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Evaluation of Different Land Preparation Techniques for Preparing Medium Textured Soil in Rice Production under Agro-Ecological Conditions of Sheikhupura-Pakistan

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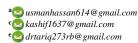*Corresponding author*

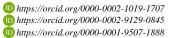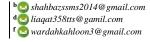| ARTICLE INFO	ABSTRACT
	Tillage is an important factor affecting different soil properties and crop yields. Tillage relates to applying forces to soil using different implements for preparation of a proper seed bed. For rice crop, land preparation is a rigorous and time consuming operation that needs special attention for preparing a puddled soil condition to transplant the weak and tender rice seedlings. A field experiment was established under agro-ecological conditions of Sheikhupura to evaluate different land preparation techniques during fall in 2017 and 2018 years. The experiment was performed at Adaptive Research Farm Sheikhupura. It was laid out in randomized complete block design (RCBD) with four different land preparation techniques including T_1= Cultivator (4 times) + Planking (2 times) (Farmer's Practice), T_2=MB plough (1 time) + Disc Harrow (1 time) + Planking (2 Times), T_3=MB plough (1 time) + Cultivator (2 times) + Planking (2 Times) and T_4= Rotavator (1 time) + Disc Harrow (1 time) + Planking (2 Times), each treatment replicated thrice during both the years. All the other agronomic and crop husbandry operations were kept uniform throughout the growing season every year. The results revealed that preparing land with MB plough (1 time), Disc Harrow (1 time) and Planking (2 times) is the best land preparation method can increase the paddy yield 13.5-17.5% as compared to the traditional method practised by the farmers. Moreover, highest plant height (134.00 cm and 132.00 cm), number of tillers (224 and 220 m^{-2}), number of grains per spike (130 and 116) and 1000-grain weight (23.0 and 22.0 g) respectively during Kharif-18 and Kharif-19 was also recorded in the same treatment. So, preparation of land for paddy in agro-ecological conditions of Sheikhupura using MB plough (1 time), Disc Harrow (1 time) and Planking (2 times) can significantly enhance the paddy yield.

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Introduction

Rice is considered among the most important cereals of the world. About 33% world population use rice as staple food making it an important cereal crop of the world (Nasiri et al., 2008). In Pakistan, it is grown on an area of about 10% of total cultivated area.

Rice is an important cash crop in Pakistan. Rice grains fulfil the 60 % food needs of people of Pakistan. Pakistan is a major rice exporter with an annual export of approximately 2.0 million ton of basmati rice (Rehman et al., 2015). Despite the multi-dimensional efforts from all stake holders concerned with rice, the paddy yield is still very low in Pakistan. There are several factors of low rice yield such as low plant density, poor seed quality, and deficient moisture in seed bed, attack of insect pests, different diseases, climate change, improper fertilizer application, improper irrigation management and proper seed bed preparation for rice crop. Among all these factors land preparation is an important factor for rice cultivation. Seed bed preparation is the factor that may cause low productivity of rice. Improper seed bed may cause salinity, waterlogging, moisture and loss of nutrients. For uniform land preparation, it is necessary to use proper tillage combinations. Tillage relates to applying forces to soil with the help of different implements for preparation of proper seed bed. Tillage control weeds, incorporate residues in the soil, loose the soil and enhance the aeration of soil hence change occurs in different physiochemical properties of soil which ultimately effect the crop development and yield of a crop (Shahidur-Rehman et al., 2004). Tillage is an important factor that influences the soil physical properties and yield of crop. Selection of appropriate tillage practices is crucial for crop growth otherwise improper practices

may cause the adverse effect on crop productivity (Md. Khairul Alam et al., 2014). Tillage is the primary part of any crop production system and has direct effect on crop yield and crop stand (Hobbs, 2001) and the changes in the soil layer to provide a favourable environment for crop growth (Culpin, 1981). Changes in soil properties due to tillage depends upon several factors including moisture contents in soil at the time of tillage, tillage depth, equipment used and climatic conditions (Chang and Lindwall, 1990). Increasing the plough depth and time of ploughing increases the total porosity and decreases the bulk density of the soil as compared to zero or no tillage (EI-Gohary, 1978). Seedbed preparation also affects the root properties of plants like root volume as Sharma et al. (1988) pointed out that increasing tillage intensity increased the root volume that might be due to better aeration in tilled soils. Keeping in view, all these aspects a study was carried out at Adaptive Research Farm Sheikhupura to evaluate different land preparation methods for super basmati rice.

