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RESEARCH ARTICLE

HAPPY SEEDER AND ROTAVATOR TECHNOLOGY FOR *IN-SITU* MANAGEMENT OF PADDY STRAW

Avtar Singh, Maninder Kaur, J. S.Kang and Ashu Geol
Department of Agronomy, Punjab Agricultural University, Ludhiana-141 004

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Abstract

In the four district of Jalandhar, Kapurthala, Patiala and Fatehgarh Sahib on farm trials were conducted to accelerate the technology of happy seeder and rotavator for sowing of wheat in the combine harvested fields for *in-situ* management of paddy straw during 2009-10. Data recorded on grain and straw yield of rice from the field of selected farmers to know the average straw yield during *kharif* of 2009. It was about 10.0, 9.6, 9.4 and 8.1 tha^{-1} in Fatehgarh Sahib, Patiala, Kapurthala and Jalandhar, respectively. Generally farmers follow the practice of paddy straw burning to vacant the fields for sowing of wheat with conventional tillage and lost with this method an average of 33.66 $kgha^{-1}$ available nitrogen, 7.48 $kgha^{-1}$ available phosphorous and 65.85 $kgha^{-1}$available potassium. With the recycling of paddy straw by the adoption of happy seeder and rotavator technology for sowing wheat add the nutrients remained in the paddy straw and helps to improve the soil health. The results of this study indicated that the happy seeder (zero tillage) and rotavator (reduced tillage) produced same or slightly higher grain yield as compared to farmer's practice, and found to be the suitable methods for *in-situ* management of paddy straw. However, happy seeder is the most efficient method to reduce the cost of production and manages the combine harvested paddy straw and ultimately improves the soil productivity. Therefore, the farmers are advised to adopt the happy seeder technology for sowing wheat in the combine harvested fields for *in-situ* management of paddy straw and also for higher profit.

Introduction

Although the several benefits of the crop residues, most of the crop residues are removed and/or burnt. The residue burning is widely practiced, which is not acceptable for sustainable agriculture particularly in intensively cultivated irrigated system (Singh et al., 2012). In the Indo-Gangetic plains of India, the rice-wheat system is producing about 192 million tones of residue, out of this approximately 84 million tones of wheat straw is mostly used as wheat *bhusa* for feeding of livestock. However, remaining paddy straw is mostly burnt, which is huge loss of nutrients and also cause environmental pollution.

Burning of straw causes environmental pollution leading to many diseases. Burning also produces CO_2, which creates Green House Effect by producing the 17.23 million tones of CO_2 during the short span of 15-20 days (1 kg of paddy straw on burning produces about 1.46 kg CO_2). The Green House Effect disturbs the natural climate of the planet. In addition, burning also decreases the efficiency of some herbicides used for controlling weeds in wheat crop (Singh et al., 2012). Agriculture sector emitted 371.68 million tons of CO2 -equivalent, of which 13.76 million tons is and 0.15million tons is N_2O. The major sources in the agricultural sector are enteric fermentation (57.06%), rice cultivation (22.66%), agricultural soils (17.41%), livestock manure management (0.66%) and burning of crop residues on the fields (2.21%). The crop production sector (manure management, rice cultivation, soil and field burning of crop residues), thus contributes CO_2 42.94%, CH_4 27.02 % and N_2O 100 % to the total emissions from agriculture (INCCA, 2010). The wheat straw can be used as animal fodder but the management of paddy

decomposition of paddy straw delays the sowing of wheat. The delay of sowing wheat after 15 November results in yield losses of 1 % per day (Brar et al., 2010). To solve the problem of burning of paddy straw and late sowing of wheat, a machine called Happy seeder has been developed for in-situ management of paddy straw (Sidhu et al., 2007). Another machine rotavator was also popularized by the Department of Agriculture, Government of Punjab for management of paddy straw. But Punjab Agricultural University had not recommended due to some problems related to soil. The happy seeder machine is recommended in Punjab for sowing of wheat in combine harvested field of rice. This study was planned to evaluate the happy seeder, rotavator for sowing of wheat in combined harvested fields in comparison with farmer's practice (Conventional tillage) by conducting the on farm trials during 2009-10.

