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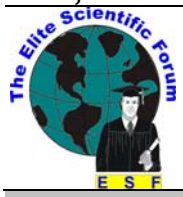

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RESEARCH ARTICLE

Determining Critical Period of Weed Competition in Wheat under Different Tillage Systems

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ABSTRACT

This study was conducted to determine the critical period of weed competition in wheat under different tillage systems during 2011-2012. The experiment comprised of two factors including tillage and weed control period. The tillage treatments were conventional, minimum and zero tillage in main plots and weed control period were weedy check, weed competition for 20, 40, and 60 days after germination and weed free throughout the growing season in sub plots. The experiment was laid out in randomized complete block design with split plot arrangement having three replications with a net plot size of 6 m × 2.2 m. Data regarding weeds, yield and yield components was recorded following the standard procedures. The agronomic parameters plant height, number of productive tillers, number of grain per spike, 1000-grain weight, biological and grain yield showed significant results under zero tillage along with 20 days competition period. The results showed that zero tillage suppressed total weed density and total weed dry weight up to 59 % and 38 % respectively and increase the yield up to 6 % over conventional tillage. The results of weed control periods showed that weed control after 20 DAE suppress the weed density and dry weight up to 76 % and 95 % respectively and increase the grain yield up to 34 % over weedy check.

INTRODUCTION

Wheat is one of the major cereals and staple food of Pakistan. It has great nutritional value and contains starch (60-90%), protein (11-16.5%), fat (1.5-2%), inorganic ions (1.2-2%) and vitamins. It contributes 2.6% in GDP and 12.5% value added in agriculture. Area under wheat crop was 8.67 million hectare in 2011-12 (Anonymous, 2012).

Many problems are associated with wheat production in Pakistan but weeds are main yield limiting factor. Wheat yield is mainly limited by weed competition (Hussain et al., 2007). In Pakistan, reduction in wheat yield is mainly due to weeds which are about 18-30% (Ashiq and Cheema, 2005). World widely weed losses in wheat are about 37-50% (Waheed et al., 2009). Weeds compete with crop for light, nutrient, space, water and ultimately reduce the crop yield and quality (Qasim and Foy, 2001; Gupta, 2004). Weeds also have allelopathic effect on crop and reduce its quantity and quality (Gupta, 2004). Sometimes, it results in complete crop failure (Zand et al., 2007). Most common weeds of wheat are *Chenopodium album*, *Cronopus didymus*, *Rumex dentatus* L., *Avena Fatua* and *Phalaris minor* and their losses are more than pest and diseases (Siddiqui et al., 2010).

Cultural practices improve wheat yield up to 50-70 % if managed properly (Ashrafi et al., 2009). Weeds are notorious competitor, if not controlled during whole season, yield losses reach up to 80 % (Karlen et al., 2002). Nadeem et al. (2010) reported that minimum yield losses occur if weeds were manually controlled at early stages.

Wheat yield is limited by many factors but mainly two are more responsible for yield reduction viz. weed competition and type of tillage (Arif et al., 2007). Mechanical manipulation of soil is called tillage and the operation done of seed bed preparation is called tillage system (Muqaddas et al., 2005). Type of tillage has effect on weed population and distribution (Lindwall et al., 1994). Conventional tillage affects the soil properties and soil health (Karlen et al., 2001). After 25th November, every day delay in wheat sowing results in yield reduction of about 1% per day (Gupta, 2002).

Now a day, reduced tillage is getting importance because it is a resource conservation technology and

environment friendly technique (Vogeler et al., 2006). Zero tillage or no tillage is the sowing of wheat without seedbed preparation in standing stubble and the soil remain undisturbed from planting to harvesting, only nutrient injection is done. Usman et al. (2009) studied that tillage and herbicides have significant effect on weed distribution and zero tillage showed the best results. The resulting more yield of zero tillage over conventional tillage is mainly due to timely sowing of wheat (Wang et al., 2007; DeVita et al., 2007). Zero tillage has the minimum weed density and weed dry matter and highest 1000-grain weight and grain yield of maize (Tahir et al., 2011).

