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DETERMINING CRITICAL WEED COMPETITION PERIOD IN MAIZE (*Zea mays* L.) SOWN UNDER DIFFERENT TILLAGE INTENSITIES

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ABSTRACT

A field experiment was conducted at the Agronomic Research Area, Department of Agronomy, University of Agriculture, Faisalabad to determine the critical weed competition period in maize (Zea mays L.) sown under different tillage intensities. The field trial was laid out with split plot design having three replicates with a net plot size of 4.5 m x 6 m. The experiment comprised of three tillage practices namely deep cultivation with disc plough + 3 cultivations with cultivator, rotavator + 3 cultivations with cultivator, and only 3 cultivations with cultivator; and five weed competition periods of 20, 30, 40 days after crop emergence along with weed free and weedy check. The linear increase in the density of weeds (m^{-2}) with the competition periods would be due to more time period available for weed seed germination which ultimately resulted in the reduction of total grain yield. Plant population at harvest, number of grains cob^{-1}, number of grain rows cob^{-1}, total number of grains cob^{-1}, 1000-grain weight (g), grain yield, dried stalk yield and biological yield were maximum in disc plough + 3 cultivations with cultivator.

Keywords: Maize, weed competition period, tillage, *Zea mays*.

INTRODUCTION

In Pakistan, after wheat and rice the third most vital cereal crop is maize (*Zea mays* L.). Maize crop is very imperative due to its short duration nature and high yielding potential. Maize demand is increasing day by day due to its multipurpose nature. Due to increasing demand for poultry feed and others the area of maize is increasing (Govt. of Pakistan, 2010). The average grain yield of maize crop in Pakistan is 3.56 t ha^{-1} and it is cultivated on an area of 0.94 m ha with the overall production of 3.34 m t (Govt. of Pakistan, 2011). Its importance is clear because of its high food value for human beings and used as edible oil, nourishment for farm animals and poultry. The average grain production of maize is less than those of other important maize producing countries but the production potential of existing genotypes (Govt. of Pakistan, 2005).

Among various factors for the low yield of crop weed infestation is the most important. Although maize plant is vigorous and tall growing in

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nature, but at early stages of growth and development of maize plant, it is very sensitive to weed competition (Kumar and Sundari, 2002). Maize production is decreased up to 35-80% due to the heavy weed infestation, because the weeds are the most important pest group of this crop (Oerke and Dehne, 2004). The early growth period maize crop is very sensitive to weed competition (Reddy, 2004). As competitiveness of weeds depends upon period of weed emergence with the crop plants, the time of weed removal and removal of weeds itself are equally important (Akhtar *et al.,* 2000). If the weed control efforts are carried out before and after the critical weed competition periods the considerable profit and effective weed management cannot be attained (Tanveer *et al.,* 1999). Weed infestation is the most important factor for the low yield of crop. At early stages of growth and development maize crop is very sensitive to weed competition, because maize plant is tall growing and vigorous in nature (Kumar and Sundari, 2002). Deep tillage, conventional tillage, conservation tillage, minimum tillage and no tillage are different tillage operations are well adopted by the farmers' community (Lal, 2002). Deep tillage operations increase the crop production usually and also improve water infiltration, movement in soil, breaks up high density soil layers (Halvorson *et al.,* 2002). According to Streit *et al.* (2002a), increase in soil bulk density and the soil compactness are the problems concerned with heavy machinery tillage operations, which ultimately results in the decrease in soil permeability and create mechanical restrictions in root growth. That's why to reduce cost-effective inputs and to save time in field preparation, the least tillage technologies are being adopted throughout the world (Arif *et al*., 2007). When the weed crop competition is for long season the yield losses of maize crop are more (Dalley *et al.,* 2006).

The instant project was undertaken at Agronomic Research Area, Department of Agronomy, University of Agriculture, Faisalabad during 2011 spring season with the objective to determine the critical weed competition period in maize (*Zea mays* L.) sown under different tillage intensities.

