Pak. J. Weed Sci. Res. 19(1): 109-121, 2013

EFFECTS OF TILLAGE PRACTICES AND SOWING METHODS ON WEEDS AND BIOLOGICAL YIELD OF WHEAT UNDER SEMI-ARID ENVIRONMENT

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ABSTRACT

Field experiments were conducted at the New Developmental Research Farm, University of Agriculture Peshawar, Pakistan during the year 2009-2010, and were repeated in 2010-2011 to find out the effects of tillage practices and sowing methods on wheat production and its associated weeds. Experiments were established using a randomized complete block design with split plot arrangements and each treatment being replicated four times. Tillage treatments consisted of five farmers practices (tine cultivator twice - TC-2, tillage implements chisel plow + rotavator - CR, mouldboard plow + rotavator - MR, disc plow + rotavator - DR and tine cultivator + rotavator - TCR) and assigned to the main plots. Three sowing methods (broadcasting -BC, single box seed drill - SD and combined drill - CD) were used and assigned to the sub plots. Analysis of the two years mean data revealed that tillage practices had a significant influence on weed dry biomass and biological yield of wheat crop. Similarly, sowing methods had also a significant effect on biological yield of wheat crop. The least weed dry biomass (95 g m^{-2}) was recorded for plots plowed with MR tillage equipment followed by DR tillage equipment 9104 g m^{-2}). The greatest biological yield (10.4 t ha^{-1}) and plant height of wheat (105 cm) were recorded for MR tillage practices followed by DR, TCR and CR. Wheat crop sowing by drill method produced the maximum biological yield as compared to broadcast method. MR and DR tillage practices resulted 51 and 46% reduction in weed dry biomass, respectively as compared to TC-2. Therefore, to achieve efficient weed control and gain maximum biological yield of wheat, MR tillage practices should be adopted in semi-arid environments.

Key words: Tillage practices, sowing methods, weed control, wheat production.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important cereal crop in the world as well as in Pakistan, and is grown on larger land area. In Pakistan it was grown on an area of 8.805 million hectares during the

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year 2010-2011 with an average yield of 2750 kg ha^{-1} (MINFAL 2010 - 2011). In Khyber Pakhtunkhwa Province, this crop was grown on 0.725 million hectares land area with an average yield of 1434 kg ha^{-1}. The average yield of wheat was lower in Khyber Pakhtunkhwa as compared to its national production per unit area (CSKP, 2010 - 2011).

Tillage is the mechanical manipulation of soil which makes the soil fine for planting, uproot weed plants and provide conducive conditions for plant growth and development. Lack of appropriate tillage implements and planting equipment are the major constraints limiting the production of wheat crop. Despite the larger investment in the provision and improvement of seed and fertilizers, the crop production in Pakistan is still low (Choudhary, 1985). Different tillage operations had diverse effects on production of crops (Ahmad *et al*., 1990; Rehman *et al*., 1995; Usman *et al*., 2010). The inappropriate use of tillage implements restrict the crop plants root growth, compact the soil, increase fuel expenditure of the machinery and reduce crop yield. Tillage also plays an important role in controlling weeds and managing crop residues. Tillage after harvest of previous crop is usually performed by using primary tillage implements. Mouldboard plow is common primary tillage implement for the use of inversion of the soil, burying of weeds, and residues. Chisel plow and disk plow are also common primary tillage implement. The chisel plow is suitable for cutting the soil without complete burying or mixing of surface debris. The chisel plow is considered as a potential conservation tillage method. Disk plow is used as a primary tillage and is suitable for the virgin, hard, stony and wet soil, for cutting crop residues and roll over the roots. The action of the concave disk blade is such that the soil is lifted, pulverizes, partially inverted and displaced to one side. Secondary tillage includes the use of single or double passes of cultivator to produce a seedbed for drilling (Boydas and Turgut, 2007).Tine type cultivator is the common tillage implement used in Pakistan for primary tillage operation as well as for seedbed preparation in a variety of soils (Soomro *et al*., 1985). Tine cultivator does not satisfy the proper tillage requirement, soil is lifted untilled between two consecutive tines and the farmers have to till the field repeatedly causing over tilling. The overuse of tine cultivator compact the soil restricts root growth, water infiltration, disturb the soil structure and increase fuel expenditure (Rehman *et al*., 1995; Hussain and Muner, 1986). Conservation tillage is not yet widely accepted by farmers because inversion tillage is considered to be necessary for weed control. Primary tillage by chisel plow resulted in significantly higher annual weed density compared to other tillage (Gruber and Claupein, 2009). Conventional tillage operation with mouldboard