Materials and Methods

Site Description
The study was undertaken consecutively for Kharif 2017 and 2018 at ARF, Sheikhupura. The experimental site is located in the Sheikhupura district of Pakistan. This area is renowned for the production of basmati rice and is called rice tract of Pakistan. The climate is moist sub-humid with an annual rain fall of 250–500 mm. This region has rice-wheat cropping system as the major cropping system.

Crop Husbandry
Each year rice nursery (super basmati) was raised in 2nd week of June and at the age of 30 days was transplanted manually at experimental site. Fertilizers were applied to crop as recommended by Department of Agriculture, Government of Punjab with 140-80-62 kg ha^{-1} as N-P-K. Whole P and K were applied at the time of transplanting of nursery, while N was applied in 3 equal splits at tillering, panicle initiation and flowering stage. The sources of N, P and K were urea, di-ammonium phosphate (DAP) and sulphate of potash (SOP), respectively. All the experimental units were also fertilized with zinc sulphate 33 % @ 5 kg ha^{-1} to fulfil the Zn requirements of the crop at tillering stage. All other operations like weed management, irrigation scheduling and management of pests etc. were kept uniform in all experimental units. Each year, the crop was harvested and threshed manually from each plot at maturity.

Experimental Design and Treatments
Experiment was laid out in randomized complete block design (RCBD) with 4 different land preparation techniques as the treatments and was replicated thrice. The following treatments were applied:

T_1 = Cultivator 4 times + Planking 2 times (Farmer's Practice)

T_2 = MB plough 1 time + Disc Harrow 1 time + Planking 2 Times

T_3 = MB plough 1 time + Cultivator 2 times + Planking 2 Times

T_4 = Rotavator 1 time + Disc Harrow 1 time + Planking 2 Times

The net plot size was 12 m × 44 m for each experimental unit during both years.

Data Collection and Statistical Analysis
Data regarding, plant height at maturity, number of fertile tillers, number of grains per spike, 1000-grain weight and paddy yield was collected using the standard procedures. The collected data were analysed statistically by employing the Fisher's analysis of variance technique. The significance of treatment means was tested using least significance difference (LSD) test at 5% probability level (Steel et al. 1997).

Results and Discussion

Plant Height (cm)
Plant height of rice was significantly affected by different land preparation techniques (Table-1). Data presented in table 1 shows that land preparation technique T_2 (MB Plough (1 time) + Disc Harrow (1 time) + Planking (2 times) gave the maximum plant height during both the years i.e., 2017 (134 cm) and 2018 (132 cm) as compared to other land preparation techniques. The plant height (131.00 and 129.33 cm during 2017 and 2018, respectively) in treatment T_3 (MB plough 1 time + Cultivator 2 times + Planking 2 Times) was also statistically at par with that of plant height in T_2 (Table-1). Traditional land preparation technique T_1 comprising only cultivator (4 times) + Planking (2 times) had the lowest plant height (121 and 122.33 cm for 2017 and 2018, respectively) among all the applied treatments during both years (Table-1).

Number of Productive Tillers (m²)
Productive tillers are the most important yield contributing parameter in rice crop. Data presented in table-2 reveals that for both the years i.e., 2017 and 2018, land prepared by using T_2 i.e., MB Plough (1 time) + Disc Harrow (1 time) and Planking (2 times) gave the highest number of productive tillers i.e., 224 and 220 for 2017 and 2018, respectively. The number of productive tillers (220 and 213 m^{-2} for 2017 and 2018, respectively) with the use of T_3 (MB plough 1 time + Cultivator 2 times + Planking 2 Times) was also statistically similar to T_2. However, land prepared by using MB Plough (2 times) + cultivator (2 times) + Planking (2 times) also gave the similar result for 2017 only as 220 tillers per m^2 were recorded in this treatment for 2017. Lowest number of productive tillers (207 and 202 m^{-2} for 2017 and 2018 respectively) were observed in T_1 where cultivator (4 times) and planking (2 times) were used for both the years (Table-2).

Number of Grains Per Spike
Different land preparation techniques significantly affected the number of grains per spike during both the years. Results given in Table-3 depict that maximum number of grains per spike (130 and 116 grain per spike for 2017 and 2018, respectively) were observed in case of T_2 where MB Plough (1 time) + Disc Harrow (1 time) + Planking (2 times) was used for both years. Moreover, in T_3 i.e., MB Plough (1 time) + Disc Harrow (1 time) + Planking (2 times), the number of grains per spike (127 and 112 for 2017 and 2018, respectively) were also statistically similar to T_2. Minimum number of grains per spike (121 and 103 for 2017 and 2018 respectively) were recorded in traditional land preparation technique where only cultivator (4 times) + planking (2 times) was used during both years (Table-3).

