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STUDY THE CRITICAL PERIOD OF WEED COMPETITION IN MAIZE

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ABSTRACT

Two field experiments were carried out at the Experimental Farm of the National Research Centre, at Shalakan, Kalubia Governorate, Egypt, to determine the critical period of weed competition in maize fields during 2000 and 2001 in summer seasons.

The main results could be summarized as follows:

- The first 12-24 days after sowing (DAS) were the most critical period for weed removal in maize fields.
- Weed removal at 12, 24 and 36 DAS decreased the number of total weeds to 29.14, 36.57 and 44.00% in season 2000 and 27.17, 35.33 and 42.39% in season 2001, respectively and reduced fresh weight to 40.95, 44.49 and 50.23 % in season 2000 and 39.89, 45.93 and 50.28 in season 2001 and decreased dry weight to 40.10, 43.40 and 49.15% in season 2000 and 39.23, 44.98 and 49.31% in season 2001 respectively, when compared to unweeded check.
- Weed free until harvest and weed removal at 12, 24 and 36 DAS improved the growth of maize plants and produced the longest ears, the highest number of grains/row, the highest weight of ear grain, weight of 100-grain and the highest grain yield per fed as compared to unweeded check.
- Shelling percentage was not significantly affected by all weed removal period in both seasons.
- When weeds left to grow for 48, 60, 72, 84, 96 and 108 DAS, the grain yield per fed was reduced by 28.82, 33.30, 35.70, 41.19, 44.36 and 51.60% in season 2000 and 30.00, 33.12, 36.09, 39.37, 43.09 and 49.08% in season 2001 respectively, when compared with the weed free treatment.

The highest percentage of protein and oil in both seasons was obtained when weed free until harvest and weed removal at 12, 24 and 36 DAS. On the other hand, further delay in weed removal for later stages reduced grain protein and oil percentage, while the least protein and oil percentage was recorded at unweeded check through the two seasons.

Weed removal at 12-24 days after sowing was adequate for getting optimum yield in maize.

INTRODUCTION

Maize (*Zea mays,* L.) is one of the most important cereal crops in the world. In Egypt, maize is considered one of the main cereal crops, it ranks the third after wheat and rice. Productivity of maize plants depends on the available amount of light interception, nutrients and water. Weeds are considered as a major problem in production of maize in Egypt. Maize is often infested with numerous types of weeds which compete with the crop plants.

The critical period for weed control (CPWC) is the period in the crop growth cycle during which weeds must be controlled to prevent unacceptable yield losses. Thus weed competition is a critical factor affecting growth and productivity of maize plants. Yield losses due to the prevailing weeds were estimated to be about 43-57% (Varshney, 1991) and by about 87% (Kozlowski, 2002). The relative competitive ability of crop plants and weeds changes in the course of plant life cycle (Hall *et al.* , 1992). Ferrero *et al.* (1991) and Varshney (1991) they noticed that early competition usually reduce maize yield more than later season weed growth, therefore early weed control is extremely important.

The length of the critical period, during which weed competition must be absent to avoid crop loss, varies with the crop grown, the weed present and other factors (Hewson and Roberts, 1971). The critical period of weed competition in maize was 14-21 (Ferrero *et al.,* 1991); 21-42 (Shad *et al.,* 1993); 28-56 days after sowing (Hall *et al.,* 1992). Meanwhile, on the other side, the competition may occure even before crop and weed emerge (Bowden and Friesen, 1967).

Time of weed removal has a significant effect on yield of maize crop (Moolani, 1965). Varshney (1991) found that weeding at 40 DAS is essential for getting maximum yield in maize. Metwally and Youssef (1998) reported that weeding at 20 DAS as well as 35 DAS gave the highest yield in maize per fed as compared with unweeded check. Ahmed (2000) showed that weed free in maize until harvest and weed removal 2, 4 and 6 weeks after sowing (WAS) gave the maximum yield per fed as compared to unweeded check.
Weed control for 9 weeks after sowing in corn gave the best crop yields than uncontrolled weed (Usman *et al.*, 2001).

Therefore, the main target of this study was to ascertain the critical period of maize-weed competition to control weeds at the most appropriate time in maize fields.