plowing gives good preparation of the seed-bed with weed free condition and high yield than direct seeding, due to the fact that weed manifestation was greater in direct seeding than the conventional method (Yalcin *et al.*, 2005). However, Ali (1985) reported no effect of the types of plow on the yield of wheat and the density of weeds. The conventional sowing practices are one of the reasons for low crop yield in the country (Khan *et al*., 1990). To mechanize sowing operation, an appropriate drill should be used to places the seed and fertilizer in the zone of adequate moisture and at desired soil depths.

Keeping in view the importance of tillage, the present study was performed to find out the effects of different tillage practices and sowing methods on weed biomass and biological yield of wheat.

MATERIALS AND METHODS

Experimental site description

Field experiments were conducted at the New Developmental Research Farm (at latitude of 34° N', longitude of 71.3° E, and 359 meters above sea level), University of Agriculture Peshawar, Khyber Pakhtunkhwa, Pakistan during 2009-2010 and repeated in 2010-2011 to evaluate the effects of different tillage practices and sowing methods on weed biomass and biological yield of wheat crop. The soil at the experimental site is silt clay loam with low organic matter (0.31%). The experimental site has warm to hot, semi-arid and sub-tropical climate with a mean annual temperature (26.31°C) and with average annual rainfall (284 mm) during the study period. Most of the rainfall at the site occurred during the months of January and February. The crop water requirements was fulfilled by irrigation when needed; two irrigations were applied to the crop during both years.

Experimental Design

The experiment consisted of two factors i.e. tillage practices and sowing methods. A randomize complete block design (RCBD) with a split plot arrangements. The tillage practices were assigned to the main plots while the sowing methods were assigned to the sub plots. All other inputs (variety, number of irrigations and dose of fertilizer) were applied uniformly as per recommended practices. Herbicide was not applied to any plots during the experiments. All experimental treatments were replicated four times in five main plots for tillage practices and three sub plots for sowing practices. Each main plot being divided into three sub plots for different sowing methods. For access of drills to each sub plot and turning of seed drills, 4.5 m spaced at two spots were left in the middle of the main plots. The net sub plot size was 25 m x 2.4 m. The total number of experimental sub plots was 60. Therefore the total experimental area was (25 m $\times$ 2.4 m $\times$ 60) 3600 m^2. Tillage implements combination and sowing methods

used in the experiment were, Tine Cultivator twice (farmers' practices), Moldboard Plow, Disk plow, Chisel Plow, Tine cultivator each followed by a Rotavator, Single box seed drill and Seed cum fertilizer drill), while broadcasting was performed by hand (Table-1).

Table-1. Tillage implements combination and sowing methods used in the experiment.

Code	Tillage and Sowing Treatments	
TC-2	Tine Cultivator Twice (Farmers Practices)	
MR	Moldboard Plow followed by Rotavator	
DR	Disk Plow followed by Rotavator	
CR	Chisel Plow followed by Rotavator	
TCR	Tine Cultivator followed by Rotavator	
BC	Broadcast by hand	Conventional sowing
SD	Single-box Seed Drill	Used for seed sowing only
CD	Combine Seed Drill (Seed-Cum-fertilizer drill)	Used for seed sowing and fertilizer application

Before the tillage operation each implement was checked, adjusted and then used in the same plot in each season. Locally made single box seed drill and combined drill (seed-cum-fertilizer drill) were adjusted and calibrated before sowing. Seed drills (SD) and combined drill (CD) were adjusted for 30 cm rows to row distance of each crop, and were calibrated for seed at the seed rate of 125 kg ha^{-1} for wheat before sowing. For application of fertilizer combined drill was calibrated at the rate of 120 kg ha^{-1} for wheat, while in the plots of seed drill and broadcast, fertilizer were applied by hand broadcasting at the rate of 120 kg ha^{-1} wheat before sowing.