MATERIALS AND METHODS

On farm trials 10 were conducted in each district of Jalandhar, Kapurthala, Patiala and Fatehgarh Sahib to accelerate technology of happy seeder and rotavator for sowing of wheat in the combine harvested fields for *in-situ* management of paddy straw during 2009-10. Data recorded on grain and straw yield of rice from the field of selected farmers to know the average straw yield during *kharif* of 2009. All the sites in Kapurthala, Jallandhar, Fatehgarh Sahib had the soil texture loamy sand except one location in Fatehgarh Sahib. However, in Patiala, all the locations showed the soil texture sandy loam. Soil of all the locations of the four districts is low in available nitrogen, medium in available potassium, however, in Kapurthala five sites medium and five high in available phosphorus, in Jallandhar, all were in high available phosphorus except one was medium and in Fatehgarh Sahib and Patiala soil at all the sites was high in available phosphorus. Happy seeder and rotavator machines were used for sowing of wheat in combine harvested paddy fields without any straw burning or removal of paddy straw. Happy seeder and rotavator machines were used for sowing of wheat in combine harvested paddy fields without any straw burning or removal of paddy straw. The loose straw was uniformly distributed in the field before sowing wheat with happy seeder. In case of sowing with rotavator, one time it was used in the combine harvested paddy fields to incorporate the paddy straw and second time it was used to mix the broadcasted seed of wheat in the soil. The inputs like one quintal urea and herbicide (Total 75 WP, 16 gm/acre) were supplied as an incentive to the selected farmers. Before sowing the demonstration plots, soil samples were taken from 0-15 cm soil depth to examine the texture of the soil. The performance of wheat sown with happy seeder and rotavator was compared with farmer practice followed for sowing of wheat. The observations such as plant height, tillers per plant, and tillers per meter square, ear length, grain and straw yield were recorded from the demonstration fields to compare the performance of wheat sown with happy seeder, rotavator and farmer's practice. One acre area was sown with each of happy seeder, rotavator and farmer's practice at 10 farmer's field in the each district of Jalandhar, Kapurthala, Fatehgarh Sahib and Patiala. Soil samples for physical and chemical analysis from 0-15 cm were collected from the demonstration sites. The samples were sun dried first then oven dried at 62±5° C for 24 hours. The data pertaining to soil physical and chemical properties was depicted in table 1 and 2.

Table1: Soil status of fields of on farm trials in different district before sowing

Kapurthala					Jallandhar				
Name of farmer and village	**Soil texture**	**N (kgha^{-1})**	**P (kgha^{-1})**	**K (kgha^{-1})**	**Name of farmer and village**	**Soil texture**	**N (kgha^{-1})**	**P (kgha^{-1})**	**K (kgha^{-1})**
Harjinder Singh, Kohliwal Navan	Loamy Sand	154.1	15.4	130.0	Raman Kumar, Akkalpur	Loamy Sand	131.5	44.8	192.4
Surinder Singh, Kohliwal Navan	Loamy Sand	142.1	20.4	130.5	Satpal Singh, Nahal	Loamy Sand	109.0	33.6	167.2
Viranpreet Singh, Kohliwal Navan	Loamy Sand	165.2	16.2	125.0	Arwind Kaur, Kartarpur	Loamy Sand	94.9	26.9	170.8
Hardeep Singh, Kohliwal Navan	Loamy Sand	170.9	15.7	120.0	Avikramjit Singh, Kartarpur	Loamy Sand	100.4	27.2	165.6
Bhajan Singh, Kohliwal Navan	Loamy Sand	190.2	36.9	135.5	Paramjit S. Makar, Ballan	Sandy Loam	133.0	42.6	187.6
Baldev Singh, Kohliwal Navan	Loamy Sand	150.0	35.6	137.5	Sandeep Singh, Mumandpur	Loamy Sand	100.3	22.6	164.8
Ranjit Singh, Kohliwal Navan	Loamy Sand	162.4	34.8	130.0	Sukhwinder Singh, Mumandpur	Loamy Sand	109.0	26.9	156.8
Lakhbir Singh, Kohliwal Navan	Loamy Sand	100.0	35.8	125.0	Sukhdev Singh, Kotla	Loamy Sand	157.0	42.6	176.7
Hazara Singh, Jabowal	Loamy Sand	109.3	20.9	120.0	Gurdev Singh, Kot Badal Khan	Loamy Sand	100.3	18.9	138.2
Navjeet Singh, Jabowal	Loamy Sand	145.9	26.8	127.5	KVK, Nurmahal	Loamy Sand	188.0	18.9	137.4