MATERIALS AND METHODS

Two field experiments were conducted in the Agricultural Experimental Station of the National Research Centre at Shalkan, Kalubia Governorate, Egypt during 2000 and 2001 seasons in a clay loam soil, to study the effect of different weed removal periods on plant growth, grain yield, its components and chemical composition of grains in maize. The chemical analysis of soil was as follows in Table (1).

Table (1): Chemical analysis of soil site.

pH	E.C. (mmhos)	Organic matter%	Total N%	P (ppm)	K (ppm)	$CaCo_2$ %
8.12	1.53	1.73	0.1	16.1	26.83	2.81

The treatments consisted of weed removal at 12, 24, 36, 48, 60, 72, 84, 96 and 108 days after sowing (DAS) by hoeing and hand weeding, besides weed free and unweeded check for comparison. The treatment of

weed free was done by frequent hand weeding throughout the season. In the unweeded treatment, weeds were left without removing over the growing season.

Grains of maize (*Zea mays,* L.) cv. single cross 122 were sown on 12th and 17th of June in 2000 and 2001 seasons, respectively. The experimental plot was consisted of 5 ridges each 3 m long and 70 cm width (10.5 m^2=1/400 of fed). Grains of maize were planted in hills 25 cm apart. All the recommended cultural practices of growing maize were applied. The experimental design used was randomized complete block design with four replications. Weeds were randomly taken from an area of one square meter for each plot at harvest. Weeds were identified and classified into annual broad-leaved, annual grasses and total weeds, the number, fresh and dry weights of weed species were recorded. At the end of growing season, samples of five maize plants were randomly taken from each plot and the following data were recorded:

1. Plant height (cm)
2. Stem diameter (cm)
3. Ear length (cm)
4. Ear diameter (cm)
5. Ear weight (g)
6. Number of rows per ear
7. Number of grains per row
8. Ear grains weight (g)
9. Weight of 100 grains (g)
10. shelling %
11. Grain yield (ardab/fed).

Chemical composition of maize grains:

1. Crude protein percentage was determined according to A.O.A.C. (1980).
2. Oil content was determined using the method described and used by (Bedov, 1970) using Soxhlet equipment.

Data obtained during the two growing seasons were subjected to statistical analysis by the technique of analysis of variance (ANOVA) as published by Gomez and Gomez (1984). Least significant difference (LSD) method was used to test the differences between treatment means at 1% and 5% level of probability.

RESULTS AND DISCUSSION

The dominant weeds in the experimental field in the two seasons were *Corchorus olitorius,* L.*; Echinochloa colonum,* L.*; Portulaca oleraceae,* L.; *Xanthium strumarium*, L.; *Hibiscus trionum,* L., *Chenopodium album,* L. and *Amaranthus caudatus,* L.

1. Effect on number, fresh and dry weights of weed:

Data presented in Table (2) showed that weed population in unweeded check at harvest was 175/m^2 and 184/m^2 in both seasons (2000 and 2001). Broad-leaved weeds dominated up to 45.71 and 45.11% of the total weeds number in unweeded treatment in the two seasons, respectively. Removing weeds at 12, 24 and 36 days after sowing (DAS) decreased number of total weeds by 29.14, 36.57 and 44.00% of season 2000 and 27.17, 35.33 and 42.39% of season 2001, respectively in comparison with unweeded check. It is evident that number of weeds was progressively

decreased as weed removal period increased, especially at the later stage of maize growth (after 48 days from sowing) the reduction was 50.86% and 50.50% in both seasons, respectively.

Table2

This may be due to the efficiency of weed control and the effect of maize shading. Shetty *et al.* (1982) noticed that dicotyledonous are less shade-sensitive than monocotyledonous.

Concerning the fresh weight of total weeds (annual broad-leaved and annual grass weeds) the same table cleared that the fresh weight of weeds in unweeded treatment at harvest stage were 1400.30 and 1450.00 g/m^2 in 2000 and 2001 seasons, respectively. Broad-leaved weeds constituted 70.65 and 69.89% of the total fresh weight of weeds in unweeded treatment at harvest in both seasons of 2000 and 2001.

