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Comparative Performance of Machine for Crop Residue Management in Rice-Wheat Cropping System

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A B S T R A C T

Rice (*Oryza sativa* L.) and Wheat (*Triticum aestivum*) is the most extensively cultivated cereal crops in India and other countries. In the experiment, for crop residue management in rice wheat cropping system various farm machines were used *viz.*, zero till happy seeder (T_1), mulcher + zero till drill (T_2), zero till drill (T_3). In T_2 treatment fuel consumption was measured higher as compared to other treatments because there are used two machines. Happy seeder was cut higher length of straw as compared to rotary mulcher. T_1 and T_2 were higher conservation of moisture content of the soil caused by incorporation of rice straw. A maximum weight of 1000 grain (49.70g) was measured in T_2 treatment. Highest energy (5214.11 MJ/ha) consumption and cost requirement (2452.11₹ /ha) were measured in case of conventional system.

Introduction

Rice-wheat cropping system is very common in India, Pakistan, Bangladesh and Nepal and this cropping system contributes 70% of total food grain production with an area covered is 12 M ha in India. But, it is estimated that under rice and wheat crop separately, the area covered is 42.31 and 22.98 M ha respectively (Chauhan, 2016). Crop residues are parts of the plants which are leftover the field after crops have been harvested by a combine harvester. Crop residues burn in India due to which the environment polluted and soil fertility also decrease.

Though in many countries the crop residues are used as a source of energy in different way viz. livestock feed, mushroom cultivation, compost making, bio-fuel, bio-oil production, gasification, bio-char production etc.

Materials and Methods

Experimental site

The experiment was conducted in *Rabi* season at Research Farm, Indira Gandhi KrishiVishwaVidyalaya, Raipur (C.G.)at $21^0$23'54" North latitude and $81^0$69'56"East longitude with an altitude of 268.99 meter above mean sea level on paddy crop residue on combine harvested paddy field.

Design of experiment

In the experiment, for crop residue management in rice wheat cropping system various farm machines were used *viz* zero till happy seeder (T_1), mulcher + zero till drill (T_2), zero till drill (T_3) and conventional system for wheat cropping.

In these experiment machine parameter (operation speed, a slip of tractor, effective field capacity and fuel consumption), soil parameter (moisture content, bulk density and nutrient content of soil), residue parameter (length, weight and moisture content of residue/straw), plant parameter (height of plant, population of plant, length of ear head, grain weight, straw grain-ratio), energy analysis and cost analysis was done.

Machine parameter

Slip of tractor

Tire slip occurs when the tires are turning faster than the ground speed of the tractor. Due to slip the power of a tractor engine develops is used to pull an implement through the soil. The conventional method of measuring tractor drive-wheel slip consists of measuring the base (unloaded) distance for a given number of drive wheel revolutions and then measuring the loaded distance for the same number of wheel revolutions.

Percent slip is given by the relation (Zoerb and Popoff, 1967):

$$\text{Per cent slip } (\%) = \frac{100(B - L)}{B}$$

Where,
B = Base distance, m;
L= Loaded distance, m.

Effective field capacity

Effective field capacity (EFC) of a farm machine is calculated by dividing the area ended or completed by the hour of actual time.

$$EFC = \frac{WS}{10} \times n$$

Where,
EFC = Effective field capacity of the machine, ha/h;
W = Width of the machine, m;
S = Speed of the machine, km/h; and
n = Efficiency of the machine, percentile.

Fuel consumption

Fuel consumption (FC) was determined by top-up method. The fuel tank was filled full level before the operation. After one hour of work, it was again filling up to top level. The quantity of fuel top-up was measured by a measuring cylinder.

$$FC\ (^{lit}/_{h}) = \frac{\text{Consuption of fuel}\left(\frac{lit}{h}\right)}{\text{Coverd area}\left(\frac{ha}{h}\right)}$$

Moisture content of the soil

In experiment, three times irrigation was applied and after each irrigation moisture content of the soil was measured.