MATERIALS AND METHODS

A field experiment was carried out at Agronomic Research Area, Department of Agronomy, University of Agriculture, Faisalabad to assess the different weed competition periods through different tillage intensities in spring planted maize (*Zea mays* L.). The experiment was laid out according to Randomized Complete Block Design (RCBD) with split plot arrangement with a plot size 4.5m x 6m and row to row distance 75 cm and plant to plant distance of 20 cm. Seeds a hybrid maize cultivar "High Corn 8288" was sown on spring 2nd Feburary, 2011. The experiment comprised three tillage practices namely deep cultivation with disc plough + 3 cultivations with cultivator (T_1), rotavator + 3 cultivations with cultivator (T_2) and 3 cultivations with cultivator (T_3) and in each main plot there were five sub plots comprised of five weed competition periods of 20, 30, 40 days after crop emergence (DAE) along with weed free and weedy check plots.

The fertilizer was applied at 175:85:65 kg ha^{-1}.as Urea, DAP and sulphate of potash fertilizer half of the nitrogen and whole of phosphorus was side drilled at the time of sowing. While for recording weed biomass weeds from the above mentioned area were harvested from ground level separated and their individual oven dry weight was measured using electric balance,

For recording plant population all the plants in each plot were counted at harvest. Ten plants were selected at random from each plot to measure number of grains per row, and number of grains per cob. Two samples of 1000 grains each were taken at random from seed lot of each ploy for recording 1000-grain weight Grain Yield, dried stalk yield and biological yield were recorded on whole plot basis and was converted on hectare basis. Harvest index was calculated by dividing the economic yield with biological yield. Economic Analysis was carried as suggested by CIMMYT (1988).

Data collected were tabulated, analyzed statistically according to Fisher's Analysis of variance technique. Least significant difference (LSD) test at 5% probability level was applied to test the significance of treatment's mean (Steel *et al.,* 1997).

RESULTS AND DISCUSSION

Weed density m^{-2}

Cyperus Rotundus, Dactyloctenium aegyptium, *Triantheme Portulacastrum*, *Rumex dentatus* L., *Cynodon dactylon* and *Convolvulus arvensis* were the main weeds observed in the field. Data relating to density of *C.rotundus* at different weed competition periods and different tillage showed that different tillage treatments differed significantly (Table-1). The maximum density of *C. rotundus* was observed in cultivator (T_3) followed by rotavator + cultivator (T_2) treatment, whereas, disk plough+ cultivator (T_1) showed minimum density of *C. rotundus*. The density of *C. rotundus* was significantly reduced 62.66% in disk plough + cultivator (T_1) over cultivator (T_3). As for as weed competition periods are concerned, the maximum density of *C. rotundus* was observed in case of weedy check (W_1) and density reduced considerably with every reduction in competition period. The minimum density of *C. rotundus* was observed in weed free plots (W_5). The interaction of tillage treatments and weed competition periods, the maximum density of *C. rotundus* (43 m^{-2}) was observed in cultivator + weedy check (T_3W_1) treatment where weeds were not controlled followed by use of rotavator + cultivator along with weedy check (T_2W_1). The density of *C. rotundus* decreased significantly with each decrease in competition period and increase in tillage intensities. However, the differences between competition periods of 20 and 30 DAE were not statistically different at all tillage intensities.

The minimum density of *C. rotundus* in disc plough + cultivator (T_1) due to the reason that soil was cut and inverted that resulted in the tubers of *C. rotundus* might have buried in deeper layers of soil and unable to germinate, whereas, in case of cultivator (T_1) soil conditions were made favorable for germination of *C. rotundus* so, the maximum number of plants of *C. rotundus* were observed in this treatment. These findings are similar with Arif *et al.* (2007) concluded that deep tillage decreased the weed density. Variation in the density of *C. rotundus* in treatments due to the weed competition periods was significant. Decrease in density with shorter competition periods might have been due to less time for weeds to compete. The minimum weeds densities in weed free plots have also been reported by Mubeen *et al*. (2009). The minimum densities of weeds were observed in weed free treatments at all tillage intensities because the weeds were not allowed to grow and were removed with repeated hand hoeing operation. These results are similar by Streit *et al.* (2002b) who concluded that reduction in weed density due to different weed competition periods over weedy check.