Removing of weeds at different crop stages significantly influenced fresh weight of broad-leaved and grass weeds. Removing weeds at 12, 24 and 36 DAS reduced fresh weight of total weeds by 40.95, 44.49 and 50.23% of season 2000 and 39.89, 45.93 and 50.28 of season 2001, respectively as comparison with unweeded check.

With regard to dry weight of weeds, data also in Table (2) indicated that total dry weight of weeds in unweeded treatment at harvest were 281.80 and 290.60 g/m2 in both seasons. Broad leaved weeds constituted 65.51 and 65.07% of the total dry weight of weeds in weedy check at harvest in seasons of 2000 and 2001, respectively.

Removing weeds at 12, 24 and 36 days after sowing decreased total dry weight of weeds by 40.10, 43.40 and 49.15% of season 2000 and 39.23, 44.98 and 49.31% of season 2001, respectively in comparison of unweeded check. Delayed weeding at 48 DAS significantly suppressed dry weight of weed to 55.82% and 56.06% in both seasons in comparison of unweeded treatment, respectively. Prasad and Mani (1986) recorded that maximum accumulation of weed biomass up to 40 days after emergence in maize. It is evident that most weeds emerged during the early stages of maize growth. While, biomass of weed species associated with maize plants was eventually reduced at the later stages of maize growth (after 48 days from sowing). This, because the weed species that emerged later were suppressed by the crop shading, in addition to the competition between weed species and between the weeds and the crop. These results are in harmony with those obtained by Ferrero *et al.* (1991), Varshney (1991), Hall *et al.* (1992), Shad *et al.* (1993), Hussein (1996), Metwally and Youssef (1998) and Ahmed (2000).

2. Effect on plant growth:

A: Plant height (cm)

Data in Table (3) showed that significant differences between various weed removal periods were found for maize plant height at harvest in both seasons. Plant height ranged from 228.75 to 290.00 cm in season 2000 and from 220.0 to 280.0 cm in season 2001.

The tallest maize plants were obtained from weed free treatment and treatments of weed removal at 12, 24 and 36 DAS compared with unweeded check in both seasons. This might be attributed to the effective weed control at these times. On the other hand, maize plant height was significantly reduced with the increase in the duration of weed infestation for 48, 60, 72, 84, 96 and 108 DAS in the two seasons compared to weed free treatment. The shortest maize plants were obtained from unweeded check.

Table3

This may be due to the competition between weed species and maize plants. Same observations were found by Hussein (1997), Metwally and Youssef (1998) and Ahmed (2000). Khan *et al.* (2002) reported that weed infestation periods significantly affected plant height in wheat.

B. Stem diameter (cm):

Significant differences between various weed removal periods were found for maize plants stem at harvest in both seasons in Table 3. Stem diameter ranged from 2.10 to 3.50 and from 2.17 to 3.02 cm in the first and second seasons, respectively. Treatments of weed free until harvest and weed removal at 12, 24, 36, 48, 60, 72, 84 and 96 DAS in both seasons recorded significantly thicker stem diameter as compared to unweeded check.

From the same Table, it can show that 108 days treatment did not differ significantly with unweeded check in this trait. Moreover, stem diameter for the other treatments was thicker than unweeded treatment. Similar findings were reported by Metwally *et al.* (1994) they found that weeding at 21 and 35 days after sowing achieved the higher stem diameter for maize plants. Metwally and Youssef (1998) reported that the same results after 20 and 35 days after sowing.

3. Effect on yield and its components:

A: Ear length, diameter and its weight

Data in Table 3 observed that ear length, diameter and its weight of maize plants were significantly affected by weed removal treatments at different times in 2000 and 2001 seasons.

Ear length obtained from weed free treatment and weed removal at 12, 24 and 36 DAS was significantly taller than those obtained from all other weed removal treatments as well as unweeded check. Delaying weed removal at 48, 60, 72, 84, 96 and 108 DAS significantly decreased ear length by 6.42, 8.40, 9.11, 9.98, 16.32 and 19.29% and 9.45, 9.85, 10.85, 14.39, 20.02 and 23.63%, respectively in both seasons as compared to those which remained weed free until harvest. Weed free treatment surpassed other weed removal treatments in ear length. It was followed by 24 and 12 DAS treatments without any significant differences in this trait.