Table2: Soil status of fields of on farm trials in different district before sowing

Fatehgarh Sahib					Patiala				
Name of farmer and village	**Soil texture**	**N (kgha^{-1})**	**P (kgha^{-1})**	**K (kgha^{-1})**	**Name of farmer and village**	**Soil texture**	**N (kgha^{-1})**	**P (kgha^{-1})**	**K (kgha^{-1})**
Palwinder Singh, Baraunga	Sandy Loam	113.0	26.9	167.2	Lakhvinder Singh, Meeranpur	Sandy Loam	163.0	56.0	254.1
Varinder Singh, Baraunga	Loamy Sand	149.1	33.6	187.5	Balvinder Singh, Meeranpur	Sandy Loam	149.1	42.6	187.6
Chamkor Singh, Sadugarh	Loamy Sand	213.0	44.8	192.4	Sukhdev Singh, Meeranpur	Sandy Loam	157.0	33.6	288.2
Harjit Singh, Sangatpur Sodian	Loamy Sand	207.0	56.0	237.2	Kuldeep Singh, Meeranpur	Sandy Loam	157.0	67.2	237.2
Harbhajan Singh, Fathepur Rian	Loamy Sand	194.0	44.8	192.4	Raju Singh, Nizampur	Sandy Loam	149.1	67.2	297.4
Amrinder Singh, Sangatpur Sodhian	Loamy Sand	194.0	42.6	187.6	Manjit Singh, Nizampur	Sandy Loam	125.4	42.6	217.4
Sucha Singh, Meerpur Sodhian	Loamy Sand	181.5	42.6	271.4	Gurmeet Singh, Meeranpur	Sandy Loam	138.0	42.6	187.6
Gurnaib Singh, Mullanpur	Loamy sand	168.4	39.4	197.2	Amrik Singh, Swaisinghwala	Sandy Loam	163.0	78.4	276.7
Sukhwinder	Loamy	198.4	40.1	192.4	Lakhvinder Singh,	Sandy	163.0	47.1	212.8

Singh, Meerpur	Sand				Swaisinghwala	Loam			
KVK, Fatehgarh Sahib	Loamy sand	206	54	235.2	Iqbal Singh, Jalalabad	Sandy Loam	170.1	67.2	267.4

RESULTS AND DISCUSSION

Grain and straw yield of rice

Data recorded on rice grain and straw yield are presented in the table 3. It shows that an average of grain yield of rice was 7.7, 6.5, 6.4 and 5.4 tha^{-1} and straw was 10.0, 9.6, 9.4 and 8.1 tha^{-1} in Fatehgarh Sahib, Patiala, Kapurthala and Jalandhar, respectively. Farmers generally follow the practice of burning of paddy straw for sowing of wheat with conventional tillage. They lost with burning of paddy straw an average of 33.66, 7.48 and 65.85 $kgha^{-1}$ available nitrogen, phosphorous and potassium, respectively. Farmers can add large quantity of nutrients with the recycling of paddy straw by sowing the wheat with happy seeder and rotavator and this will help to improve the soil productivity. The long term use of this technology reduces the fertilizer requirement and save the environment from pollution by reducing the emission of CO_2 with an average of 13.0 t/ha (Table 3).

Table 3: Effect of different locations on straw yield, emission of CO_2, organic carbon and nutrient present in the straw

Location	Grain yield (tha^{-1})	Straw Yield (tha^{-1})	Emission of CO_2 ($t\ ha^{-1}$)	Nutrient present in the straw		
				Nitrogen ($kgha^{-1}$)	Phosphorous ($kgha^{-1}$)	Potassium ($kgha^{-1}$)
Kapurthala	6.4	9.4	13.2	33.84	7.52	66.74
Jalandhar	5.4	8.1	11.3	29.16	6.48	57.51
Fatehgarh Sahib	7.7	10.0	14.0	35.64	7.92	71.00
Patiala	6.5	9.6	13.4	36.00	8.00	68.16
Mean	6.5	9.3	13.0	33.66	7.48	65.85

Paddy straw contains 0.36 Nitrogen, 0.08 Phosphorous, 0.71Potassium (*Source*: Handbook of Agriculture ICAR)

