Pak. j. life soc. Sci. (2017), 15(1): 7-10 E-ISSN: 2221-7630;P-ISSN: 1727-4915

Pakistan Journal of Life and Social Sciences
www.pjlss.edu.pk

RESEARCH ARTICLE

Effects of Different Tillage Implements on the Growth and Yield of Wheat in Cotton-Wheat Zone of Pakistan

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ARTICLE INFO
Received: Mar 07, 2016
Accepted: Jan 09, 2017

Keywords
Tillage implements
Wheat production
Yield components
Benefit cost ratio

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ABSTRACT

The current study was carried out to evaluate the effects of different tillage implements on growth and yield of wheat at farmer's field in District Toba Tek Singh, Punjab-Pakistan during 2013-14 and 2014-15. Randomize complete block design with five treatments and three replications was used in the study. The treatments T1: 1 cultivator, 1 disc harrow and 1 planking (CDP); T2: 1 mouldboard plough, 1 disc harrow and 1 planking (MDP); T3: 1 cultivator, 1 rotavator and 1 planking (CRP); T4: 1 mouldboard plough, 1 rotavator and 1 planking (MRP); and T5: 2 cultivator and 1 planking (CP) were applied. Maximum germination rate (276.2 Nos.) was obtained, when T4 (MRP) was used, while minimum germination rate (255.5 Nos.) was recorded when T5 (CP) was used. Maximum grains per spikes (33.7 Nos.) were recorded in T4 (MRP). Tillage implement practiced in T4 (MRP) yielded 421.38 tillers per square meter which were significantly higher than all other tillage implements. Similarly, T4 (MRP) showed higher grain yield (4439.7 kg/ha) as compared to other four tillage practices. The benefit cost ratio for T4 (MRP) is 3.41 which is higher than other tillage practices used in this research. The tillage practice of T4 (MRP) is recommended in cotton-wheat zone of Pakistan after the harvesting of cotton.

INTRODUCTION

Wheat is considered to be the most important staple crop of Pakistan since 1960's and major contributor to Pakistan's Gross Domestic Product (GDP). Most of the Pakistan's population derives up to 45% of nutrition from wheat. It is essential part of meal for poor and rich families of Pakistan. Agriculture sector has a share of 21% in total GDP of the country. Production level of wheat in Pakistan in 1961 was 822.16 kg/ha and very slowly reached up to 2,832.79 kg/ha in 2011 (FAO, 2012). Pakistan could not perform notably in wheat production comparing to its neighboring countries such as China. In 1961, China's wheat yield was 559.1 kg/ha which was increased to 4837.58 kg/ha in 2011 (FAO, 2012). One of the reasons of declining crop production is the soil health which can be degraded by use of unsuitable management practices (Ramos at al., 2011). The key aspect which affects crop yield and properties of soil is the soil tillage (Khurshid et al., 2006).

Tillage is mechanical handling of soil which makes the soil fine and favorable for planting, affects soil properties and provides favorable conditions for the growth and development of plants (Abolanle et al., 2015). The change in soil properties brought by the tillage can effect infiltration, evaporation and water distribution in soil after rainfall (Schwartz et al., 2010). The increased infiltration after tillage can be changed during wetting and drying processes of soil (Moret and Arrue, 2007). Some features of soil can be improved by reduced tillage operations while they can be deteriorated by excessive and unnecessary tillage operations. So there is dire need to shift from over tillage operations to less or no tillage operation (Iqbal et al., 2005) as use of conventional tillage operations, energy resources results in wastage including rigorous soil handling and un-stability (Wang et al., 2012). Tillage can be categorized as conservation or conventional tillage (FAO, 2000). Conservation tillage is valuable than conventional tillage as it improves soil

physical and chemical properties increases crop yields (Abolanle et al., 2015; FAO, 2000).

One of the main reasons, limiting the wheat production in Pakistan is inappropriate use of tillage and planting equipments in the farmer's field. Tillage implements which are being used in the field had various effects on crop yield (Ahmad et al., 1990; Rehman et al., 1995; Usman et al., 2010). Crop yield and production can be increased by use of proper tillage operations (Memon et al., 2013).

The purpose of this study was to evaluate the effects of different tillage implements used in the preparation of field before sowing of wheat. In this study, the disc harrow, cultivator, rotavator, chisel plough and planking have been used as a primary tillage implements and their effects have been evaluated on the germination, productive tiller, number of grains and yield of wheat.