With respect of ear diameter, the data in the same table indicated that ear diameter of maize plants ranged from 3.90 to 5.00 cm and from 3.83 to 5.04 cm in both seasons of 2000 and 2001, respectively. Treatments of weed free and weed removal at 24, 12 and 36 DAS gave the highest thicker of ear diameter relative to other weed removal periods. However, the difference between weed free and weed removal at 24 DAS treatments did not reach the 5 and 1% levels of significance. On the other side, unweeded treatment recorded the lowest thicker of ear diameter.

With regard to ear weight of maize plants, data also cleared that treatments of weed free and weed removal periods significantly increased ear weight of maize plants than weedy check in both seasons. The highest ear weight was produced by weed free treatment and weed removal at 24, 12 and 36 as well as 48 DAS, respectively when compared to the unweeded check. On the contrary, the lowest value of ear weight was observed in

unweeded check. These results are in the same line with those of Hussein (1997), Metwally and Youssef (1998), Ahmed (1999) and Ahmed (2000).

B: Number of rows per ear

Significant differences were observed in number of rows per ear between values of weed free treatment and those of weed removal treatments at different periods as compared to unweeded check in both seasons (Table 3). Treatments of weed removal at 12, 24 and 36 DAS gave number of rows per ear statistically equal with treatment of weed free until harvest, but significantly higher than unweeded check. On the other hand, no significant reduction in number of rows per ear was showed when weeds eliminated at 96 and 108 DAS as compared with unweeded check in both seasons.

C: Number of grains per row:

Data presented in Table (3) through the two successive seasons, number of grains per row gave significant influence owing to treatments of weed free and weed removal at different periods than those of unweeded check. Number of grains per row decreased with delaying weed removal period (longer than 48DAS). Thereby, continuous weed infested plots gave the lowest number of grains per row (weedy check). On the other side, continuous weed-free plots gave the greatest number of grains per ear (weed-free treatment). From the previous results, it could be concluded that elimination of weeds at 48 DAS is necessary to prevent further significant reduction in such yield component. Similar trends has been obtained by Varshney (1991), Shad *et al.* (1993), Hussein (1997), Metwally and Youssef (1998), Ahmed (2000) and Evans *et al.* (2003).

D. Ear grains weight (g)

Results in Table (4) revealed that the ear grain weight (g) at harvest was significantly increased due to treatments of weed free and weed removal periods in both of 2000 and 2001 growing seasons compared with weedy check. The highest ear grains weight were produced by weed free treatment and weed removal at 12 and 24 DAS as well as 36 DAS compared to the unweeded check. Such superiority may be due to the competitive ability of weeds which emerged later than 36 DAS was poor, which gave a competitive advantage to the maize plants in utilizing the necessary demands of nutrient elements and water. Delaying weed removal at 48, 60, 72, 84, 96 and 108 DAS significantly reduced the ear grains weight by 15.34, 18.73, 26.59, 33.07, 34.38 and 38.68%, respectively in season 2000 and 16.32, 20.54, 23.45, 26.18, 30.85 and 35.99%, respectively in season 2001 in comparison with weed free treatment until harvest. On the other hand, the lowest ear grains weight was obtained from unweeded check. This may be due to the weed competition effects on such yield component.

E: Weight of 100 grains (g) " Seed index "

As shown in Table (4), noticed that treatments of weed free and weed removal at different stages of maize growth were significantly increased the weight of 100-grain compared with unweeded check in both seasons. Highest values of 100 grains weight were achieved from treatments of weed free and weed removal at 24 and 12 DAS, respectively.

Table4

These treatments minimizing the competition effects on the crop in this period. Delaying weed removal at 36, 48, 60, 72, 84, 96 and 108 DAS significantly reduced the weight of 100 grains by 4.26, 6.02, 6.28, 10.25, 11.09, 12.60 and 16.38% in season 2000 and 7.07, 6.98, 8.56, 9.83, 11.84, 15.25 and 15.52% in season 2001, respectively as compared to weed free treatment until harvest.

On the other hand, the lowest weight of 100-grain was obtained from unweeded check. These results are coincided with those recorded by Varshney (1991), Shad *et al.* (1993), Hussein (1997), Metwally and Youssef (1998) and Ahmed (2000) they reported that seed index was significantly reduced by weed competition. The same results obtained by Khan *et al.* (2002) in wheat.