Weed biomass was recorded in mid season of wheat crop using a quadrate (50 × 50 cm) which was randomly thrown inside each sub plot and weeds inside the quadrate were cut at soil level and then converted to m^{-2}. Weight of fresh weed samples was measured by an electronic balance in the laboratory. Then all weed samples were dried in an oven for 72 hours (65^{o}C) and weed dry biomass was noted and converted to m^{-2}

Plant height was measured in randomly selected five plants in each sub plot from the ground to the top of the tallest plant, including spike at maturity, and average length per plant was calculated.

Biological yield data for wheat crop was recorded by harvesting the crop plants from two meter lengths in three rows of drill sowing methods and square meter frame was used for harvesting crops of

broadcast sowing methods, three samples from each sub plot were collected, sun dried, weighed by spring balance and converted to kg ha^{-1}.

$$\text{Biological Yield} = \frac{\text{Weight of plant biomass x 10000}}{\text{No. of rows x R-R distance x Row lwngth}}$$

Statistical analysis

The data were analyzed using analysis of variance appropriate for RCBD with split plot arrangements. To detect significant differences between the means, LSD test (0.05 level of probability) was applied (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Fresh Weed Biomass

The data for fresh weed biomass m^{-2} in wheat crop is given in Figures 1a and b. Analysis of variance for fresh weed biomass m^{-2} revealed that the effect of different tillage practices on weed fresh biomass was significant while the sowing methods was not significant. Mean values for fresh weed biomass due to different tillage practices were in the range of 267-517 g m^{-2}. Minimum fresh weed biomass 267 g m^{-2} was noted when MR tillage practices were used, while a maximum of 517 g m^{-2} was obtained with TC-2. This may be due to the inversion of the soil and burying of weeds in the soil with the moldboard plowing. The results agree with Khan *et al*. (1986/1990) who reported that inversion of the soil by the mouldboard plow reduced weed population. Demejanova *et al*. (2009) reported that significantly less weed biomass was recorded in mouldboard plowing as compared to reduced tillage practices. Ozpinor (2006) reported that least weed density was observed by mouldboard plowing. Average values for fresh weed biomass m^{-2} due to different sowing methods were ranging between 343-361 g m^{-2}. Maximum fresh weed biomass of 361 g m^{-2} was obtained by SD sowing methods, while minimum weed of 343 g m^{-2} was obtained when the CD method of sowing.

Weed dry biomass

Data for weed dry biomass in wheat crops is presented in Figures 2a and b. The analysis of variance for dry weed biomass indicated that the effect on weed of different tillage practices was significant while the effect of sowing methods was not significant. Weed dry biomass of different tillage practice was in the range of 95-193 g m^{-2}. Minimum dry weed biomass of 95 g m^{-2} was noted when MR tillage practices were used, while maximum dry weeds of 193 g m^{-2} was recorded when TC-2 was used. This may be due to the inversion of the soil and burying of weeds in the soil with the mouldboard plowings.

