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Research Article
Effect of various tillage implements on the growth and yield of wheat

Mueen-ud-din[1], Umm-e-Kalsoom[2], Laila Khalid[3*] Dr. Alamgir Akhtar Khan[4], Masood Qadir Waqar[5] and Muhammad Anjum Ali[6]

[1]Senior Subject Matter Specialist (Agronomy), Department of Adaptive Research Farm, Vehari
[2]Assistant Research Officer (Engineering), Department of Adaptive Research Farm, Vehari
[3]Research Officer Adaptive research Station Bahawalnagar
[4]Assistant Agricultural Engineer, AMRI, Multan
[5] Director, Adaptive Research Punjab, Pakistan
[6] Director General, Agriculture (Ext.) Punjab, Pakistan
*Corresponding Author

Keywords

Wheat,
tillage implements,
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and
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Abstract

Field experiment was conducted in ecological zone of Vehari at Adaptive Research Farm, Vehari, Pakistan during the year 2010-2012 to find out the effect of different combinations of tillage implements on wheat production and its growth parameters. Experiments were conducted using a randomized complete block design with and each treatment being replicated three times. Tillage treatments consisted of five practices that are T_1 (one pass of disc harrow, two passes of cultivator and one planking), T_2 (one pass of disc harrow, one pass of rotavator and one planking), T_3 (two passes of rotavator, two passes of cultivator and one planking), T_4 (one pass of chisel, one pass of rotavator and one planking) and T_5 (four passes of cultivator and two passes of planker). Results revealed that tillage practices had a significant influence on germination (m^{-2}), number of grain per spike, 1000-grain weight (g) and grain yield (kg/ha) of wheat crop. On the other hand it has no significant effect on numbers of tillers (m^{-2}) and plant height (cm). The plots ploughed by two passes of rotavator, two passes of cultivator and one planking (T_3) gave the highest germination 204.34 per sq. m and grain yield 4305.15 kg/ha followed by the plots ploughed by one pass of chisel, one pass of rotavator and one planking (T_4) with 203.34 per sq. m germination and grain yield of 4130.5 kg/ha on an average for the year 2010-11 and 2011-12 as compared to other combinations.

Introduction

Wheat is the chief cereal crop in the world and is grown on large area. Wheat crop is the most important food crop in third world countries and has a vital role in their national economies. About 8.91 million hectares area was sown in Pakistan, with an average yield of 2750 kg ha^{-1} (MINFAL, 2011). For better wheat production, land preparation and sowing methods are important operations. To increase agricultural productivity, agricultural machinery is an important factor as far as tillage and sowing practices are concerned. In Pakistan, lack of appropriate tillage implements and planting equipments are the major constraints limiting crop yield. In mechanized agriculture soil compaction is one of the serious problem which affects many soil properties and yield. Decreased emergence, weak stem, thin tillers, irregular growth, small grain per spikes, abnormal rooting patterns, and reduced soil organic matter is the reflection of the soil compaction in wheat crop.

The purpose of tillage for crop production is to create the best possible condition for seed germination and emergence, maintaining adequate soil moisture and maximized crop yield (Picker *et al.,* 2001).The improper use of tillage implements restrict the root growth, compact the soil, increase fuel expenditure and reduce crops yield (Hussain and Munir, 1986).Tillage operations had diverse effects on the emergence and yield of crops (Sheikh *et al.,* 1978; Ahmad *et al.,* 1990;

Rehman *et al.,* 1995). Studies have indicated that some form of deep tillage is needed prior to planting wheat (Hargrove and Hardcastle, 1984; Karlan and Gooden, 1987). The grain yield was higher with chisel and rotavator used in combination as compared to cultivator and plank for seed bed preparation of wheat after paddy harvesting (Sing and Pansar, 1991; Ahmad *et al.,* 2008). Manian *et al.,* (1999); Karayel and Ozmerzi (2003) and Iqbal *et al.,* (2007) studied on wheat response to tillage and found maximum yield from plot plowed with one pass of cultivator and one pass of rotavator. Keeping in view the importance of tillage practices and sowing methods, the present study was conducted by using locally available tillage and sowing implements with objectives, to determine the performance of different tillage implements and sowing methods on emergence, number of tillers and harvest index of wheat.