F: Shelling %

Data in Table (4) indicated that all weed removal periods in both 2000 and 2001 seasons shelling percentage was not significantly affected. The highest shelling percentage was produced by weed free treatment and weed removal at 12, 24 DAS as well as 36 DAS compared to the unweeded check. Weed free treatment was the favorable which recorded the highest mean of shelling%, 83.02 and 82.91 in both seasons; it was followed by 12, 24 and 36 DAS treatment..

G: Grain yield per fed:

In both seasons, data presented in Table (4) showed that the grain yield per fed at harvest was increased significantly due to treatments of weed free and weed removal periods in both 2000 and 2001 seasons compared with weedy check. The loss in grain yield due to unweeded check was 15.99 and 14.82 ardab/fed in both seasons of 2000 and 2001, respectively as compared with weed free treatment. This may be due to the effective competition of weeds for maize plants particularly in the early stage of maize growth. Removal of weeds at 12, 24 and 36 DAS produced 22.65, 23.14 and 21.37 ardab/fed, respectively while, weed free treatment produced 27.48 ardab/fed in season 2000 while, produced 21.67, 22.37 and 20.19 ardab/fed and weed free treatment produced 26.57 ardab/fed in season 2001. These treatments significantly produced the highest grain yield per feddan compared to unweeded check. Chandrasagar (1983) reported that weeding at 30 DAS is an essential operation for getting maximum yield in maize.

On the other side, further delay in weed removal accentuated the adverse effect of weeds and greatly reduced grain yield/fed at 48, 60, 72, 84, 96 and 108 DAS by 28.82, 33.30, 35.70, 41.19, 44.36 and 51.60% in season 2000 and 30.00, 33.12, 36.09, 39.37, 43.09 and 49.08% in season 2001, respectively than weed free treatment. In this context, Rao (1983) recorded no significant yield reduction when the naturally-occuring weeds were left for up to 3 weeks after sowing. If they remained for longer than this, final yield was significantly reduced. Based on the previous result, it can be concluded that the critical influence of weeds on grain yield started to appear from 12 to 24 days after maize sowing. These findings mean that the critical period of weed competition with maize crop was 12-24 DAS. Weed control through

those period is necessary to obtain a maximum grain yield in maize and the more the delay of weed control, the less yield was obtained. Our findings are in good accordance with those obtained by Varshney (1991), El-Wekil *et al.* (1992), Shad *et al.* (1993), Ramos and Pitelli (1994), Hussein (1997), Metwally and Youssef (1998), Ahmed (2000) and Evans *et al.* (2003). Khan *et al.* (2002) found that uncontrolled weeds caused 65% grain yield loss compared to weed infestation only for the first two and four weeks after sowing in wheat.

H. Effect on chemical composition of maize grains:

1. Grain protein%

The results in Table (4) clear that treatments of weed free and weed removal at different stages of maize growth were significantly increased the grain protein percentage compared with unweeded check in 2000 and 2001 seasons. Highest values of protein percentage were achieved from treatments of weed free and weed removal at 12, 24 and 36 DAS in both seasons of 2000 and 2001, respectively. The grain protein percentage reduced for delaying weed removal at 48, 60, 72, 84, 96 and 108 DAS by 4.72, 6.53, 8.44, 9.85, 11.26 and 13.57% in season 2000 and by 4.96, 6.89, 8.51, 10.03, 11.85 and 13.27% in season 2001, respectively than weed free treatment. The lowest protein percentage was recorded with unweeded check in both seasons.

2. Oil percentage:

Data in Table (4) indicated that the oil percentage in grain maize was significantly increased by weed removal at different crop stages compared to unweeded check in both seasons. The highest oil percentage was produced by weed free treatment and weed removal at 12, 24 and 36 DAS compared to unweeded check. These treatments recorded the highest oil percentage 4.73, 4.60, 4.54 and 4.50%, in the first seasons and 4.69, 4.63, 4.57 and 4.55%, in the second season, respectively. Whereas, the least oil percentage was recorded from unweeded check in both seasons. On the other hand, further delay in weed removal reduced oil percentage in the maize grains.