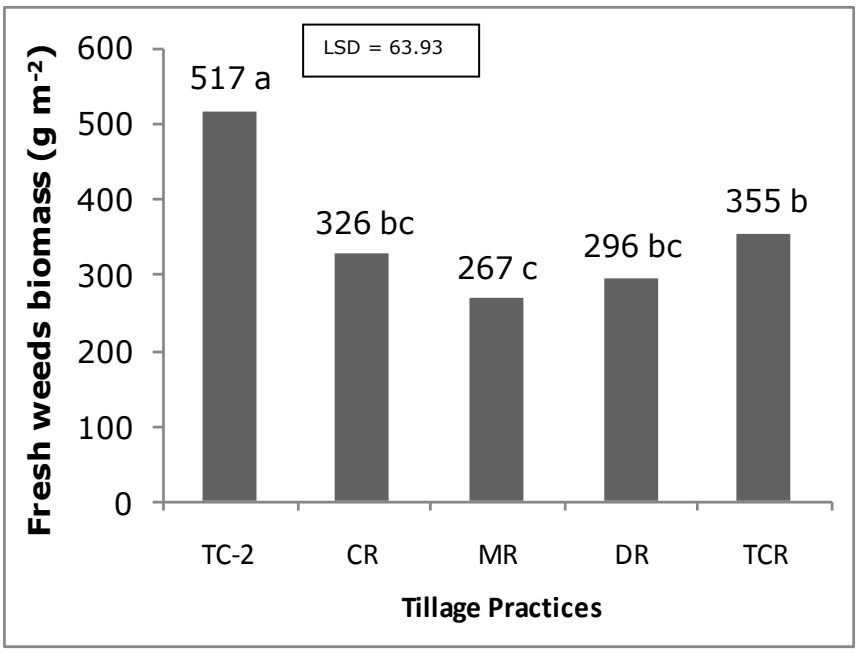

Figure 1a. Effect of tillage practices on the fresh weed biomass in wheat fresh weed biomass.

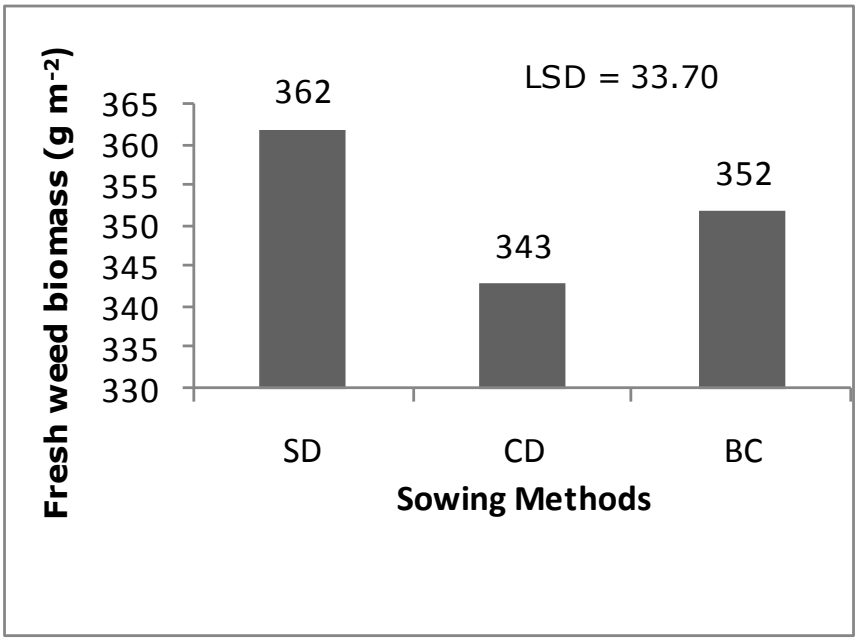

Figure 1b. Effect of sowing methods on the fresh weed biomass in wheat fresh weed biomass.

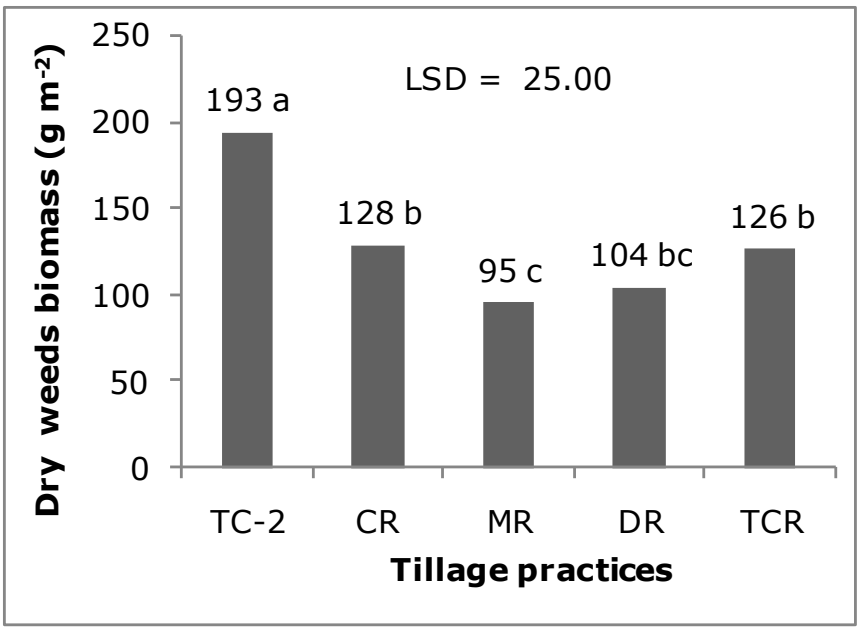

Figure 2a. Effect of tillage practices on dry weed biomass in wheat.