MATERIALS AND METHODS

The proposed study was conducted at Agronomic research farm, University of Agriculture Faisalabad, Pakistan during 2011-2012. Wheat seed of variety Punjab-2011 was taken from Wheat Research Institute, Ayub Agriculture Research Institute, Faisalabad. Seedbed was prepared according to the treatments i.e. conventional, minimum and zero tillage. In case of conventional tillage seedbed was prepared by cultivating the soil with disc plough for residues incorporation than cultivating the soil thrice fallowed by planking. In reduced or minimum tillage seedbed was prepared by cultivating the soil with disc plough for residues incorporation and then one time cultivating the soil fallowed by planking. Zero tillage was accomplished in single pass by happy seeder. Fertilizers N: P: K at the rate of 100: 65: 50 kg ha^{-1} was applied. The whole of the phosphorous and potassium and half of the nitrogen was applied at the time of sowing and remaining half was applied at the time of first irrigation. The crop was sown by recommended seed rate 125 kg ha^{-1} with the help of wheat drill but in case of zero tillage "Happy Seeder" was used. First irrigation was applied after 25 days of sowing and subsequent irrigation was applied at different critical crop growth stage especially tillering, booting, anthesis, and grain filling stages. Other agronomic practices were kept normal and uniform. Necessary plant protection measures were adopted to keep crop free of weeds, insects and diseases. Experiment was conducted in randomized complete block design (RCBD) under split plot arrangement with three replications. Different weeds were counted individually from a unit area of one square meter at two places selected at random in each plot at 20, 40, and 60 days after emergence of crop (DAE) using a quadrate then average was calculated. For recording the dry weight of all weeds harvested m^{-2} were allowed to dry for 10-12 days at room temperature and then dried in an oven at 70°C till the constant weight was achieved. Fifteen plants were selected at random from each plot to record data regarding plant height and number of grains per spike. Total number of productive tillers was counted from one square meter in each plot. The random sample of one thousand grains was obtained from the produce of each plot and weighed to calculate 1000-grain weight in grams. Total weight of sun-dried harvest of each plot was recorded. After threshing grain weight was recorded for each plot was converted to ton per hectare. After harvesting and sun drying the crop for 10 days, total weight of bundles was recorded from each plot and converted into ton per hectare. The data collected were analyzed statistically by using Fisher's analysis of variance technique and least significant difference test was applied at 5% probability level to test the significance of the treatment means (Steel et al., 1997).

RESULTS AND DISCUSSION

Total weed density (m^{-2})

Density of weeds (m^2) at different weed crop competition periods and different tillage systems has given in table 1. Significantly the maximum densities of *Convolvulus arvensis, Chenopodium album, Rumex dentatus* and *Cyperus rotundus* was observed in conventional tillage (32.17 m^{-2}) as compared to minimum (23.92 m^{-2}) and zero tillage (13.17 m^{-2}). The density of weeds was increased significantly with each increase in competition period. The result showed that significantly higher weed density was observed in 60 days (26.56 m^{-2}) competition period as compared to 40 (18.67 m^{-2}) and 20 (9.00 m^{-2}) days competition periods. Weeds control after 40 days competition period also showed significant result as compared to 60 days competition period. But maximum weeds density was observed in weedy check (38.11 m^{-2}).

Significantly the maximum densities of weeds were recorded in weedy check (w_4) under all the tillage systems. The decrease in density could reach to the level of significance when competition period was decreased from 60 to 40 and 20 days competition period in conventional, minimum and zero tillage. A significant decreasing trend in the density of weeds was observed as the tillage intensities were decreased under all competition periods. The conventional, minimum and zero tillage showed the significant lower density of weeds, under 20, 40 and 60 days competition periods. In weedy check there was a significant decrease in weed density with each decrease in tillage intensity and minimum was recorded in zero tillage system. Wheat yield has limited by many factors but mainly two are more responsible for yield reduction viz. weed competition and type of tillage (Arif et al., 2007). Karnal et al. (1999) reported similar results the critical period of weed crop competition were worked out to be the first 32 to 40 DAE in wheat.

