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Effect of different machinery system on plant growth and yield of wheat under combine harvested paddy field

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Abstract
Evaluation of different wheat sowing technologies under paddy residue conditions were conducted in a combine harvested paddy field. Wheat variety (GW 366) was sown with different farm machines *viz.*, T1: Happy seeder, T2: Rotavator with zero till drill, T3: Disc harrow+zero till drill, T4: Trichoderma application + Disc harrow with zero till drill zero and T5: Mulcher + zero till drill in combine harvested paddy fields. All the rice straw was remained in the field itself but spreaded uniformly manually/stubble shaver, In case of happy seeder both the operation is cutting of paddy and sowing of wheat accomplished in one operation. In T2: Rotavator + Zero till drill is loose paddy straw and stubble are incorporate in the soil with the help of rotavator, In T3 Disc harrow + Zero till drill loose paddy straw and stubble are incorporate the soil, In T4: Trichoderma application + Disc harrow + zero till drill, application of Trichoderma help to easily decomposition of paddy straw incorporated in the soil. In T5: Mulcher with zero till drill are cut the stubbles and loose paddy straw spared then sowing the wheat. In Among the treatments, T2 gave better result over the rest of the treatment. The grain yield was maximum in treatment T2 (2454.4 kg/ha).

Keywords: Trichoderma, disc harrow, happy seeder, mulcher, stubbles, incorporate

Introduction
Rice is the major cropping system of Chhattisgarh. The increasing constraints of labour and time have led to the adoption of mechanized farming in highly intensive rice system. In Chhattisgarh, mostly the paddy and wheat crops are harvested by combines. The total crop residue generated in India and Chhattisgarh State was 501.73 and 11.25 million tonne, respectively (MNRE, 2009) [4]. The wheat residue is collected by the farmers after combine harvesting using straw combine and often fed to animals, paddy straw is considered as poor feed for animals due to high silica content. One tonne of rice straw contains approximately 5-6 kg N, 0.8-0.9 kg P and 15-20 kg K, while one tonne of wheat straw contains 4 kg N, 0.6-0.7 kg P and 8-10 kg K (Singh, 2012). Burning is the normal and easiest method of crop residue management option because residues interfere with tillage and seeding operations for the next crop. Residue burned by the farmers in India and Chhattisgarh State were 92.81 and 0.83 million tonne, respectively (Pathak, Himanshu *et al*., 2010). The gaseous emissions from burning of rice straw analyzed 70 per cent CO_2, 7 per cent CO, 0.66 per cent CH_4 and 2.09 per cent N_2O. Substantial loss of plant nutrients (especially N and S) and organic carbon occurs during burning of crop residues, which has important implications for soil health (Singh *et al*., 2005). Burning of paddy has an ill effect on environment. Many problems are associated with straw burning such as smoke, ash deposition and damage to property and trees. Direct drilling of wheat in combine harvested paddy field faces the problem of accumulation of straw in drill's furrow openers. The no-till drill does not perform satisfactorily under heavy crop residues because loose straw residue present on the soil surface resulted in frequent choking of no-till drill. Straw incorporation of the remaining stubble and straw into the soil returns most of the nutrients and helps to conserve soil nutrient re-serves in the long-term. Direct drilling of wheat in combine harvested field with conventional drills faces the problems of accumulation of straw in drill's furrow openers, traction problem in the ground wheel due to the presence of loose straw and non-uniform depth of seed placement due to frequent lifting of the machine under heavy trash conditions (Shukla *et al* 2002) [1].

A lot of work has been done in developing tractor drawn mulcher for mulching of paddy straw. Straw mulch-cum-spreading machine was developed which cut the stubbles left after combining, chop it into pieces and spread in the field, in a single operation. Nowadays Mulcher, choppers, shredders and reapers for chopping of paddy residue are commercially available in market.

Among the many available farm machinery for crop residue management and sowing of wheat few of them are selected in the study to evaluate this performance in Chhattisgarh field condition.

Materials and Methods

The different experiments regarding tillage and sowing operations with different implement and machineries for the cultivation of wheat was conducted at research farm of SVCAET&RS, Faculty of Agricultural Engineering, IGKV, Raipur during Rabi-2018.

The brief description of various farm machines used for sowing of wheat in paddy residue conditions is as follows.

Happy Seeder

This machine could be used for direct drilling of wheat in combine harvested field with uniformly spreaded paddy straw. Rotor was used to cut the straw and spread over the chickpea seed as mulch. It provides a suitable atmosphere for proper growth of wheat. It consists of a rotor for managing the paddy residues and a zero till drill for sowing of wheat. Flail type straight blades were mounted on the straw management rotor which cuts the standing stubbles/loose straw coming in front of the sowing tine for proper placement of seed in soil. The rotor blades/flails guide/push the residues as surface mulch between the seeded rows. This PTO driven machine can be operated with 45 hp tractor and could cover 0.3-0.4 ha/h.

Fig 1: Sowing of wheat with happy seeder

Rotavator

It consists of a MS frame, a rotary shaft on which blades are mounted, power transmission system having primary and secondary speed reduction unit. The blades are made from medium carbon steel or alloy steel, hardened and tempered to suitable hardness. Rotary motion of the tractor PTO is transmitted to the rotor shaft carrying the blades through transmission system having primary and secondary speed reduction unit. A good seedbed with pulverized soil is achieved in a single pass of the rotavator

Fig 2: Rotavator

Zero till drill

Zero till drill consists of frame, seed box, fertilizer box, seed metering mechanism, fertilizer metering mechanism, seed tubes, inverted T-type furrow openers, seed adjusting lever and transport cum power transmitting wheel. The frame is made from mild steel box section. The tynes are mounted with the help of clamps, to obtain desired row spacing. Zero till drill should be capable of sowing wheat crop in unprepared field after harvesting of paddy.