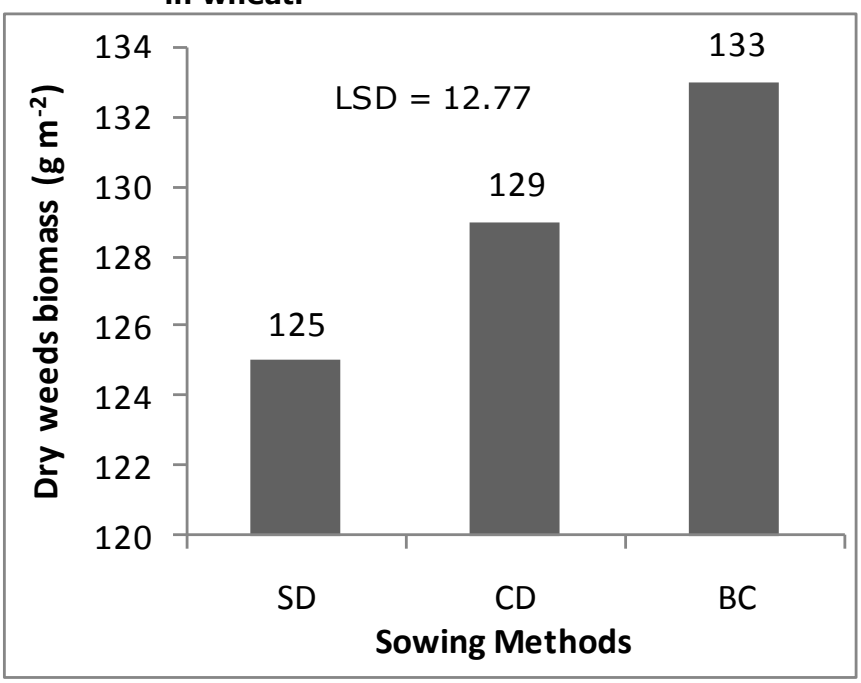

Figure 2b. Effect of sowing methods on dry weed biomass in wheat.

The result agrees with Khan *et al.* (1986/1990) they reported that inversion of the soil by the mouldboard plow reduced weed population. Demejanova *et al*. (2009) reported that significantly minimum weed dry biomass was noted in mouldboard plowing as compared to reduced tillage practices. Ozpinor (2006) also reported that least weed density was recorded by mouldboard plowing as compared to other tillage implements. Maximum dry weed biomass of 133 g m^{-2} was noted by BC sowing methods, while minimum weed m^{-2} of 125 g m^{-2} was observed with the SD sowing method.

Plant height

Data on plant height (cm) is presented in Figures 3a and 3b. Analysis of variance showed no significant differences for tillage practices and sowing methods. Average values for plant height of different tillage practice 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 MR and CR were used. This may be due to deep plowing of moldboard plow and chisel plow, which provides favorable condition for the 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, Javadi *et al*. (2009) reported that there was no significant difference in plant height between different tillage implements. Maximum plant height of 104 cm was noted when CD was used. Abbas *et al*. (2009) reported that the better plant height was noted in drill planting. 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.

Biological yield

Biological yield is the major contributor to the total output of any crop and depend upon species, growing season and other factors. Analysis of variance for biological yield of wheat revealed significant difference for different tillage practices and sowing methods. The mean values for biological yield under different tillage practice ranged from 9283 to 10435 kg ha^{-1}. A maximum biological yield of 10435 kg ha^{-1} was recorded when MR tillage practices was used, while minimum biological yield of 9283 kg ha^{-1} was obtained, when TC-2 tillage was practiced. Average values for biological yield due to different sowing methods ranged from 9560 to 10320 kg ha^{-1}. A maximum biological yield of 10320 kg ha^{-1} was recorded when combined drill was used followed by SD with 10146 kg ha^{-1}, while minimum 9560 kg ha^{-1} was obtained when broadcast method of sowing was used.