Materials and Methods

Experimental site

Field experiments were conducted at the Adaptive Research Farm, Vehari, Punjab, during 2010-2011 and 2011-2012 on wheat crop, to study the effect of different tillage implements for improving productivity of wheat crop under irrigated conditions. The site was situated at 30° 01' 56" N latitude and 72° 21' 22" E longitude, while the elevation is 455 ft. The weather of the study area is sub-tropical. The climate of the district is hot and dry in summer and cold in winter. The maximum and minimum temperature ranges between 42°C and 28°C in summer. During winter, the temperature fluctuates between 21°C and 5°C. The average rainfall is about 127 mm. The topography of the study area is plain land and moderately well drained. The soil on the site is clayey loam.

Tillage Practices

Study was conducted by using various tillage implements and treatments consisted of T_1= Disk harrow (1) + Cultivator (2) + Planking (1); T_2= Disk harrow (1) + Rotavator (1) + Planking (1); T_3= Rotavator (2) + Cultivator (2) + Planking (1); T_4= Chisel (1) + Rotavator (1) + Planking (1) and T_5= Cultivator (4) + Planking (2). Effect of these primary and secondary tillage implements used for primary bed preparation before sowing was observed on the growth and yield of wheat.

Sowing

Wheat variety Sahar-2006 was sown in mid November according to RCBD with three replications. The tillage implements used in the experiment were cultivator, disk harrow, chisel plow, rotavator, planker while sowing was completed mechanically through seed drill. Drill was adjusted and calibrated at the seed rate of 125 kg ha^{-1} for wheat crop before sowing.

The net plot size was (18.28 m * 11 m) and (19 m * 13.7 m) for the year 2010-11 and 2011-12 respectively.

Management practices

Full dose of P_2O_5 i.e., 114 kg/ha was applied at the time of sowing and half dose of N i.e., 64 kg/ha and remaining half dose of N was applied at the time of second irrigation. Isoprotoran was applied as and when needed for both the study years.

Observed data

1. Germination count (m^{-2})
2. Number of tillers (m^{-2})
3. Plant height (cm)
4. 1000 grain weight (g)
5. Grain yield (kg/ha)

Statistical analysis

Data on plant characteristics such as germination count, number of tillers m^{-2}, plant height (cm), no. of grains/spike, thousand grain wt (TGW), and grain yield were recorded from each of the experimental plot and were subjected to analysis of variance to sort out significant difference among treatments. MSTAT-C was used to find least significant difference (LSD) at 5% for the treatment means.

Results and Discussion

Number of germination (m^{-2})

Data concerning number of germination counts is shown in Table 1. Statistical analysis of the data revealed that the different combinations of tillage implements have significant results on germination counts for the growing seasons. Average maximum germination counts were recorded as 219.67 in T_3 for the Rabi 2010-11 and 198 in T_2 & T_3 for Rabi 2011-12. On the other hand, lowest value were recorded as 177.67 and 185 in T_5 (farmers practice) for Rabi 2010-11 and 2011-12 respectively. This variation is purely an effect of the combination of cultural practices. Sorour *et al.,* (1995) reported significant differences in the emergence.m^{-2} of wheat seeds.

Number of tiller (m^{-2})

Different combinations of tillage implements have non-significant effect on tillering counts. Data regarding number of tillers m^{-2} is presented in table 1. Average maximum tillering counts were recorded as 322.66 and 327.33 in T_3 for the Rabi 2010-11 and 2011-12 respectively. On the other hand, lowest values were recorded as 294.33 and 304.33 in T_1 for the Rabi 2010-11 and 2011-12 respectively.

Plant height (cm)

Data concerning plant height is shown in Table 1. Statistical analysis of the data showed that plant height has non-significantly ($P \leq 0.05$) affected by the different combinations of tillage implements. Average values for plant height of different tillage practice ranged from 97.23 to 108 cm. Average value of the data (2010-11) indicated that taller plants were produced from those plots on which T_3 was applied (113.4 cm), while shorter plants (108 cm) were noted in the plots where T_2 was applied. Similarly, average value of the data (2011-12) indicated that taller plants were produced from those plots on which T_5 was applied (101.57 cm), while shorter plants (97.23 cm) were noted in the plots where T_3 was applied. The possible reason for this variation could be the availability of more space, light and nutrients to wheat plants and water applied. The results are in line with Javadi *et al.,* (2009) that reported that there was no significant difference in plant height between different tillage implements.

1000-grain weight (g)

Data recorded on thousand-grain weight is shown in Table 1 for the two growing seasons. Analysis of the data revealed that 1000-grain weight was significantly ($P \leq 0.05$) affected by the different combinations of tillage implements. The data also indicated that maximum thousand grain weights (40.3 and 49.15) were recorded from the plots on which T_3 and T_4 treatments were applied, while minimum thousand grain weight (39 and 44.44) were recorded from plots where farmer practice was adopted (T_5) for both Rabi seasons 2010-11 and 2011-12.