Data pertaining to density of *D. aegyptium* at different weed competition periods and different tillage intensities (Table-1) showed that both tillage operations and weed competition periods significantly reduced the density of *D. aegyptium.* As concerns with tillage operations, data trend shows that increasing tillage intensity decreased the weed density. The significant highest density (24.13 m^{-2}) of *D. aegyptium* was observed in cultivator (T_3) treatment followed by rotavator + cultivator (T_2) and minimum density is observed in disc plough + cultivator (T_1). So, mean decrease 49.60% in the density of *D. aegyptium* was observed in case of disk plough+ cultivator (T_1) over cultivator (T_3) treatment. As for as weed competition periods are concerned, the maximum mean value of *D. aegyptium* was observed in case of weedy check (W_1) and density of *D. aegyptium* decreased with each decrease in competition period and minimum was recorded in weed free. The interaction was also significant and the maximum density of *D. aegyptium* (42 m^{-2}) was observed in treatment combination cultivator + weedy check (T_3W_1) due to the more time period available for weed seed germination, followed by rotavator + cultivator along with weedy check (T_2W_1). The density of *D. aegyptium* decreased significantly with each decrease in competition period with increase in tillage intensities. However, the differences between disc plough + cultivator + weedy check (T_1W_1) treatment and rotavator + cultivator + 40 DAE (T_2W_4) treatments were not statistically different from each other. So with every increase in tillage intensities there is significant reduction in the density of weeds with increasing competition periods.

Table-1. Effect of weed competition period on the weed density (m^{-2}) of maize under different tillage intensities.

Treatments	*C. rotundus*	*D. aegyptium*	*T. portulacastrum*	*R. dentatus*	*C. arvensis*
Weed competition periods					
W1=Weedy check	34.67 A	35 A	27.44 A	27.89 A	22 A
W2=20 DAE	11.56 D	17.11 D	14.11 D	15.11 D	10.33 D
W3=30 DAE	14.56 C	21.56 C	19 C	17.44 C	14 C
W4=40 DAE	18.89 B	27.33 B	22 B	20.67 B	18 B
W5=Weed free	0.00 E	0.00 E	0.00 E	0.00 E	0.00 E
T1= (disc plough + cultivator)	12.13 C	16.13 C	11.73 C	12.20 C	9.60 C
T2= (rotavator + cultivator)	15.93 B	20.33 B	16.53 B	16.80 B	13.27 B
T3=(only cultivator)	19.73 A	24.13 A	21.27 A	19.67 A	15.73 A
T1W1	27 c	29 c	21.33 de	22.33 cd	18.67 cd
T1W2	6.67 j	13 h	8.33 h	9.33 i	5.33 g
T1W3	11 i	17 g	12.67 g	13 h	9.67 f
T1W4	16 fg	21.67 e	16.33 f	16.33 g	14.33 e
T1W5	0 k	0 i	0 i	0 j	0 h
T2W1	34 b	34 b	26.33 bc	27.67 b	21.67 b
T2W2	12 hi	18 fg	14.33 fg	16.33 g	11.67 ef
T2W3	14.67 gh	22.33 e	19.67 e	18.33 fg	14.33 e
T2W4	19 e	27.33 cd	22.33 d	21.67 cde	18.67 cd
T2W5	0 k	0 i	0 i	0 j	0 h
T3W1	43 a	42 a	34.67 a	33.67 a	25.67 a
T3W2	16 fg	22.33 ef	19.67 e	19.67 ef	14 e
T3W3	18 ef	25.33 d	24.67 c	21 de	18 d
T3W4	21.66 d	33 b	27.33 b	24 c	21 bc
T3W5	0 k	0 i	0 i	0 j	0 h

DAE= Days after emergence
Any two means not sharing a letter in common with in a column differ statistically at 5% probability