The moisture content of the soil is calculated after every week until the next irrigation. Oven drying method was used for soil moisture analysis. Soil sample are taken in the oven at 105^0C. After 24 hours dry soil sample weight was measured and moisture content of soil was determined by using following relation:

$$mc, \% \text{ (dry basis)} = \frac{W2 - W3}{W3 - W1} \times 100 \quad --(3.8)$$

Where, mc = Moisture content;
W_1= weight of container;
W_2 = weight of the container and wet soil:
W_3= weight of the container and oven-dry soil.

Crop parameter

Grain weight

After harvesting of crop 1000 grain was selected manually and weighed by using of electronic balance from each plots.

Straw-grain ratio

Straw grain ratio (SRG) was fiend by dividing of the weight of straw and weight of total grain.

$$SRG = \frac{Ws}{Wg}$$

Where, W_s = weight of straw; and
W_g = weight of grain

Energy and cost analysis

Energy required for wheat crop was measured as source and operation wise in which input-output energy ratio and other energy calculation was measured for experiment (Jat *et al.*, 2015). The operation cost was calculated in two way fixed cost and operation cast. In operation cast include Lubricants, fuel, Repair- maintenance and wages (Fig. 1–3).

Results and Discussion

Machine parameter

Slip of tractor

Slip of tractor in happy seed drill, rotary mulcher, zero till and cultivator was observed 1.5, -1.2, 1.8 and 1.5, respectively. Rotary mulcher measured negative slip (Table 2).

Effective field capacity

It was found that maximum field capacity was recorded in T_3 followed by T_1. Lowest EFC was observed in the case of T_2 and T_4 due to the combination of two to three operations imposed in the same field, which was given in Table 1.

Fuel consumption

Minimum fuel consumption was found in T_3 treatment, zero till seed drill while maximum fuel consumption was obtained for T_2 treatment, rotary mulcher + zero till drill.

Soil parameter

Observing moisture content was higher in T_1 treatment and lower in T_4 treatment before second irrigation. A similar observation was done in the moisture content of soil for other irrigation. After 18 week save rage moisture content of the soil at T_1, T_2 T_3 and T_4 treatment were observed 14, 12, 11 and 10%, respectively (Table 3).

Crop parameter

Straw grain ratio 1.35 was measured higher in T_4 treatment while 1000 grain weight 49.9 g was measured higher in T_2 treatment (Table 4).

Table.1 Experiment Detail

S. No.	Particulars	Specification
1.	Number of Treatment	4
2.	Number of replications	5
3.	Net Plot size	62 m X 22.5 m
4.	Total no. of plot	20
5.	Distance between replications	0.5 m
6.	Distance between plots	0.5 m
7.	Last crop harvested	Paddy
8.	Soil type	Vertisol
9.	Sowing crop	Wheat
10.	Varity	GW-366
11.	Date of sowing	15.11.2018
12.	Date of harvesting	27.03.2019

Table.2 Average Machine parameter

Treatments	Slip (%)	Effective ield capacity	Fuel consumption
T_1	1.5	0.251	4.5
T_2	-1.2	0.33	2.9
T_3	1.8	0.34	2.96
T_4	1.5	0.310	6.4

Table.3 Average moisture content of soil under different treatments

Treatments	Weeks																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
T_1	39	34	28	21	37	33	27	20	34	31	25	19	31	23	21	19	17	14
T_2	39	32	27	20	36	32	28	20	33	29	23	18	32	20	19	17	14	12
T_3	39	30	25	17	32	26	21	19	30	24	19	17	28	23	17	16	13	11
T_4	39	29	21	16	30	26	23	18	29	23	20	17	27	23	18	15	12	10

Table.4 Average straw-grain ratio and Grain weight of wheat crop in various treatments

Treatment	Straw-grain ratio	1000 Grain weight (g)
T_1	1.31	49.24
T_2	1.308	49.9
T_3	1.30	48.68
T_4	1.35	49.7