Table 1: Determining critical period of weed competition in wheat under different tillage systems.

Treatments	Weed density m^{-2}				Weed dry weight (g m^{-2})			
Sowing methods	Density of *C. album* L.	Density of *C. arvensis* L.	Density of *R.dentatus.*	Density of *C. didymus* L.	Density of *C. album* L.	Density of *C. arvensis* L.	Density of *R. Dentatus* L.	Density of *C. didymus*
T_1 Conventional tillage	8.25 a	4.50 a	10.08 a	9.33 a	34.20 a	6.96 a	8.13 a	8.75 a
T_2 Minimum tillage	5.75 b	3.25 b	7.41 b	7.50 b	27.26 b	5.88 b	6.01 b	7.35 b
T_3 Zero tillage	2.75 c	2.00 c	4.08 c	4.33 c	21.29 c	3.89 c	4.80 c	5.78 c
LSD	0.5667	0.7674	1.2813	0.4998	0.5247	0.4212	0.3157	1.0549
Weed control periods								
W_0 [Weed free]	---	---	---	---	--	---	---	---
W_1 [Weed control 20 DAE]	2.00 d	1.33 a	2.56 d	3.11 d	3.12 d	0.39 d	0.50 d	1.04 d
W_2 [Weed control 40 DAE]	4.89 c	2.78 b	5.56 c	5.44 c	12.65c	2.76 c	2.69 c	3.32 c
W_3 [Weed control 60 DAE]	6.67 b	3.56 c	8.00 b	8.33 b	31.79 b	5.65 b	7.39 b	9.95 b
W_4 [Weedy check]	8.78 a	5.33 d	12.67a	11.33 a	62.79 a	13.51 a	14.68 b	14.87 a
LSD	0.6102	0.4470	0.7801	0.6806	1.2927	0.4751	0.6499	0.9351
Interaction	S	S	S	S	S	S	S	S

Any two means not sharing a letter in common in a column differ statistically at 5% probability level; *DAE: Days after emergence

Table 2: Determining critical period of weed competition in wheat under different tillage systems

Treatments	Yield parameters			
Sowing methods	Plant height (cm)	No of productive tillers	No of grain $spike^{-1}$	1000-grain weight
T_1 Conventional tillage	83.13 NS	413.20 a	42.73 b	42.73 b
T_2 Minimum tillage	83.07	362.20 c	40.73 c	40.73 c
T_3 Zero tillage	83.60	401.27 b	46.53 a	46.53 a
LSD	1.2554	1.7429	1.7265	0.8616
Weed control periods				
W_0 [Weed free]	86.11 a	440.44 a	52.44 a	48.60 a
W_1 [Weed control 20 DAE]	84.89 b	427.22 b	47.33 b	46.51 b
W_2 [Weed control 40 DAE]	83.11 c	391.11 c	44.00 c	42.42 c
W_3 [Weed control 60 DAE]	81.89 d	368.56 d	40.67 d	38.29 d
W_4[Weedy check]	80.33 e	333.78 e	32.22 e	34.22 e
LSD	1.0559	2.7007	1.8757	0.8925
Interaction	S	S	S	S

Any two means not sharing a letter in common in a column differ statistically at 5% probability level.

Total weeds dry weight (g/m^2)

Density of weeds (m^2) at different weed crop competition periods and different tillage systems has given in table 1. Significantly the maximum total weed dry weight was observed in conventional tillage (34.20 g/m^2) as compared to minimum (27.26 g/m^2) and zero tillage (21.29 g/m^2). The reasons of low total weeds dry weight in zero tillage were plough less seed bed, mulching effect of rice residues and unfavourable condition for weed seed germination. The total weed dry weight was increased significantly with each increase in competition period. The result showed that significantly higher total weed dry weight was observed in 60 days (31.79 g/m^2) competition period compared to 40 (12.65 g/m^2) and 20 (3.12 g/m^2) competition periods. Total weed dry weight after 40 days competition period also showed significant result as compared to 60 days competition period.