Grain yield (kg ha^{-1})

The effect of different combination of tillage implements was found significant on grain yield (Table: 1). It was observed that grain yield was increased with the more efficiently combination of tillage implements. Maximum grain yield was obtained from T3 (Rotavator (2) + Cultivator (2) + Planking (1)) for the Rabi 2010-11 and 2011-12 in comparison of farmers practice (T5). On an average, 2.34, 3.75, 6.5 and 10.96 % yields were increased than that of farmer's practice under T1, T2, T4 and T3 respectively for 2010-11. Similarly, for 2011-12, on an average, 2.31, 2.71, 3.97 and 8.42 % yields were increased than that of farmer's practice under T1, T2, T4 and T3 respectively. These results indicated that wheat was quite responsive to increase yield in optimal combinations of tillage implements used efficiently. Deep tillage treatments were more suitable for breaking, inverting and pulverizing the soil as compared to shallow tillage treatments, reducing the bulk density of the soil as reported by Ahmad and Mauryia (2008). Deep tillage and conservation practices can be maintained by using a chisel plow instead of other implements, prior to planting wheat.

Table 1: The effect of different tillage implements on grain yield and yield components of wheat for the Rabi season 2010-11 and 2011-12.

Year	Treatments	Average germination counts (m^{-2})	Avg. Tiller counts (m^{-2})	Average plant height (cm)	Average 1000-grain weight (g)	Average grain yield (kg/ ha)
2010-11	T_1	186.33 CD	294.33	108.60	39.70 D	4017 FG
	T_2	190.67 CD	305.00	108.00	39.90 D	4072 DE
	T_3	210.67 AB	322.66	113.40	40.30 D	4355 A
	T_4	219.67 A	319.33	106.80	40.10 D	4180 C
	T_5	177.67 D	296.00	109.53	39.00 D	3925 H
2011-12	T_1	187.00 CD	304.33	100.57	46.45 B	4015.7 FG
	T_2	198.00 BC	326.67	100.33	47.06 B	4031.3 EF
	T_3	198.00 BC	327.33	97.23	47.60 B	4255.3 B
	T_4	187.00 CD	304.67	100.60	49.15 A	4081 D
	T_5	185.00 CD	309.00	101.57	44.44 C	3930.7 G
LSD		**17.09**	**Non-significant**	**Non-significant**	**1.279**	**41.89**

Table 2: Average values of all parameters from 2010-2012

Treatments	Average germination counts (m^{-2})	Avg. Tiller counts (m^{-2})	Average plant height (cm)	Average 1000-grain weight (g)	Average grain yield (kg/ ha)
T_1	186.67	299.33	104.58	43.08	4016.35
T_2	194.34	315.83	104.17	43.48	4051.65
T_3	204.34	325.00	105.32	43.95	4305.15
T_4	203.34	312.00	103.70	44.63	4130.50
T_5	181.34	302.50	105.55	41.72	3927.85

Table 3: Percentage increase in wheat yield (kg/ha) in comparison of farmer practice (T_5) for the year 2010-11 and 2011-12

Treatments	Combined Avg. yield of 2010-11 and 2011-12 (kg/ha)	Percentage increase in wheat yield (%)
T5	3927.85	-
T1	4016.35	2.253141
T2	4051.65	3.151852
T4	4130.5	5.159311
T3	4305.15	9.605764

Table 3 shows that the highest yield was produced in T_3 (combination of rotavator, cultivator and planker) with 9.605% yield increase for both study years i.e., 2010-11 and 2011-12 in comparison of farmers practice/ control treatment (T_5) which has produced the least avg. yield i.e., 3925 kg/ha. Treatment T_4 has also performed well and yielded 5.15% increase for the year 2010-11 and 2011-12 in comparison of farmers practice/ control treatment.

Conclusion

The results concluded that different tillage implements have varied effects on wheat yield and other growth parameters when used in different combinations. It has significantly ($p<0.05$) affected germination, 1000-grain weight and yield during both years of the study. Combination of two passes of rotavator, two passes of cultivator and one pass of planker has improved grain yield (4305.15 kg/ha) over 2 years in comparison of other combinations of tillage implements. Therefore under ecological zone of Vehari, this tillage implement combination for wheat crop can be recommended in the region.

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