Lower density due to deep tillage can be attributed to the burial of the seeds of *D. aegyptium* in deeper layer of the soil which failed to germinate. Minimum density of weeds was observed in weed free plot (W_5) treatment because all the weeds were removed at the time of sowing also regularly removed at different times with hand hoeing operation. These results are supported by Streit *et al.* (2002b) who reported reduction in weed density due to different weed competition periods over weedy check. The linear increase in the density of *D. aegyptium* with the competition periods would be due to more time period available for weed seed germination. Streit *et al.* (2002b) studied that early removal of weeds in maize created a considerable decrease in the density of weeds.

Both tillage operations and weed competition periods have significant individual as well as combined (interaction) effect on the reduction of *T. portulacastrum*. The increasing tillage intensity decreased the weed density. Statistically higher density of *T. portulacastrum* (21.27 m^{-2}) was observed in cultivator (T_3) treatment followed by rotavator + cultivator (T_2) treatment (16.53 m^{-2}) and minimum density of *T. portulacastrum* (11.73 m^{-2}) was observed in disk plough+ cultivator (T_1) treatment. So, mean decrease in density *T. portulacastrum* was 81.32% in case of disk plough+ cultivator (T_1) over cultivator (T_3). As for as weed competition periods are concerned, the maximum mean value of *T. portulacastrum* (27.44 m^{-2}) was observed in case of weedy check (W_1); it was followed by (22 m^{-2}) 40 DAE (W_4) and density of *T. portulacastrum* decreased with each decrease in competition period and minimum was recorded in weed free. As concern interaction of tillage systems and weed competition periods, maximum density of *T. portulacastrum* (34.67 m^{-2}) was observed in treatment combination (cultivator + weedy check) T_3W_1 due to the more time period available for weed seed germination, followed by (27.33 m^{-2}) cultivator + 40 DAE (T_3W_4). The density of *T. portulacastrum* decreased significantly with each decrease in competition period with increase in tillage intensities. However, there is statistically no difference between cultivator + competition period of 40 DAE (T_3W_4) treatment and rotavator + cultivator + weedy check (T_2W_1) treatment combinations.

The minimum density of *T. portulacastrum* was observed in weed free plots (W_5) because all the weeds were removed at the time of sowing also regularly removed at different times with hand hoeing operation. These results are supported by Streit *et al.* (2002b). The minimum number of *T. portulacastrum* was observed in disk plough+ cultivator (T_1) which was due to the inversion of soil by using deep tillage operations as a result the seeds of *T. portulacastrum* was spread in deeper layer of the soil so that, these seeds could not germinate. These results support the previous findings of Usman and Khan (2009) who reported reduced weed density in different treatments over control. The linear increase in the density of *T. portulacastrum* with the competition periods would be due to more time period available for weed seed germination. Mubeen *et al.* (2009) has also reported a decline in weed density with decreased weed competition period.

The density *R. dentatus* (m^{-2}) was affected significantly by tillage operations and weed competition periods. The density of *R. dentatus* decreased with increasing tillage intensity. Statistically higher density of *R. dentatus* was observed (19.67 m^{-2}) in cultivator (T_3) treatment followed by (16.80 m^{-2}) rotavator + cultivator (T_2) and minimum density of *R. dentatus* (12.20 m^{-2}) was observed in disk plough+ cultivator (T_1) treatment. So, mean decrease in the density *R. dentatus* was 61.22% and 37.71% in case of disk plough + cultivator (T_1) and rotavator + cultivator (T_2) respectively, over cultivator (T_3). As for as weed competition periods are concerned, the maximum mean value of *R. dentatus* (27.89 m^{-2}) was observed in case of weedy check (W_1); it was followed by (20.67 m^{-2}) 40DAE (W_4) and density of *R. dentatus* decreased with each decrease in competition period and minimum was recorded in weed free. The maximum density of *R. dentatus* (33.67 m^{-2}) was observed in treatment combination cultivator + weedy check (T_3W_1) due to the more time period available for weed seed germination, followed by (27.67 m^{-2}) rotavator + cultivator + weedy check (T_2W_1). However, there is statistically no difference between cultivator + 40 DAE (T_3W_4), disk plough + cultivator + weedy check (T_1W_1) and rotavator + cultivator + 40 DAE (T_2W_4) treatment.