Growth and yield parameters of wheat

Plant height

Data on plant height recorded from the happy seeder, rotavator and farmer's practice sown crop in the different districts are presented in the table 4. The plant height varied significantly with methods of planting in Patiala, Kapurthala and Jalandhar but it was non-significant in Fatehgarh Sahib. The happy seeder had significantly higher plant height as compared to farmer's practice and rotavator sown crop in Patiala. In Kapurthala, crop sown with happy seeder and farmer's practice had significantly same plant height, but rotavator sown crop had significantly lower plant height than happy seeder and farmer's practice, whereas, in Jalandhar, plant height was significantly higher in farmer's practice than happy seeder and rotavator sown crop. However, the differences were non-significant in the plant height recorded in Fatehgarh Sahib. Plant height of wheat did not vary due to planting methods (Kaushal et al., 2012a,b; Meenakshi, 2010). The average plant height of the crop sown in the four districts was higher in the farmer practice sown crop.

Table 4: Plant height, tillers per plant, tillers per square meter and ear length of wheat as affected by planting methods

Treatments	Plant Height (cm)			
	Jalandhar	**Kapurthala**	**Patiala**	**Fatehgarh Sahib**
Rotavator	64.70	71.72	72.16	71.91
Happy Seeder	64.50	80.06	74.96	72.51
Farmer Practice	68.94	83.77	73.85	73.42
CD (p=0.05)	2.25	6.05	0.90	NS
Tillers per plant				
Rotavator	4.55	6.20	**3.11**	10.58
Happy Seeder	6.02	7.76	**3.23**	10.79
Farmer Practice	4.48	5.45	**3.13**	10.24
CD (p=0.05)	NS	0.95	**0.88**	NS
Tillers per metre^{-2}				
Rotavator	300.54	352.32	419.40	370.16
Happy Seeder	321.74	310.45	390.20	354.26
Farmer Practice	336.14	328.89	398.20	368.33
CD(p=0.05)	NS	NS	8.37	11.22
Ear Length (cm)				
Rotavator	9.96	9.86	10.08	6.86
Happy Seeder	10.08	11.48	10.54	6.32
Farmer Practice	9.94	10.02	10.25	7.84
CD (p=0.05)	NS	0.78	0.17	0.86

Number of tillers per plant

Data on tillers per plant are depicted in the table 4. Numbers of tillers per plant were affected significantly with different planting techniques in the two districts. In Kapurthala, numbers of tillers/plant were recorded higher in the crop sown with happy seeder, which was significantly more than other methods of planting. However, the number of tillers per plant recorded under rotavator and farmer's practice was at par with each other. The similar trend was recorded in the Patiala district. The higher number of tillers was recorded in the crop sown with happy seeder, but the differences were non-significant among all methods of planting in Fatehgarh Sahib and Jalandhar districts. It was observed that the highest number of tillers per plant was observed in happy seeder sown crop in all the districts than rotavator and farmer's practice. The average numbers of tillers per plant were recorded higher in the happy seeder sown crop followed by farmer's practice and rotavator.

Number of tillers per square meter

Data on tillers per square meter are presented in the table 4. Number of tillers m^{-2} were significantly affected with different planting techniques in Fatehgarh Sahib and Patiala. In district Patiala, significantly more number of tillers m^{-2} were recorded under rotavator than happy seeder and rotavator sown crop and were at par in happy seeder and farmer's practice sown wheat. In Fatehgarh Sahib, were statistically at par with farmer's practice, however, significantly more than happy seeder sown crop. Whereas, number of tillers per square meter were recorded considerably higher in rotavator sown crop than happy seeder and farmer's practice in Jalandhar and Kapurthala districts, but the differences were non-significant in all the treatments, in general, higher number of tillers were observed under rotavator followed by farmer's practice and happy seeder. The average numbers of tillers per meter square at all the four locations were higher in the rotavator sown crop followed by farmer's practice and happy seeder. It might due to more population under rotavator and farmer's practice.

Ear length

Data on ear length of wheat of all the districts are presented in the table 4. Ear length had significant variation in wheat sown in the district of Fatehgarh Sahib, Kapurthala and Patiala except Jalandhar. In Kapurthala, happy seeder sown crop had significantly more ear length than farmer's practice and rotavator sown wheat. Similar trend was observed in Patiala district. However, happy seeder sown wheat had lowest ear length, but was statistically at par with rotavator and significantly lowers than farmer practice. In Jalandhar, ear length under different methods of planting was similar statically, but it was higher in happy seeder sown wheat than farmer practice and rotavator. The differences in ear length were non-significant among the different methods of planting (Kaushal et al., 2012a,b; Meenakshi, 2010). The average ear length of the crop sown in four districts was highest in happy seeder followed by farmer's practice and rotavator sown crop except in Fatehgarh Sahib.