Fig 3: Sowing of wheat with Zero till Drill

Rotary Mulcher (Chopper)

Rotary mulcher should be suitable for operation with 540 rpm tractor PTO. It should be suitable for hitching with three point linkage of category I/II. Rotary Mulcher should be capable of chopping and spreading the paddy stubbles and loose straw lying in the combine harvested paddy field and leave them in the field in form of mulch which can be subsequently mixed into the soil or decomposed by irrigating the field.

Fig 4: Mulcher Paddy straw and stubbles cut and spread in the surface

Disc Harrow

A disc harrow is a harrow whose cutting edges are a row of concave metal discs, which may be scalloped, set at an oblique angle. It is an agricultural implement that is used to till the soil where crops are to be planted. It is also used to chop up unwanted weeds or crop remainders. It consists of many carbon steel discs, and sometimes longer-lasting boron discs, which have many varying concavities and disc blade sizes and spacing (the choices of the latter being determined by the final result required in a given soil type) and which are arranged into two sections ("offset disc harrow") or four sections ("tandem disc harrow").

Fig 5: Disc harrow

Trichoderma application + disc harrow

Trichoderma is a soil-borne fungus that is capable of degrading straw with mycoparasitic ability against several plant pathogenic fungi (Chet & Henis 1985; Chet 1987). In rice, *Trichoderma* is responsible for the reduction of inoculum potential of *Rhizoctoniasolani* by decomposing rice straw and stubble after rice harvest.

Measurement of dependent variables for evaluation of wheat sowing technologies

Wheat variety (GW 366) was sown and the straw load was 9.05 t/ha. Five different treatments for sowing wheat in chopped paddy residue condition were done. Five treatments were compared with a control treatment. Size of each plot was 75 m^2 (30 m × 2.5 m).

a. **Germination count:** The germination count was noted for 15 days and 25 days after sowing (DAS). The number of seedlings per meter row length at five places was recorded in each plot and their average value was calculated.
b. **Effective tiller count:** The effective tiller count was taken at the time of maturity of crop. The number of effective tillers per meter row length was counted in each plot. Three observations were recorded in each plot and average of these values was calculated.
c. **Length of ear head, number of grains per ear head and thousand grain weight:** Length of ear head, number of grains per ear head and thousand grain weight was noted at harvest stage. Length of ear head was measured using a measuring scale. Twenty ear heads were selected randomly from each plot and were threshed manually to count number of grains per ear head. Weight of thousand grains was also measured from above selected ear heads by using electronic weighing balance.
d. **Grain yield:** Wheat crop was manually harvested randomly at three places having an area of 2 m2 each with the help of square meter. Grains produce plot-wise i.e. treatment-wise, was manually harvested and threshed. The threshed grains were weighed using an electronic weighing balance and yield per hectare was calculated.

Experimental results and analysis

The germination count was observed after 15 and 25 days of wheat sowing. Each treatment was replicated thrice and from each plot germination count was taken at three places and the average of these values was calculated. Treatment T2 followed by treatment T1 which had germination count of 30 per meter length. The minimum germination count of 29 was observed in T4 because uneven germination of wheat was observed in Disc harrow+ Zero till drill sown fields. The highest germination count in treatment T2 might be due to the reason that after chopping and loose straw paddy straw are cut and incorporate the soil, the accumulation of paddy straw in front of furrow openers was low and subsequent seeding operation by modified no till drill, the seed coverage was better.

Crop establishment parameters

The various wheat crop establishment parameters *viz.*, effective tiller count per meter length, length of ear head, number of grains per ear head and thousand grain weight are shown in Table 1. The length of ear head was maximum (82 mm) in T2 and minimum in T3 (65 mm). The maximum effective tiller count per meter length (54) was in case of treatment T2 and minimum number of tillers per meter length (50) was in case of T5. The maximum number of grains per ear head (28) was found in treatment T2 followed by T3 (27) and treatment T1 (26). The average value of thousand grain weight was maximum (40 g) in treatment T2 followed by treatment T1 (41 g) and T3 (40 g).

Table 1: Average values of various wheat crop establishment parameters

Crop establishment parameter				
Treatments	**Effective tiller count/ m-length**	**Length of ear head (mm)**	**No. of grains per ear head**	**Thousand grain weight (g)**
T1	52	72	26	40
T2	54	82	28	41
T3	51	65	27	40
T4	50	78	25	40
T5	51	75	28	40

Table 2: Effect of different treatments on grain yield (kg/ha) of wheat crop

Grain yield (kg/ha)					
Treatments	**Replications**			**Mean**	**SD**
	R1	**R2**	**R3**		
T1	2080.4	2055.1	2079.6	2071.70	11.74
T2	2419.2	2454.4	2449.1	2440.90	15.50
T3	2203.2	2220.5	2255.2	2226.30	21.62
T4	2000.1	2022.1	2038.5	2020.23	15.73
T5	2284.8	2242.2	2299.5	2275.50	24.30

Grain yield

The highest grain yield (2454.4/ha) was found in case of treatment T2 and lowest in T4 (2000.18 kg/ha) as depicted from Table 2. The average grain yield for treatment T2 Rotavator + Zero till drill was found better than the all other treatment. It might be due to better seeding in treatment T2 because in T2, paddy straw was chopped into small size and incorporated which might have led to better decomposition of paddy straw in the soil, thereby increasing the availability of nutrients in the soil which might have helped in yielding bolder grains and hence better yield of wheat crop.

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