The minimum number of *R. dentatus* in disk plough+ cultivator (T_1) was due to the inversion of soil in disk plough + cultivator (T_1) the seeds of *R. dentatus* was spread in deeper layer of the soil so that, these seeds could not germinate. These results support the previous findings of Anil and Bhan (1998) who reported reduced weed density in different treatments over control. The decrease in weed density of *R. dentatus* with increase in competition period was due to less time for the germination of weeds. James *et al.* (2000) and Mubeen *et al.* (2009) also reported that maximum density was recorded in weedy check and it decreased as time for weed-crop competition was decreased.

The tillage operations and weed competition periods significantly reduced the density of *C. arvensis* (m^{-2}) over control. The density of *C. arvensis* decreased with increasing tillage intensity. Statistically significant density of *C. arvensis* (15.73 m^{-2}) was observed in cultivator (T_3) treatment followed by rotavator + cultivator (T_2) and minimum density of *C. arvensis* was observed in disk plough+ cultivator (T_1) treatment. So, mean decrease in density *C. arvensis* was 63.85% in case of disc plough+ cultivator (T_1) over cultivator (T_3). As for as weed competition periods are concerned, the maximum mean value of *C. arvensis* was observed in case of weedy check (W_1); it was followed by 40 DAE (W_4) treatment and density of *C. arvensis* decreased with each decrease in competition period and minimum density was recorded in weed free.

As regard interaction of tillage systems and weed competition periods, maximum density of *C. arvensis* (25.67 m^{-2}) was observed in treatment combination (cultivator + weedy check) T_3W_1 due to the to more time period available for weed seed germination, followed by (21.67 m^{-2}) rotavator + cultivator + weedy check (T_2W_1) it was statistically at par with cultivator + 40 DAE (T_3W_4) treatment. However, there is no difference between rotavator + cultivator + 40 DAE (T_2W_4) and disc plough+ cultivator + weedy check (T_1W_1) treatments. Minimum density of *C. arvensis* was observed in weed free plots (W_5). These results are agreement with James *et al.* (2000) and Mubeen *et al.* (2009) who also reported minimum weed number in weed free.

The conditions were favorable for seed germination when cultivator was used and seeds of *C. arvensis* already present in the soil remain at the same level resulting in higher weed density compared with deep ploughing treatment where the soil was inverted and the seeds present on the upper soil layer might have buried in the soil. These results support by the previous findings of Arif *et al.* (2007) who reported that tillage had a significant effect on the density of weeds. With every increase in tillage intensity and with increase in competition periods there is more decrease in the density of *C. arvensis* which was due to less time available for weed seed germination. The maximum density in weedy check can be attributed to the unchecked and undisturbed growth in the absence of any weed control treatment. These results are in line with James *et al.* (2000) who reported that total weed density in maize increased with increasing competition period and maximum was recorded in weedy check.

The number of plants at harvest was also significantly affected at different weed competition periods treatments. The maximum number of plants at harvest (6.34) was observed by disc plough + cultivator (T1) treatment followed by rotavator + cultivator (T_3) treatment which was statistically atpar with (T_1) and (T_3) treatment. In this experiment more number of plants were observed in weed free plots (W_5) treatment and with increase in competition periods and tillage intensities there is significantly reduction in the number of weeds and ultimately affects the number of plants. The weeds presents also increased the competition for water and nutrients. The results agree with those of Lozanovski *et al*. (2001) who reported that strong weed competition reduces the dry weight of maize by two-third and decrease the leaf surface area and photosynthesis compared with weeds free crops.