Grain and straw yield

Data on grain yield of wheat sown by happy seeder, rotavator and farmer's practice are presented in table 5. Grain yield differed significantly by sowing of wheat with happy seeder, rotavator and farmer's practice in Patiala, Fatehgarh Sahib and Kapurthala. In Kapurthala, wheat sown with happy seeder gave significantly higher grain yield than rotavator and farmer practice, but grain yield was significantly similar under rotavator and farmer practice. In Patiala district, significantly higher grain yield was obtained with happy seeder sown wheat than farmer practice and rotavator. However, it was also significantly higher under farmer practice than rotavator sown crop. In Fatehgarh Sahib, significantly equivalent grain yield of wheat was recorded from the crop sown with happy seeder and farmer's practice. It was significantly more than rotavator sown crop. Whereas, method of planting did not influence significantly on the grain yield of wheat sown in Jalandhar district**.** However, the grain yield was higher of happy seeder sown crop than rotavator and farmer practice. It is interesting to mention here that the average grain yield of four districts of wheat sown with happy seeder was slightly higher than wheat sown with rotavator (1.06 qha^{-1}) and farmer's practice (1.03 qha^{-1}). It might be due to the higher number of tillers per plant and ear length. Secondly, it could be due to the presence of paddy straw on the soil surface resulted in more availability of moisture for longer period during the growing season. Mulching has been proved to be useful in conserving moisture and increasing productivity in wheat (Chakraborty et al., 2008; Huang, 2005; Li, 2005; Rahman, 2005; Verma and Acharya, 2004). The results are also in conformity with the findings of Singh et al., 2011;Yadav et al., 2005; Tripathi et al., 1999; English and Raja, 1996; Martens and Frankenberger, 1992; Sardana et al., 2002; Singh et al., 1991. They reported significantly higher grain yield under zero tillage compared with the yield obtained conventional tillage. An average 9-15 % higher grain yield of wheat was recorded with the happy seeder sowing in rice residues (Sidhu et al., 2007), with fertilizer broadcast at sowing and before the first irrigation compared with farmer's practice (conventional tillage after burning). **A**verage grain yields with no-tillage and conservation tillage were significantly greater than yields using conventional tillage (Ciha,1982).

Table 5: Grain and straw yield of wheat as affected by planting methods

Treatment	Grain yield (qha^{-1})				Straw yield (qha^{-1})			
	Jalandhar	Kapurthala	Patiala	Fatehgarh Sahib	Jalandhar	Kapurthala	Patiala	Fatehgarh Sahib
Rotavator	41.19	46.79	44.52	47.88	63.02	71.58	68.1	73.26
Happy Seeder	43.63	47.76	49.53	51.13	66.75	73.08	75.8	78.23
Farmer Practice	42.47	46.91	46.02	50.86	64.98	71.78	70.4	77.80
CD (p=0.05)	NS	0.65	1.36	2.06	NS	1.00	2.08	3.14

Data on straw yield of wheat are given in the table 5. The different methods of planting were influenced significantly on straw yield of wheat sown in Patiala, Fatehgarh Sahib and Kapurthala except Jalandhar. In Kapurthala and Patiala, the straw yield recorded from the crop sown with rotavator and farmer practice was statistically at par with each other but it was significantly higher recorded under happy seeder than rotavator and farmer practice**.** In Fatehgarh Sahib, straw yield of wheat sown with farmer practice and happy seeder was statistically at par with each other, but was significantly better than rotavator, whereas, in Jalandhar, straw yield of

happy seeder sown wheat was higher than farmer practice and rotavator, but was statistically similar among all the treatments. On an average the straw yield recorded from the crop sown with happy seeder was maximum followed by farmer practice and rotavator.

Conclusion

The results of this investigation indicated that happy seeder (zero tillage) sown wheat gave the similar or slightly higher grain yield than farmer's practice and rotavator. This method of planting found most efficient method to reduce the cost of production, *in-situ* management of the combine harvested paddy straw and ultimately to improve the soil productivity.

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