectively. Interaction between varieties and methods was non-significant with respect to grain yield. Similar results were also reported by (13) found an average yield increase of about 10% from sowing with the happy seeder compared with farmer practice.

Economic analysis : The economic analysis of all treatments with wheat sowing by various machines was carried out and as shown in table-3. In economics calculations, for the sowing machines, sprayers, straw management machinery, tillage implements and harvesting machinery fixed and variable costs were included. The cost of diesel, fertilizers and weedicides, labour, irrigation and harvesting were also included. Benefit from yield and straw were also calculated. The benefit cost ratio was worked out for all the practices and it was highest for M2 (1:72) followed by M3 (1.67). The benefit cost ratio was minimum for M7 (0.99).

Conclusions

From the above discussion, it could be concluded that Happy Seeder entails substantial time savings for the farmers because it can be brought into the field immediately into standing rice harvest stubbles. These savings are significant to the farmers because any delay in planting wheat affects its productivity. Happy Seeder also saved human and machine labour thereby solved the problem of human and machine labour shortage during sowing season. Further farmers reliance on weed control measures decrease with usage of Happy Seeder as the stubbles suppresses weeds growth in field. Thus, paddy residues help in reducing use of weedicides and makes farming more economical and eco-friendly. Surface retention of rice straw also helped in recycling of plant nutrients that otherwise are lost during burning. The Happy Seeder technology was less expensive to use than conventional tillage and does not have a negative impact on profitability.

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