As regards to tillage operations, mean value of number of grains per row was maximum (28.80) in disc plough + cultivator (T_1) whereas (25.80) only cultivator (T_3) showed minimum value of number of grains per row. While rotavator + cultivator (T_2) treatment (27.27) lies between both disc plough + cultivator (T_1) and cultivator (T_3) treatment which are also statistically at par with each other. As for as weed competition periods, the maximum mean value of number of grains per row (29.11) was observed in case of weed free plots (W_5) also it was statistically similar with 20 DAE (W_2) treatments. While minimum value of number of grains per row (26.11) was observed in case of weedy check (W_1). As regard interaction of tillage systems and weed competition periods, it showed statistically non-significantly results of number of grains per row. The result coincide with those of James *et al.* (2000) who reported that period of weed free maintenance required to produce maximum yield of sweet corn. Similar results were also observed by Zada (1998) and Akbar (1998) who reported that cob length and number of cobs/plant decreased linearly with in the plant population and cob weight gave a curvilinear response.

The 1000-grain weight was also affected by maize competition and different weeding treatments. Tillage operations and weed competition periods showed pronounced effect on 1000-grain weight (g) of maize. Evidence from Table-2 showed that in case of tillage systems maximum 1000-grain weight (g) was recorded in disc plough + cultivator (T_1) whereas (421.20 g) only cultivator (T_3) showed minimum value of 1000-grain weight (g). While rotavator + cultivator (T_2) value (432.67 g) lies between both disc plough + cultivator (T_1) and cultivator (T_3) treatments. As for as weed competition periods, the maximum mean value of 1000-grain weight (474.84 g) was observed in case of weed free (W_5) treatment followed by 20, 30 40 DAE (W_2, W_3 and W_4) which were statistically similar with each other. While minimum value (407.11 g) of 1000-grain weight was observed in case of weedy check (W_1) treatment. As regard interaction of tillage systems and weed competition periods, it showed statistically non-significantly results of 1000-grain weight (g). The results agree with those of James *et al*. (2000) who reported that grain yields of maize in weeds free plots was higher than those plots infested with weeds. Akbar (1998) also reported that the number of grains per cob and grain yield per hectare was significantly influenced by different planting patterns.

Tillage operations and weed competition periods showed pronounced effect on grain yield (t ha^{-1}) of maize. Evidence from Table-2 showed that in case of tillage systems maximum grain yield (t ha^{-1}) was recorded in (3.61 t ha^{-1}) disc plough + cultivator (T_1) treatment showing 18.36% increase over cultivator (T_3) whereas only cultivator (3.05 t ha^{-1}) (T_3) treatment showed minimum value of grain yield (t ha^{-1}). While rotavator + cultivator (T_2) treatment value (3.22 t ha^{-1}) lies between both disc plough + cultivator (T_1) and cultivator (T_3) treatment.

Table-2. Effect of weed competition periods and tillage intensities on the plant population, yield components, harvest index, grain, dried stalk and biological yields of maize.

Treatments	Plant population	Number of grains row^{-1}	Number of grains cob^{-1}	1000 grain wt. (g)	Grain (t ha^{-1})	Dried stalk yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index
Weed competition periods								
W_1=Weedy check	6.04 C	28.44 A	391.22 C	407.11 C	2.92 D	7.43 D	10.12 D	28.98
W_2=20 DAE	6.38 AB	26.56 B	429.33 B	434.67 B	3.44 B	8.87 B	12.27 B	28.21
W_3=30 DAE	6.24 BC	26.22 B	409.22 BC	425.22 BC	3.27 C	8.27 C	11.48 C	28.58
W_4=40 DAE	6.12 BC	26.11 B	401.44 C	418.89 BC	3.18 C	8.08 C	11.10 C	28.78
W_5=Weed free	6.56 A	29.11 A	466.44 A	474.78 A	3.65 A	9.27 A	13.08 A	28.07
Tillage operations								
T_1=(disc plough + cultivator)	6.34 A	28.80 A	453 A	442.53	3.61 A	9.65 A	13.24 A	29.11 A
T_2=(rotavator + cultivator)	6.26 AB	27.27 AB	438.40 A	432.67	3.22 B	8.12 B	11.07 B	29.10 A
T_3=(only cultivator)	6.22 B	25.80 B	367.20 B	421.20	3.05 C	7.37 C	10.51 C	27.36 B
Interaction								
T_1W_1	6.14	31	415.67	423.67	3.10 efg	8.17 efg	11.23 def	30.59
T_1W_2	6.44	26.33	481	449.33	3.80 b	10.40 b	14.20 b	28.98
T_1W_3	6.32	28.33	442.33	443.67	3.43 c	9.10 c	12.57 c	29.81
T_1W_4	6.23	27	453	435.67	3.31 cd	8.80 cd	11.97 cd	28.46
T_1W_5	6.54	31.33	473	460.33	4.43 a	11.80 a	16.23 a	27.72

