RESPONSE OF WHEAT GROWTH CHARACTERISTICS TO VARIOUS TILLAGE PRACTICES AND SOWING METHODS UNDER SEMI ARID ENVIRONMENT

MUHAMMAD AMIN¹, MUHAMMAD JAMAL KHAN²,
MUHAMMAD TARIQ JAN³ and JAVAID AKHTAR TARIQ²

¹ Department of Agricultural Mechanization, The University of Agriculture, Peshawar - Pakistan.
² Department of Water Management, The University of Agriculture, Peshawar - Pakistan.
³ Department of Agronomy, The University of Agriculture, Peshawar - Pakistan.

*Corresponding author: dr.amin_mechanization@yahoo.com

ABSTRACT

Field experiments were conducted at the research farm of The University of Agriculture Peshawar, Khyber Pakhtunkhwa, Pakistan during 2009-2010 and 2010-2011, to study the effect of tillage practices and sowing methods on emergence, number of tillers, plant height, spike length, and harvest index of wheat under Randomize Complete Block Design (RCBD) with split plot arrangement replicated four times. Tillage practices consisted of Tine Cultivator twice (TC-2), Chisel plow followed by rotavator (CR), Mouldboard plow followed by rotavator (MR), Disc plow followed by rotavator (DR) and Tine Cultivator followed by rotavator (TCR) assigned to main plots, while sowing methods included broadcast (BC) and drilling, (Single box seed drill (SD) and Combined drill (CD) assigned to sub plots. Statistical analysis of the two year data revealed that tillage practices had significant effect on number of tillers, and non significant effect on emergence, plant height, spike length and harvest index. Similarly the effect of sowing methods was significant for emergence, number of tillers, spike length and harvest index. The data revealed that maximum emergence, number of tillers, and harvest index was recorded in the plots tilled with tillage implements followed by rotavator as compared to the sole used of tine cultivator twice (TC-2). Similarly sowing by drills produced maximum emergence, number of tillers, spike length and harvest index (%) as compared to broadcasting. It is concluded from the results that tillage implements followed by rotavator combination performed well and should be used for tillage practices and sowing by drill method should be used to improve emergence, number of tillers, spike length and harvest index of wheat in arid environment.

Keywords: Tillage practices, sowing methods, wheat emergence, number of tillers m⁻², harvest index


INTRODUCTION

Wheat is the most important cereal crop in the world and is grown on large area. In Pakistan it was sown on an area of about 8.805 million hectares, with an average yield of 2750 kg ha⁻¹ (MINFAL, 2011). In Khyber Pakhtunkhwa Province, wheat was planted on an area of about 0.7245 million hectares with an average yield of about 1434 kg ha⁻¹, which is lower than average yield of the country (CSKP, 2011). Land preparation and sowing methods are important operations for better wheat production. Proper placement and distribution of seeds and fertilizers into the soil play vital role for optimum germination. Agricultural machinery is an important factor to increase agricultural productivity as far as tillage and sowing practices are concerned. Lack of appropriate tillage implements and planting equipments are the major constraints limiting crop yield in Pakistan. Despite the large investment in the provision and improvement of seeds, fertilizers, and irrigation, crop yield is still low and beyond the potential (Choudhary, 1985).

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 Muner, 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). The grain yield was higher with chisel plow 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., 1990). One of the other implements is the rotary tillers, which are increasingly used in various operations in agriculture, give high quality of soil cultivation, uniform mixing of soil with plant residues. (Manianet 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. On other hand sowing methods are placement of seeds in the soil at predetermined depth in line with drill machine and dropping of
seed on surface of soil (broadcasting). Traditional seed placing methods are still in use by the farmers in some parts of Pakistan, conventional sowing method is one of the reasons for low crop productivity in the country (Khan et al., 1992). Sowing methods play a significant role in enhancing the wheat yield (Sing et al., 2003; Shah et al., 2013). 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

Field experiments were conducted at the New Developmental Farm of The University of Agriculture Peshawar, Khyber Pakhtunkhwa, during 2009-2010 and 2010-2011 on wheat crop, to study the effect of tillage practices and sowing methods for improving productivity of wheat crop under irrigated conditions. Wheat variety Tatara-96 was used in the experiments. The tillage implements used in the experiment were (tine cultivator, mouldboard plow, disk plow, chisel plow, rotavator, while sowing method were single box seed drill and seed cum fertilizer drill and broadcast by hand (Table 1). Before tillage operation each implement was checked, adjusted and used in the same plot in both seasons. Locally made single box seed drill and combined seed drill (seed-cum-fertilizer drill) were adjusted and calibrated before sowing of crop. Drills were adjusted for 30 cm row to row distance, and were calibrated at the rate of 125 kg ha$^{-1}$ for wheat crops before sowing.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Tillage combination</th>
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<tbody>
<tr>
<td>TC-2</td>
<td>Tine Cultivator Twice (Farmers Practices)</td>
</tr>
<tr>
<td>MR</td>
<td>Mouldboard Plow followed by Rotavator</td>
</tr>
<tr>
<td>DR</td>
<td>Disk Plow followed by Rotavator</td>
</tr>
<tr>
<td>CR</td>
<td>Chisel Plow followed by Rotavator</td>
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<tr>
<td>TCR</td>
<td>Tine Cultivator followed by Rotavator</td>
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<tr>
<td>Sowing methods</td>
<td></td>
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<tr>
<td>BC</td>
<td>Broadcast by hand</td>
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<tr>
<td>SD</td>
<td>Single-box Seed Drill</td>
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<tr>
<td>CD</td>
<td>Combine Seed Drill</td>
</tr>
<tr>
<td></td>
<td>(Seed-Cum-fertilizer drill)</td>
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Randomize Complete Block Design (RCBD) with a split plot arrangement was used as experimental set up for the study. Tillage practices were assigned to main plots, while sowing methods to sub plots. The experiment was conducted on about 0.5 ha land divided into main and subplots. The treatment was replicated four times in five main plots for tillage practices and three sub plots for sowing practices. The total numbers of experimental subplots were 60 and the total net experimental area was (25 m$\times$ 2.4 m $\times$ 60 plots) 3600 m$^2$.