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دراسة الفترة الحرجة لمنافسة الحشائش لمحصول الذرة الشامية

سامية أمين سعد الدين

قسم النبات – المركز القومى للبحوث – الدقى – القاهرة

أقيمت تجربتان حقليتان بمزرعة المركز القومى للبحوث بشلقان محافظة القليوبية فى موسمى ٢٠٠٠ و ٢٠٠١ لدراسة الفترة الحرجة لمنافسة الحشائش لمحصول الذرة الشامية وقد أظهرت النتائج مايلى :-

- أظهرت الدراسة أن الفترة من ١٢-٢٤ يوم بعد الزراعة كانت الوقت الحرج اللازم لإزالة الحشائش من حقول الذرة الشامية.
- أدت إزالة الحشائش عند ١٢ ، ٢٤ و ٣٦ يوم بعد الزراعة إلى نقص فى عدد الحشائش الكلية بمقدار ٢٩,١٤ ، ٣٦,٥٧ و ٤٤,٠٠% فى الموسم الأول وكان النقص بمعدل ٢٧,١٧ ، ٣٥,٣٣ و ٤٢,٣٩% فى الموسم الثانى وخفض فى الوزن الغض للحشائش بمقدار ٤٠,٩٥، ٤٤,٤٩و ٥٠,٢٣% فى الموسم الأول وبمعدل ٣٩,٨٩، ٤٥,٩٣ و ٥٠,٢٨% فى الموسم الثانى وخفض الوزن الجاف بمعدل ٤٠,١٠ ، ٤٣,٤٠ و ٤٩,١٥% فى الموسم الأول و ٣٩,٢٣ ، ٤٤,٩٨ و ٤٩,٣١ فى الموسم الثانى على التوالى مقارنة بالمعاملة بدون إزالة حتى نهاية الموسم.
- أوضحت الدراسة أن معاملة إزالة الحشائش طول الموسم ومعاملات إزالة الحشائش عند ١٢ ، ٢٤ و ٣٦ يوم بعد زراعة الذرة أدت إلى تحسين نمو نباتات الذرة الشامية وأعطت أطول كيزان وأعلى عدد للحبوب بالصف ، أعلى وزن للحبوب بالكوز ، أعلى وزن لـ ١٠٠ حبة وأعلى محصول للحبوب للفدان مقارنة بالمعاملة بدون إزالة حتى نهاية الموسم.
- وجد أن جميع معاملات إزالة الحشائش لم يكن بينها تأثيراً معنوياً على نسبة التفريط للكوز.
- وجد أن ترك الحشائش تنمو لفترات ٤٨ ، ٦٠ ، ٧٢ ، ٨٤ ، ٩٦ و ١٠٨ بعد الزراعة أدت إلى نقص فى محصول الحبوب للفدان بمقدار ٢٨,٨٢ ، ٣٣,٣٠ ، ٣٥,٧٠ ، ٤١,١٩ ، ٤٤,٣٦ و ٥١,٦٠% فى عام ٢٠٠٠ وكان النقص بمقدار ٣٠.٠٠ ، ٣٣,١٢ ، ٣٦,٠٩ ، ٣٩,٣٧ ، ٤٣,٠٩ و ٤٩,٠٨% عام ٢٠٠١ على التوالى مقارنة بمعاملة إزالة الحشائش طول الموسم.
- كانت أعلى نسبة للبروتين والزيت خلال الموسمين عند معاملة إزالة الحشائش طول الموسم وإزالة الحشائش عند ١٢ ، ٢٤ و ٣٦ يوم بعد الزراعة .
- كلما تأخرنا فى إزالة الحشائش أدى ذلك لنقص فى نسبة كلا من البروتين والزيت فى الحبوب وكانت أقل نسبة للبروتين والزيت عند المعاملة بدون إزالة للحشائش حتى نهاية الموسم.

وتوصى هذه الدراسة بأنه للحصول على أعلى إنتاجية من محصول الذرة الشامية يجب مقاومة الحشائش المصاحبة لنباتات الذرة الشامية خلال الفترة من١٢-٢٤ يوم من الزراعة.

Table (2): Number, fresh and dry weights of weeds at harvest time as affected by various weed removal periods during 2000 and 2001 growing seasons.