Table 1. Effect of different land preparation techniques on plant height (cm) under Agro-ecological conditions of Sheikhupura-Pakistan during Kharif 2017 and 2018

Treatments	2017	2018
Cultivator (4 times) + Planking (2 times) (Farmer's Practice)	121.00[b]	122.33[c]
MB plough (1 time) + Disc Harrow (1 time) + Planking (2 Times)	134.00[a]	132.00[a]
MB plough (1 time) + Cultivator (2 times) + Planking (2 Times)	131.00[a]	129.33[ab]
Rotavator (1 time) + Disc Harrow (1 time) + Planking (2 Times)	128.00[ab]	125.00[bc]
LSD (P≤0.05)	7.18	4.76

Table 2. Effect of different land preparation techniques on number of productive tillers (m^2) under Agro-ecological conditions of Sheikhupura-Pakistan during Kharif 2017 and 2018

Treatments	2017	2018
Cultivator (4 times) + Planking (2 times) (Farmer's Practice)	207.0[c]	202.0[c]
MB plough (1 time) + Disc Harrow (1 time) + Planking (2 Times)	224.0[a]	220.0[a]
MB plough (1 time) + Cultivator (2 times) + Planking (2 Times)	220.0[a]	213.0[ab]
Rotavator (1 time) + Disc Harrow (1 time) + Planking (2 Times)	214.0[b]	209.0[bc]
LSD (P≤0.05)	5.50	8.72

Table3. Effect of different land preparation techniques on number of grains per spike under Agro-ecological conditions of Sheikhupura-Pakistan during Kharif 2017 and 2018

Treatments	2017	2018
Cultivator (4 times) + Planking (2 times) (Farmer's Practice)	121.0[c]	103.0[c]
MB plough (1 time) + Disc Harrow (1 time) + Planking (2 Times)	130.0[a]	116.0[a]
MB plough (1 time) + Cultivator (2 times) + Planking (2 Times)	127.0[ab]	112.0[ab]
Rotavator (1 time) + Disc Harrow (1 time) + Planking (2 Times)	123.0[bc]	109.0[b]
LSD (P≤0.05)	5.62	5.40

Table 4. Effect of different land preparation techniques on 1000-grain weight (g) under Agro-ecological conditions of Sheikhupura-Pakistan during Kharif 2017 and 2018

Treatments	2017	2018
Cultivator (4 times) + Planking (2 times) (Farmer's Practice)	19.5[c]	19.0[b]
MB plough (1 time) + Disc Harrow (1 time) + Planking (2 Times)	23.0[a]	22.0[a]
MB plough (1 time) + Cultivator (2 times) + Planking (2 Times)	22.0[ab]	21.5[ab]
Rotavator (1 time) + Disc Harrow (1 time) + Planking (2 Times)	21.5[b]	20.0[ab]
LSD (P≤0.05)	1.29	2.59

Table 5. Effect of different land preparation techniques on paddy yield (kg ha^{-1}) under Agro-ecological conditions of Sheikhupura-Pakistan during Kharif 2017 and 2018

Treatments	2017	2018
Cultivator (4 times) + Planking (2 times) (Farmer's Practice)	3700c	3360d
MB plough (1 time) + Disc Harrow (1 time) + Planking (2 Times)	4200a	3950a
MB plough (1 time) + Cultivator (2 times) + Planking (2 Times)	4000b	3850b
Rotavator (1 time) + Disc Harrow (1 time) + Planking (2 Times)	3750c	3650c
LSD (P≤0.05)	99.89	66.01

Table 6. Cost benefit analysis for paddy production using different land preparation techniques under Agro-ecological conditions of Sheikhupura-Pakistan during Kharif 2017 and 2018

Treatments	2017	2018
Cultivator (4 times) + Planking (2 times) (Farmer's Practice)	0.17	0.15
MB plough (1 time) + Disc Harrow (1 time) + Planking (2 Times)	0.19	0.18
MB plough (1 time) + Cultivator (2 times) + Planking (2 Times)	0.18	0.17
Rotavator (1 time) + Disc Harrow (1 time) + Planking (2 Times)	0.17	0.16

1000-Grain Weight (g)

Grain weight index was also significantly affected by all the land preparation techniques as presented in Table-4. The highest 1000-grain weight 23 g (2017) and 22.0 g (2018) was recorded with the use of T_2 having MB Plough (1 time) + Disc Harrow (1 time) + Planking (2 times). In treatment T_3 having MB plough (1 time) + Cultivator (2 times) + Planking (2 Times) were also recorded the statistically similar results during Kharif-2017. T_1(Cultivator (4 times) + Planking (2 times) for both years 2017 and 2018 showed the lowest 1000 grain weight. The minimum 1000-grain weight i.e., 21.5 g and 20.0 g respectively for 2017 and 2018 was recorded when cultivator (4 times) + planking (2 times) was used for land preparation (Table-4).