**Emergence m$^2$**

Emergence m$^2$ was recorded by counting the number of seedlings in three rows of one meter length of drill sowing methods and square meter frame was used for broadcast sowing method in each subplot after emergence. The counted seedlings of drill sowing methods were converted into emergence m$^2$, by using following formula.

\[
\text{Emergence m}^2 = \frac{\text{Total No. of seedlings emerged}}{\text{No. of rows} \times (R - R\text{ distance}) \times \text{Row Length}}
\]

**Number of Tillers m$^2$**

Numbers of tillers m$^2$ were counted in square meter frame area in each sub-plot of broadcasting methods. In drill sowing method, tillers were recorded by counting the number of tillers of one meter length in three central rows of each subplot and then converted to tiller m$^2$ by using the following formula.

\[
\text{Tiller m}^2 = \frac{\text{Total number of tillers counted}}{\text{No. of rows} \times (R - R\text{ distance}) \times \text{Row Length}}
\]

**Plants Height (cm)**

Plant height was measured in randomly selected five plants in each subplot from the ground to the top of the plant including spike at maturity, and then the average length per plant was calculated.
Spike Length (cm)

Length of five spikes in each subplot was measured by a ruler, and then the average length perspike was calculated.

\[
\text{Spike Length (cm)} = \frac{\text{Total spikes length (cm)}}{\text{Number of spikes}}
\]

Harvest Index (%)

Harvest index was calculated by using the following formula

\[
\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100
\]

Statistical Analysis

The data were statistically analyzed by using RCBD with split plot arrangement, as described by and Steel and Torrie (1980), and mean was compared using LSD test.

RESULTS AND DISCUSSION

Emergence m\(^{-2}\)

Data pertaining to emergence m\(^{-2}\) of wheat are presented in Fig. 1 and 2. The analysis of variance for emergence m\(^{-2}\) showed no significant mean differences in different tillage practices while sowing methods were significantly different. Mean emergence m\(^{-2}\) due to different tillage practices ranged from 101 to 109 plants. Minimum emergence m\(^{-2}\) (101 plants) were obtained when TC-2 tillage practices were used, while maximum emergence m\(^{-2}\) of 109 plants was recorded when CR tillage practices were used, followed by MR tillage practices with 108 plants. This may be due to the better pulverization of soil by a combination of rotavator with other tillage implements, so seed has close contact with the soil. The results are in line with Sheikh et al. (1978) who reported that different tillage practices had different effects on the emergence of wheat seedling. Boydas and Turgut (2007) reported that the maximum emergence rate was noted with chisel plow and chisel plow + rotary harrow. Javadi et al. (2009) reported that no significant difference in emergence of plants was observed between different tillage implements. Emergence with different sowing methods ranged from 99 to 110 plants. Maximum emergence m\(^{-2}\) of 110 plants was observed by CD followed by SD sowing methods with 108 plants, while minimum emergence m\(^{-2}\) of 99 plants was recorded when broadcast method of sowing was used. This may be due to uniform and proper placing of seed in the soil and proper covering of seeds. The results of the present study are in line with Singh et al. (2007) and Waraich et al. (1982) who reported that drilling produced better germination and higher values of growth than broadcast method.