Significantly the maximum total weed dry weight was recorded in weedy check (w_4) under all the tillage systems. The decrease in total weed dry weight should reach to the level of significance when competition period was decreased from 60 to 40 and 20 after crop emergence, under conventional, minimum and zero tillage systems. A decreasing trend in the total weed dry weight was observed as the tillage intensities were decreased under all competition periods. Usman et al. (2009) reported that significantly higher weed dry weight was recorded in conventional tillage and significantly minimum was recorded in zero tillage. However minimum tillage showed the intermediate value weed dry weight. The highest weed dry weight was found in conventional tillage was due to favourable growth environment.

Plant Height (cm)

Plant height at different weed crop competition periods and different tillage systems has given in table 2. Tillage systems had non-significant effect on plant height. Plant height was increased significantly with each decrease in competition period. The result showed that higher plant height lower the weed crop competition period. Maximum plant height (84.89 m^{-2}) was observed fallowed by 40 (83.11 m^{-2}) and 60 (81.89 m^{-2}) days competition periods. But maximum plant height was studied where weeds were not allowed to grow throughout the growing seasons and minimum

Table 3: Determining critical period of weed competition in wheat under different tillage systems

Treatments	Grain yield (Mg/ha)	Biological yield (Mg/ha)	Harvest index (Hi)
T_1	4.35 B	15.00 B	29.10 A
T_2	3.78 C	13.19 C	29.13 A
T_3	4.63 A	16.67 A	28.01 B
LSD (5%)	0.1388	0.1642	0.7674
W_0	5.26 A	19.76 A	26.64 C
W_1	4.77 B	17.50 B	27.19 C
W_2	4.48 C	14.60 C	30.75 A
W_3	3.61 D	12.30 D	29.29 B
W_4	3.16 E	10.60 E	29.85 AB
LSD (5%)	0.0116	0.1752	0.4470
W_0 T_1	5.33 ab	19.63 b	27.08 ef
W_1 T_1	4.96 cd	17.37 e	28.52 cde
W_2 T_1	4.64 e	14.93 h	31.02 ab
W_3 T_1	3.61 gh	12.43 j	28.96 cd
W_3 T_1	3.19 ij	10.63 i	29.90 abc
W_0 T_2	4.92 de	18.10 d	27.17 ef
W_1 T_2	4.14 f	16.13 g	25.59 f
W_2 T_2	3.91 fg	12.30 j	31.57 a
W_3 T_2	3.02 j	10.07 m	29.92 abc
W_3 T_2	2.94 j	9.33 n	31.42 a
W_0 T_3	5.53 a	21.53 a	25.69 f
W_1 T_3	5.21 bc	19.00 c	27.47 de
W_2 T_3	4.91 de	16.57 f	29.65 bc
W_3 T_3	4.18 f	14.40 i	28.99 cd
W_3 T_3	3.34 hi	11.83 k	28.23 cde
LSD (5%)	0.2880	0.3035	0.7742

Any two means not sharing a letter in common in a column differ statistically at 5% probability level.

(80.33 m^{-2}) was observed where weeds are not controlled throughout the growing season. Plant height increases significantly as the competition period decreases. Significantly the maximum plant was recorded in weedy check (w_4) under all the tillage systems. The decrease in plant height reaches to the level of significance when competition period was increased from 20 to 40 DAE, however further increase in competition period resulted in non-significant decrease in plant height, under conventional and zero tillage systems. All the tillage systems were statistically at par under all the competition periods. Usman et al. (2009) reported the tillage treatments showed non-significant results because this trait was genetically controlled and due to ample water and nutrient supply

Number of Productive tillers

Number of productive tillers at different weed crop competition periods and different tillage systems has given in table 2. Number of productive tillers was important character of variety which was greatly influenced by nutrients, water and environmental stress. Number of productive tillers of *Triticum aestivum* L. (m^{-2}) at different weed crop competition periods and different tillage system was given in table 4.12. The significantly maximum number of productive tillers was observed in conventional tillage (413.20 m^{-2}) as compared to minimum (362.20 m^{-2}) and zero tillage (401.27 m^{-2}). The number of productive tillers was increased significantly with each decrease in competition period. The result showed that higher number of productive tillers were observed in 20 (427.22 m^{-2}) days competition period as compared to 40 (391.11 m^{-2}) and 60 (368.56 m^{-2}) competition periods. The number of productive tiller after 40 DAE also showed significant result as compared to 60 days DAE. The interaction also showed the significant results.