Fig.1 Machine performance for different treatment

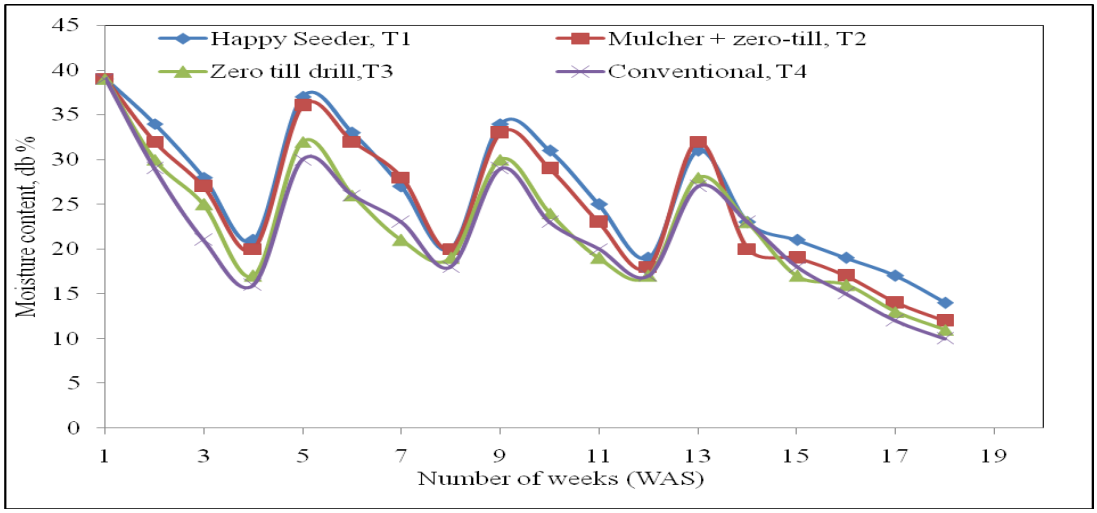

Fig.2 Moisture content of soil of various treatments

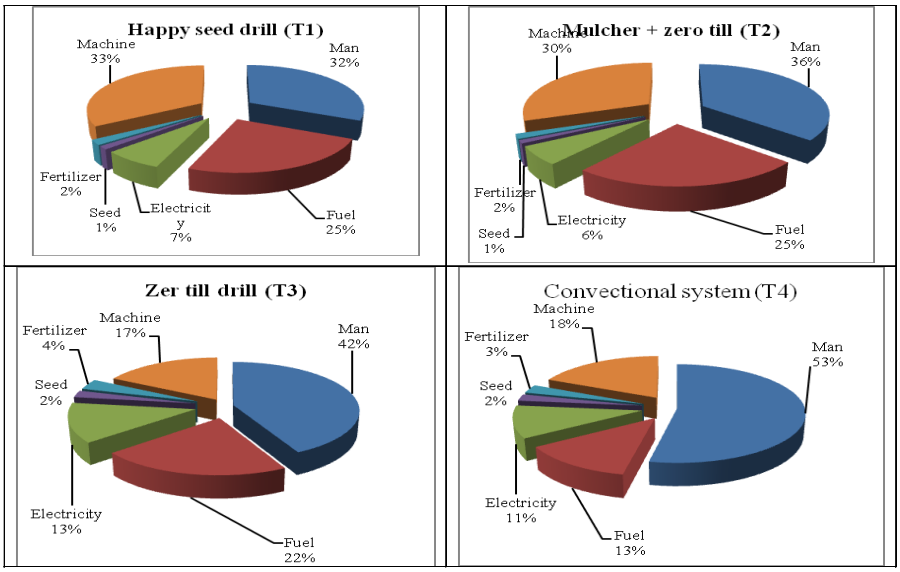

Fig.3 Energy requirement of various treatments for different sources

Energy and cost analysis

In this experiment energy required in T_1, T_2, T_3 and T_4 treatments are 4120.74, 5013.85, 2191.29 and 5214.11 MJ/ha, respectively. Minimum energy requirement observed in T3 treatment because there is no tillage done. In this experiment cost required in T_1, T_2, T_3 and T_4 are 2228.13, 2297.72, 1025.85 and 2452 ₹ /ha, respectively. In T_3 treatment observed lower cost requirement because there is no-tillage work done and labor work are minimum.

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