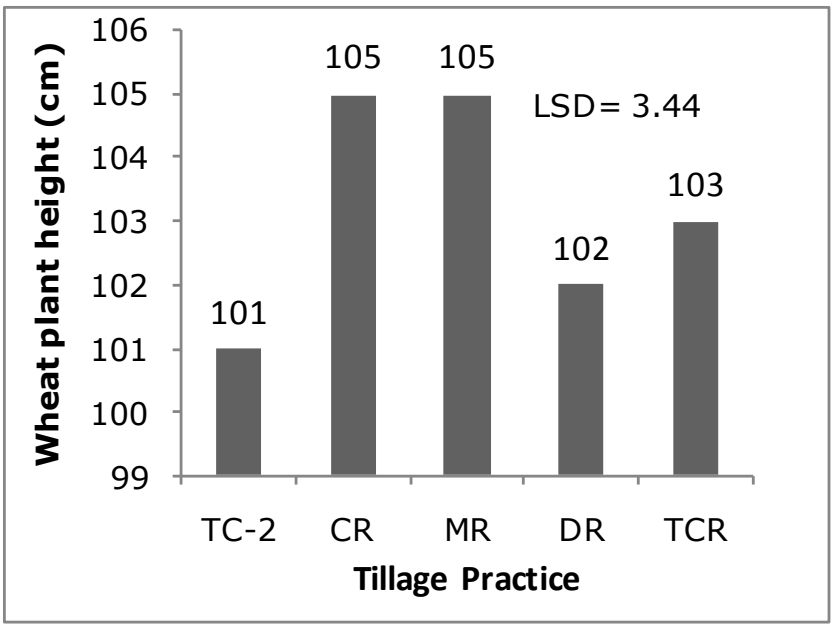

Figure 3a. Effect of tillage practices on plant height of wheat.

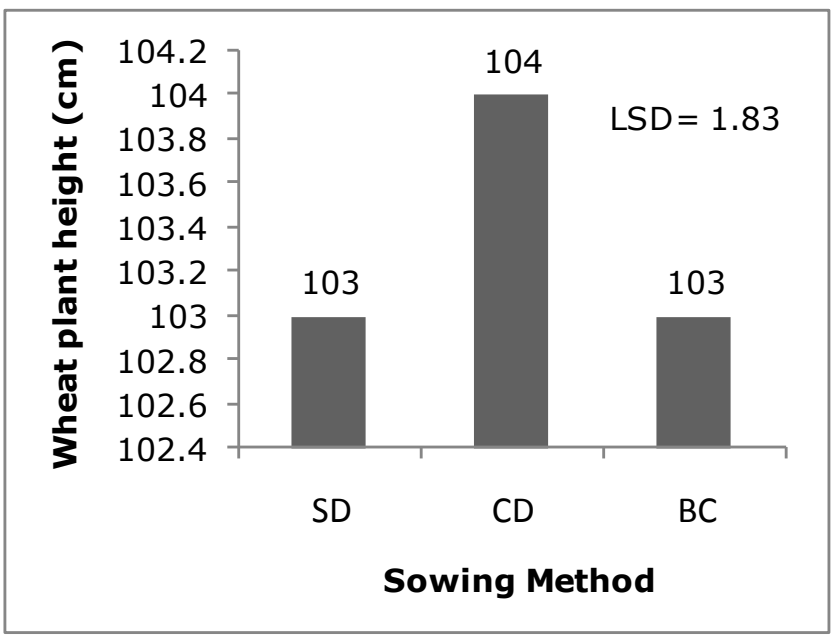

Figure 3b. Effect of sowing methods on plant height of wheat.