MATERIALS AND METHODS

This study was conducted at farmer's field in Toba Tek Singh, Punjab, Pakistan during 2013-2014 and repeated in 2014-2015 to evaluate the effect of different tillage implements on the growth and yield of wheat (Fig. 1). The soil analysis showed that the soil at the site was clay loam with 32% silt, 37% sand and 31% clay. The water requirement of the crop during the research was fulfilled by canal water from the Khikhi Distributary and from Tube-well water. A randomize complete block design (RCBD) with five treatments and three replications was used in this study. The treatments were designed as follows:

T1: CDPCultivator (1) + Disk Harrow (1) + Planking (1)

T2: MDP Mouldboard plough (1) + Disk Harrow (1) + Planking (1)

T3: CRPCultivator (1) + Rotavator (1) + Planking (1)

T4: MRP Mouldboard plough (1) + Rotavator (1) + Planking (1)

T5: CP Cultivator (2) + Planking (1)

The net plot size was 0.25 ha for each treatment. The crop was sown in rows on 20th November in both years using drill machine after the harvest of cotton. The quantity and variety of seed, fertilizer, measures for the protection of plants, quantity of irrigation water, harvesting and threshing methods were same for all treatments. The quantity of seed was 100 kg/ha of wheat variety 8203 was sown. The total quantity of fertilizers used for all the treatments were DAP (50 kg), SOP (50 kg) and Urea (100 kg). Quantity of irrigation water per treatment was 975 m^3. Buctrial super (500 ml) and axial (250 ml) were sprayed as plant protection measures on all treatments. The crop was harvested manually and threshed using thresher machine. The layout of the experimental field is shown in Fig. 2.

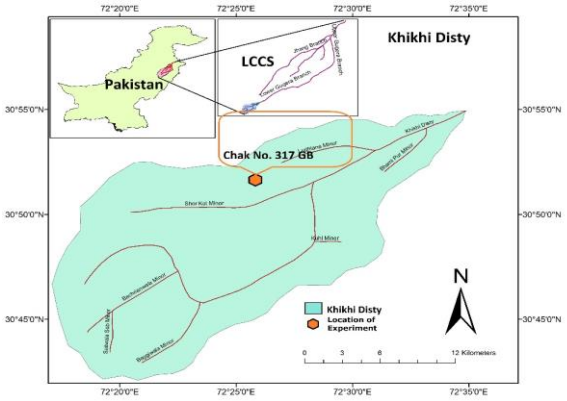

Fig. 1: Location of study area

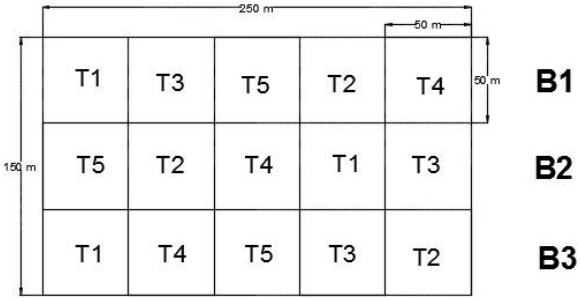

Fig. 2: Layout of experimental field

RESULTS AND DISCUSSION

Germination rate (GR)

Data of germination rate (GR) per square meter is presented in Table 1. Analysis of variance showed that different tillage implements have significant effect on GR. Maximum GR was obtained, when MRP (276.17 Nos.) was used, while minimum GR was recorded when CP (255.5 Nos.) was used. CRP showed significant results with MRP and CP, and showed non-significant results for MDP (269.5 Nos.) and CDP (262.83 Nos.). Similar results have been shown previously by Prasad (1995).

No. of grains per spike

Maximum grains per spikes were recorded by MRP (33.66 Nos.) which is non-significant with MDP (32.83 Nos.), CDP (31.66 Nos.) and CRP (32 Nos.). Minimum grains/spikes were recorded by CP (30.66 Nos.) which is non-significant with CDP (31.66 Nos.) and CRP (32.00 Nos.). These results are shown in Table 1.

1000 grain weight

Tillage implements have significant effect on 1000 grain weight. CRP produced highest weight (32.333 g) of 1000 grain which is non-significant with MRP (31.833 g) and MDP (31.333 g) and significant with CDP (29.667 g) and CP (28.833 g). Bukhari et al. (1992) also found the similar results in their study. The CP produced lowest weight of 1000 grains. These findings are shown in Table 1.

Table 1: Yield and yield parameters of wheat crop

Tillage practice (T)	Germination rate/m^2	Productive tillers/m^2	No. of grains/ spike	1000 grain weight(g)	Grain Yield (kg/ha)
T1: CDP	262.83^{bc}	391.33^{c}	31.667^{ab}	29.667^{bc}	3484.0^{c}
T2: MDP	269.50^{ab}	405.50^{b}	32.833^{a}	31.333^{ab}	3878.8^{b}
T3: CRP	265.33^{b}	402.50^{b}	32.000^{ab}	32.333^{a}	3827.2^{b}
T4: MRP	276.17^{a}	421.83^{a}	33.667^{a}	31.833^{a}	4439.7^{a}
T5:CP	255.50^{c}	376.00^{d}	30.667^{b}	28.833^{c}	3091.7^{d}
LSD	9.3132	3.5794	2.1318	1.8657	343.00

Treatment mean with different letters are significantly different (P=0.05).