Treatments	Plant population	Number of grains row^{-1}	Number of grains cob^{-1}	1000 grain wt. (g)	Grain (t ha^{-1})	Dried stalk yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index
Interaction								
T_2W_1	6.10	30	418.67	407.67	2.90 gh	7.47 i	10.13 g	28.62
T_2W_2	6.42	27	439.67	434.33	3.30 cde	8.40 def	11.43 de	28.86
T_2W_3	6.22	24.67	421.33	419.67	3.26 cde	8.13 efg	11.37 def	28.67
T_2W_4	6.05	26	415.67	410.33	3.22 cdef	8.10 efgh	10.67 efg	30.23
T_2W_5	6.64	28.67	496.67	491.33	3.42 c	8.50 cde	11.77 cd	29.15
T_3W_1	5.90	24.33	339.33	390	2.75 h	6.67 j	9 h	27.74
T_3W_2	6.27	26.33	367.33	420.33	3.23 cde	7.80 fghi	11.17 def	26.78
T_3W_3	6.19	25.67	364	412.33	3.13 def	7.57 ghi	10.50 fg	27.26
T_3W_4	6.07	25.33	335.67	410.67	3.03 fg	7.33 i	10.67 efg	27.67
T_3W_5	6.51	27.33	429.67	472.67	3.11 defg	7.50 hi	11.23 def	27.35

DAE = Days after emergence
Any two means not sharing a letter in common with in a column differ statistically at 5% probability

Grain yield was significantly affected by weed competition periods as is shown in Table-2. The maximum grain yield (3.65 t ha^{-1}) was obtained in the plots which were weed free (W_5) plots. This was significantly different from all other treatments. With increase in competition periods the grain yield was significantly decreased.

As regard the interactive effect of tillage and weed competition periods, the maximum grain yield (4.43 t ha^{-1}) of spring planted maize was observed in treatment combination disc plough + cultivator + weed free (T_1W_5) that were 61.09% higher than cultivator + weedy check (T_3W_1). It was followed in descending order by disc plough + cultivator + 20 DAE (T_1W_2), disc plough + cultivator + 30 DAE (T_1W_3) which was statistically similar with rotavator + cultivator + weed free (T_2W_5), giving grain yield of 3.80, 3.43, 3.42 respectively. An increase of 38.18, 24.73 and 24.36% grain yield respectively over cultivator + weedy check (T_3W_1). Maximum grain yield obtained in (T_1) was attributed to the combined effect of yield components. In deep tillage disc plough + cultivator (T_1) treatment yield increases may be due to increase in porosity and differences in water storage and movement of nutrients. The significantly minimum grain yield (2.92 t ha^{-1}) was observed in weedy check plots. The decrease in grain yield with increased competition periods was due to decrease in the main component of grain yield like number of cobs per plant, number of grains in the cobs, number of grain rows per cob, number of grains per row and 1000-grain weight. The reduction in the yield due to weed competition was also reported by Ahmad and Shaikh (2003) in wheat crop.

CONCLUSION

Based on the present study it is concluded that due to weed should be controlled upto 20 days after emergence and disc plough should be used for effective weed control and higher grain yield in maize.

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