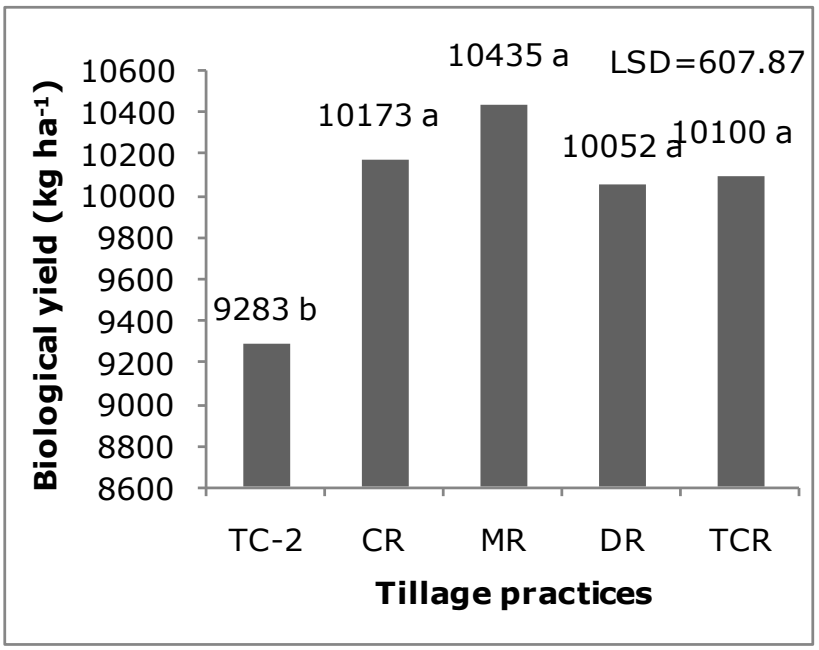

Figure 4a. Effect of tillage practices on biological yield.

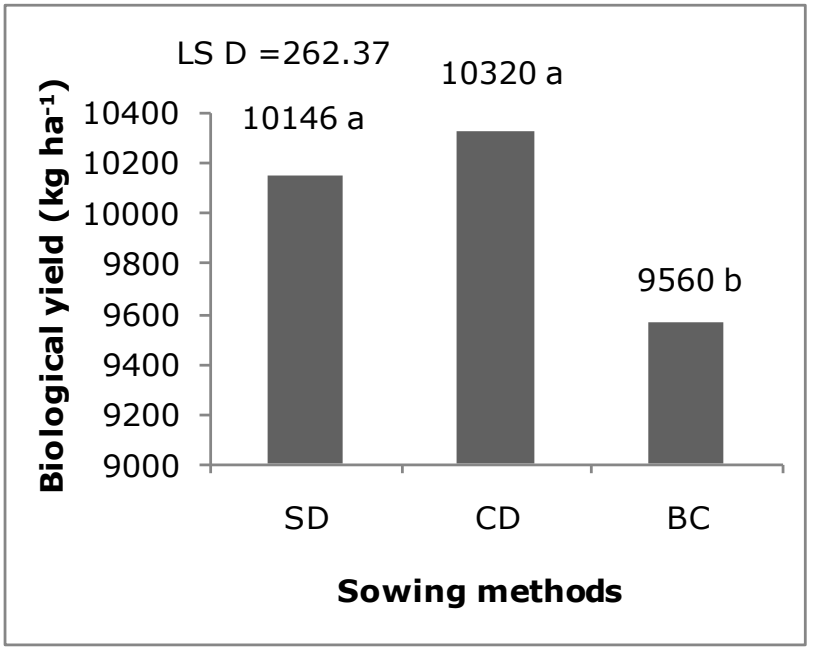

Figure 4b. Effect of sowing methods on biological yield of wheat.

This may be due to uniform and proper placing of seed in the soil and proper covering of seeds .As reported by Khan *et al*., (1990) that drill places the seed and fertilizer in the zone of adequate moisture and at desired depth. The results of the present study are in line with Senapati *et al*., (1988) they reported that the efficiency of seed-cum-fertilizer drill CD was the highest. Singh *et al.,* (2007) reported that sowing by drill produced higher yield attributing characters, grain and straw yield followed by conventional sowing.

CONCLUSION

Tillage practices had significant effect on weeds fresh and dry biomass in wheat crop. The MR and DR tillage practices resulted 51 and 46% reduction in dry weed biomass as compared to TC-2. Maximum wheat biological yield was obtained when the plots were plowed with MR tillage practices and seeds were sown with drill. It is concluded from the results that for minimizing weeds biomass and maximizing biological wheat yield MR tillage practices and drill sowing methods should be used as compared sole used of TC-2.

ACKNOWLEDGEMENT

This study is a part of the PhD dissertation which will be submitted to the University of Agriculture, Peshawar, Pakistan.

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