![Fig1. Effect of tillage practices on emergence m\(^{-2}\) of wheat](image1)

![Fig2. Effect of sowing methods on emergence m\(^{-2}\) of wheat](image2)

Number of Tillers m\(^{-2}\)
Data concerning number of tillers m$^{-2}$ are shown in Fig. 3 and 4. Statistical analysis of the two years data revealed that tillage practices and sowing methods showed significant effect on number of tillers m$^{-2}$ of wheat. Average values for number of tillers m$^{-2}$ with different tillage practices ranged from 344 to 403 plants. Minimum number of tillers m$^{-2}$ (344 plants) were obtained when TC-2 tillage practices were used, while the maximum number of tillers m$^{-2}$ of (403 plants) were recorded when DR tillage practices were used, followed by CR and MR tillage practices. This may be due to deep tillage and better pulverization of soil by rotavator with tillage implements as compared to the lonely use of tine cultivator twice. Khan et al. (1990) reported that more tillers m$^{-2}$ were recorded by deep plowing with mouldboard plow as compared to tine cultivator. Number of tillers m$^{-2}$ due to different sowing methods ranged from 367 to 396 plants. Maximum number of tillers m$^{-2}$ of 396 plants were recorded when the CD was used followed by SD with 388 tillers m$^{-2}$, while a minimum of 367 tillers m$^{-2}$ were observed when the broadcast method of sowing was used. This may be due to uniform and accurate placing of seed in the soil and proper covering of seeds. These results are in line with Khan et al. (1990) who reported that drill places the seed and fertilizer in the zone of adequate moisture and at desired depth, Waraich et al. (1982) reported that maximum number of tiller m$^{-2}$ were obtained by drill sowing methods. Senapati et al. (1988) also mentioned that the efficiency of (CD) seed-cum-fertilizer drill was the highest.

**Fig. 3. Effect of tillage practices on number of tillers m$^{-2}$ of wheat**

**Fig. 4. Effect of sowing methods on number of tillers m$^{-2}$ of wheat**

**Plant Height (cm)**

Statistical analysis of the data regarding plant height Fig. 5 and 6 showed that tillage practices and sowing methods did not significantly affected plant height of wheat. Average values for plant height (cm) of different tillage practices ranged from 101 to 105 cm. Minimum plant height of 101 (cm) was obtained, when TC-2 was used, while maximum plant height of 105 (cm) was recorded when CR and MR tillage practices were used. This may be due to deep plowing of moldboard plow and chisel plow, which provides favorable conditions for growth of plants. The results are in line with Manian et al. (1999) who reported that maximum plant height was observed by chisel plow. Wiatrak et al. (2006) reported that plant height was greater in conventional tillage than no-tillage, however Javadi et al. (2009) reported that there was no significant difference in plant height between different tillage implements. Plant height (cm) with sowing methods ranged from 103 to 104 cm. Maximum plant height of 104 (cm) was noted by (CD) sowing methods, while minimum plant height of 103 (cm) was obtained when BC and SD method of sowing were used. Abbas et al. (2009) reported that the better plant height was noted in drill planting with 30 and 25 cm rows. Waraich et al. (1982) also found that sowing methods imparted significance difference in plant height, Senapati et al. (1988) mention that the highest efficiency was shown by (CD) seed-cum-fertilizer drill, however, Ansari et al. (2006) reported that maximum plant height was recorded with broadcasting method.
Fig. 5 Effect of tillage practices on plant height of wheat

**Spike Length (cm)**

Data regarding spike length are shown in (Fig. 7 and 8). Analysis of variance for spike length revealed that tillage practices were not significant while sowing methods were significantly different. The average spike length of different tillage practice ranged from 8.7 to 9.1 cm. Minimum spike length 8.7 cm was obtained when TC-2 and DR tillage practices were used, while maximum spike length 9.1 cm was recorded, when CR tillage practices was used followed by MR and TCR with 9 and 8.9 cm respectively. The mean value for spike length with different sowing methods ranged from 8.2 to 9.7 cm. Maximum spike length of 9.7 cm was recorded when (SD) seed drill was used, while the minimum spike length of 8.2 cm was obtained when broadcast method of sowing was used. These results are in agreement with Singh et al. (2007) who reported that drilling produced higher values of growth than conventional sowing method. Ansari et al. (2006) reported that longer spike length was obtained with the drill sowing method.
Harvest Index (%)

Statistical analysis of the data presented in Fig. 9 and 10 revealed that tillage practices were not significant while sowing methods significantly affected harvest index of wheat. Mean value of the data for tillage practices indicated that maximum harvest index (45.5%) was observed for DR and TCR followed by CR and MR tillage practices with (44.3% and 44.1%) respectively, while minimum harvest index (43.6%) was recorded by tine cultivator twice (TC-2). Javad et al. (2009) reported that no significant differences were noted on harvest index between different tillage implement. Sowing methods SD showed maximum harvest index (46.2%) followed by CD with (44.1%) while minimum harvest index (43.6%) was obtained by (BC) broadcast method of sowing. The results agree with the finding of Singh et al. (2007) who reported that drilling produced higher values of growth, yield attributing characters, grain and straw yield than conventional sowing method.

CONCLUSION AND RECOMMENDATIONS

It is concluded from the results that tillage implements followed by rotavator showed better performance in terms of number of tillers and harvest index of wheat than sole use of tine cultivator twice. Sowing by drill produced better results in terms of emergence, number of tillers, spike length and harvest index as compared to broadcasting. Tillage implements followed by rotavator and drill sowing methods should be adopted for improving emergence, number of tillers and harvest index of wheat under semi-arid environment.

Fig. 9 Effect of tillage practices on harvest index (%)

Fig. 10 Effect of sowing methods on harvest index (%) of wheat

REFERENCES