Table 2: Cost of production of wheat (Rs./ha)

Operation/Input	Quantity/Amount	Rate/Unit (Rs.)	Cost/ha (Rs.)
Tillage techniques			
T1: Cultivator + Disk Harrow + Planking	1+1+1	800+1800+700	3300
T2: Mouldboard + Disk Harrow + Planking	1+1+1	2200+1800+700	4700
T3: Cultivator + Rotavator + Planking	1+1+1	800+2200+700	3700
T4: Mouldboard + Rotavator + Planking	1+1+1	2200+2200+700	5100
T5: Cultivator + Planking	2+1	1600+700	2300
Seed and sowing charges			
Seed	100 Kg/ha	47/Kg	4700
Sowing by drill	--	2000/ha	2000
Fertilizer (Bag)			
DAP	50 kg	3700/50 kg	3700
Urea	100 kg	1850/50 kg	3700
SOP	50 kg	4000/50 kg	4000
Irrigation			
Canal Irrigation	3 irrigation	200/season	200
Tubewell irrigation	1 irrigation	350/irrigation	350
Inter-culture			
Spray	2	650/Application	1300
Harvesting			
Harvesting charges	--	300 kg wheat/ha	9750
Threshing charges	--	7500/ha	7500
Total Expenditures cost (Rs.)			
T1: CDP		40500	
T2: MDP		41900	
T3: CRP		40900	
T4: MRP		42300	
T5:CP		39500	

Table 3: Economic analysis of different tillage implements in cotton-wheat cropping system

Tillage	Total income (Rs. ha-1)	Total Expenditure cost (Rs. ha-1)	BCR
T1: CDP	113230	40500	2.79
T2: MDP	126061	41900	3.00
T3: CRP	124416	40900	3.04
T4: MRP	144290	42300	3.41
T5:CP	100480	39500	2.54

BCR= Benefit cost ratio.

Productive tillers (PR)

Tillage implement MRP yielded 421.38 tillers per square meter which were significantly higher than all other tillage implements. The MDP (405.5 Nos.) and CRP (402.5 Nos.) showed non-significant effect among each other but significant effect for CDP (391.33 Nos.) regarding productive tillers. The CP yielded significantly lowest productive tillers (376) as shown in Table 1. These results are in line with findings of Prasad (1995).

Tillage practices showed significant difference among each other. The MRP exhibited more grain yield (4439.7 kg/ha) as compared to other four tillage practices. Similar results have been reported previously (Asadi et al., 1998; Hemmat and Asadi, 1998). The MDP and CRP showed non-significant behaviour. The CDP and CP were significant from each other. The effects of tillage practices on grain yield are shown in Table 1 and Fig. 3.

Economic analysis

The economic analysis of any agronomic practice is essential from farmer's point of view, as they are often interested in benefits and cost of a certain technology/ technique. The benefit cost ratio is an indicator that shows the profitability and adoptability of any new sowing technique. If the benefit cost ratio workout is less than 1, then the present worth of the costs at this discount rate would have exceeded the present worth of the benefit and would not recover initial expenditure plus the return on investment from the farm practice.

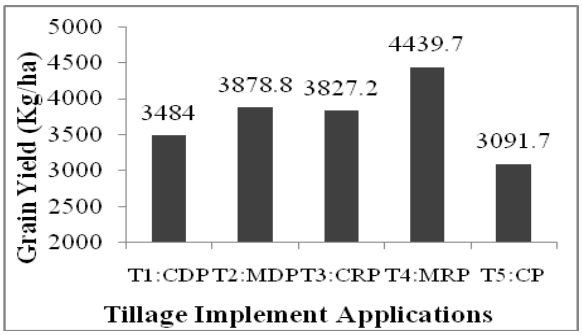

Fig. 3: Effects of different tillage implements on grain yield Grain yield (kg/ha)

Total cost of wheat production including field preparation, seed, fertilizers, irrigation and harvesting cost has been given in Table 2. The data in table 3 showed a higher benefit cost ratio under the MRP practice as compared with other tillage practices. This was due to the sowing of crop on more pulverized seed bed at proper time. These results are also in contrast with Hughes and Baker (1977). In conclusion, the tillage practice of MRP in T4 showed the highest germination rate and productive tillers per square meter and ultimately the highest grain yield as compared to the tillage practices in other treatments. So the tillage practice of MRP is recommended as the best tillage practice in terms of benefit cost ratio for clay loam soils in cotton-wheat zone of Pakistan after the harvesting of cotton.

Authors' contributions

All authors contributed equally in this experiment.

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