Number of grains per spike

Number of grains per spike at different weed crop competition periods and different tillage systems has given in table 2. Significantly the maximum number of grain per spike was observed in zero tillage (46.53) as compared to conventional (42.73) and minimum tillage (40.73). The number of grain per spike was increased significantly with decrease in competition period. The result showed that significantly higher number of grain per spike was observed in 20 days (47.33) competition period as compared to 40 (44.00) and 60 (40.67) days competition periods.. Interaction also showed significant results.

1000 grain-weight (g)

1000 grain-weight at different weed crop competition periods and different tillage systems has given in table 2. The significantly maximum 1000-grain weight was observed in zero tillage (45.15 g) as compared to conventional (41.95 g) and minimum tillage (38.93 g). The minimum was observed in minimum tillage which was significantly lower than conventional tillage and zero tillage. 1000-grain weight was higher in zero tillage because of less weeds competition. The 1000-grain weight was increased significantly with decrease in competition period. The result showed that significantly higher 1000-grain weight was observed in 20 days (46.51g) competition period as compared to 40 (42.42 g) and 60 (38.29 g) days competition period. Husnain et al. (2011) reported that zero tillage has higher 1000-grain weight than conventional, reduced and deep tillage due to better micro environment for crop. Maqsood (1999) reported that period of weed crop competition has significant effect on 1000-grain weight and ultimately on yield.

Grain yield (Mg/ha)

Grain yield at different weed crop competition periods and different tillage systems has given in table 3. The significantly maximum grain yield was observed in zero tillage (4.63 Mg/ha) as compared to conventional (4.35 Mg/ha) and minimum tillage (3.78 Mg/ha). The grain yield was increases significantly with decrease in competition period. The result showed that significantly higher grain yield was observed in 20 (4.77Mg/ha) days competition period which was statistically higher then

40 (4.48 Mg/ha) and 60 (3.61 Mg/ha) days competition periods. Interaction also showed significant results. Mondol et al. (2007) also has similar findings that significantly maximum grain yield was found in weed free and significantly minimum grain yield was found in weedy check. The critical period of weed competition lies between 20 and 40 DAE. Zero tillage showed higher grain yield due to significantly less weed population, batter fertilizer and water use efficiency (Mehla et al. 2000; McMaster et al., 2002; Ibrahim et al., 2011).

Biological yield (Mg/ha)

Biological yield at different weed crop competition periods and different tillage systems has given in table 3. The significantly maximum biological yield was observed in zero tillage (16.67 Mg/ha) as compared to conventional (15.0 Mg/ha) and minimum tillage (13.19 Mg/ha). The biological yield was increased significantly with decrease in competition period. The result showed that significantly higher biological yield was observed in 20 days (17.50 Mg/ha) after crop emergence which is statistically different from 40 (14.60 Mg/ha) and 60 (12.30 Mg/ha) days competition periods. Husnain et al. (2011) reported that zero tillage has higher biological yield then conventional, reduced and deep tillage due to batter micro environment for crop and nutrient utilization.

Harvest index (%)

Harvest index at different weed crop competition periods and different tillage systems has given in table 3. The significantly maximum harvest index was observed in conventional tillage (29.10) as compared to minimum (29.13) and zero tillage (28.01). The harvest index was decreased with decrease in competition period. The result showed that lower harvest index was observed in 20 days (27.19) after crop emergence which is statistically lower then 40 (30.75) and 60 (29.29) days competition periods. Interaction also showed significant results.

Conclusion:

On the basis of research work, keeping in view the general performance The results showed that zero tillage suppress weed density and weed dry weight up to 59% and 38% over conventional and minimum respectively and increase the yield up to 6% over conventional tillage. The results of weed control periods showed that weed control after 20 DAE suppress the weed density and dry weight up to 76% and 95% respectively and increase the grain yield up to 34%.

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