Paddy Yield (kg ha⁻¹)

A significant effect of different land preparation techniques was observed on paddy yield during year 2018 by the application of different land preparation techniques as presented in Table-5. Highest paddy yields 4200 kg ha^{-1} and 3950 kg ha^{-1} for the year 2017 and 2018, respectively was recorded in T_2 when MB Plough (1 time) + Disc Harrow (1 time) + Planking (2 times) was used for the land preparation. Moreover, statistically similar results were recorded from Cultivator (4 times) + Planking (2 times) and Rotavator (1 time) + Disc Harrow (1 time) + Planking (2 Times) only for the year 2017. Minimum paddy yields 3700 kg ha^{-1} and 3360 kg ha^{-1} for the year 2017 and 2018 respectively was recorded in case of Cultivator (4 times + Planking (2 times) at Adaptive Research Farm, Shiekhupura (Table 5).

Cost Benefit Analysis

The final paddy yield achieved in each treatment was divided by the cost incurred in that treatment to find the cost benefit ratio as presented in table-6. The values are describing the paddy yield in kg achieved with each PKR (Pak-Rupee) incurred on producing the paddy. It showed that the highest return (0.19 and 0.18 kg per PKR for 2017 and 2018) was gained with the application of treatment T_2 i.e., MB plough (1 time) + Disc Harrow (1 time) + Planking (2 Times). The net return in case of T_3 was also more or less equal to that of T_2, however in case of T_1 and T_4, the net return was much lesser as compared to that of T_2 and T3.

It is well reported in literature that different tillage practices alter soil physical, chemical and biological properties that ultimately affect the final crop yield (Çarman, 1997; Ozpinar and Clay, 2006; Rashidi and Keshavarzpour, 2007). In case of rice, soil tillage is generally associated with puddling intensity and puddling intensity has significant effect on soil bulk density (Sharma et al., 2005), its structure and hydraulic conductivity (Kakul and Aggarwal, 2002) and penetration resistance (Mohanty et al.,2004).Results given in table 1-5 show that different land preparation techniques had significantly affected the yield of paddy and all other yield contributing parameters like number of tillers, number of grains per spike and 1000 grain weight. It might be due to change in soil structure and different soil physical properties including bulk density, porosity water holding capacity etc. Shad and De Datta (1986) showed that among zero, minimum and conventional tillage, the last one i.e., conventional tillage is best for growing rice as it gave highest paddy yield. It is also reported that increasing the tillage intensity in clay soils increase the root volume of rice plant that causes better aeration and more nutrient uptake which might be the best possible explanation for higher paddy yield under deep tillage systems than in zero and minimum tillage (Sharma et al., 1988). Different tillage techniques impose significant effect on puddling index, infiltration rate and grain yield of rice crop (Tripathi et al., 2007). Deep tillage or intensive tillage decrease hydraulic conductivity of soil that in turn decreases evaporation from the surface of soil limiting the evaporation losses from the soil surface (Ringrose-Voase et al., 2002). In the present study, highest yield in one double puddling might be due to optimum puddling density that optimized the evaporation from soil surface, increased

soil aeration and did not affect the penetration resistance to risky extents whereas in case of dry land preparation and of two double puddles all these soil properties were modified in such a way that did not favour the plant growth ultimately leading to lower paddy yields. The highest yield and all other associated parameters in case of T2 could be considered as the result of use of disc harrow for land preparation. It is well documented in literature that the use of disk harrow increases soil pulverization than that of moldboard plough (Nassir et al, 2016; Aday et al, 2001). In this study, the use of disk harrow might had increased the soil pulverization leading toward more root penetration in the soil to extract mote nutrient ultimately increasing the crop yield. The use of MB plough had also done the same but the level of pulverization was less than that of disk harrow, so a little lower yield was recorded in case of use of MB plough.

Conclusion

The present study suggests that under agro-ecological conditions of Sheikhupura-Pakistan, T_2 (MB plough 1 time + Disc Harrow 1 time + Planking 2 Times) is the best land preparation method for optimum paddy yields, so it should be adapted by farmers of this region.

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