Characters	Annual broad-leaved weeds						Annual grass weeds						Total weeds					
	Number/m^2		Fresh weight (g/m^2)		Dry weight (g/m^2)		Number/m^2		Fresh weight (g/m^2)		Dry weight (g/m^2)		Number/m^2		Fresh weight (g/m^2)		Dry weight (g/m^2)	
	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
Treatments																		
Weed removal at																		
12 days	56.00	63.00	536.60	566.80	100.20	105.70	68.00	71.00	290.30	304.80	68.60	70.90	124.00	134.00	826.90	871.60	168.80	176.60
24 days	45.00	50.00	493.70	486.30	92.50	90.70	66.00	69.00	283.60	297.70	67.00	69.20	111.00	119.00	777.30	784.00	159.50	159.90
36 days	37.00	41.00	431.80	442.50	80.60	82.60	61.00	65.00	265.10	278.40	62.70	64.70	98.00	106.00	696.90	720.90	143.30	147.30
48 days	33.00	35.00	376.50	383.10	70.20	71.50	53.00	56.00	230.00	241.50	54.30	56.20	86.00	91.00	606.50	624.60	124.50	127.70
60 days	28.00	29.00	315.90	320.40	58.90	59.80	44.00	47.00	191.70	201.30	45.40	46.80	72.00	76.00	507.60	521.70	104.30	106.60
72 days	21.00	25.00	253.30	271.60	47.30	50.30	30.00	31.00	130.40	136.90	30.80	31.80	51.00	56.00	383.70	408.50	78.10	82.10
84 days	16.00	19.00	197.50	210.30	36.80	39.20	24.00	25.00	103.80	108.00	24.50	25.10	40.00	44.00	301.30	318.30	61.30	64.30
96 days	12.00	16.00	143.40	185.90	26.80	34.70	17.00	19.00	75.30	81.70	17.80	19.00	29.00	35.00	218.70	267.60	44.60	53.70
108 days	9.00	10.00	115.90	127.80	3.00	23.80	11.00	12.00	50.50	54.30	11.90	12.60	20.00	22.00	166.40	182.10	14.90	36.40
Weed free check	3.00	4.00	43.20	53.70	8.30	10.00	7.00	8.00	31.70	34.90	7.50	8.10	10.00	12.00	74.90	88.60	15.80	18.10
Unweed check	80.00	83.00	989.30	1013.40	184.60	189.10	95.00	101.00	411.00	436.60	97.20	101.50	175.00	184.00	1400.30	1450.00	281.80	290.60
F-Test	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
LSD 0.05	3.07	3.07	19.04	19.79	7.39	7.87	4.00	5.54	9.61	11.34	3.16	4.00	5.91	6.06	20.76	23.85	6.95	7.20
LSD 0.01	4.14	4.14	25.64	26.65	9.95	10.60	5.39	7.46	12.94	15.27	4.26	5.39	7.96	8.17	27.95	32.12	9.36	9.69

Table (3): Average of plant height (cm), stem diameter (cm), ear length (cm), ear diameter (cm), ear weight (g), No. of rows per ear and No. of grains per row of maize at harvest time as affected by different weed removal periods during 2000 and 2001 growing seasons.

Characters	Plant height (cm)		Stem diameter (cm)		Ear length (cm)		Ear diameter (cm)		Ear weight (g)		Number of rows per ear		Number of grains per row	
Treatments	**2000**	**2001**	**2000**	**2001**	**2000**	**2001**	**2000**	**2001**	**2000**	**2001**	**2000**	**2001**	**2000**	**2001**
Weed removal at														
12 days	263.75	265.00	3.00	2.78	24.38	23.88	4.91	4.86	252.00	250.00	13.50	14.00	52.75	51.50
24 days	265.00	273.75	3.22	2.92	25.18	24.30	4.96	4.98	259.00	255.00	14.00	14.50	54.25	52.00
36 days	261.25	263.75	2.65	2.66	24.08	23.33	4.82	4.86	241.00	246.00	13.50	14.50	52.25	50.75
48 days	256.25	258.75	2.58	2.64	23.63	22.53	4.73	4.73	237.00	229.00	13.50	13.50	50.00	48.75
60 days	255.00	258.75	2.41	2.48	23.13	22.43	4.71	4.53	229.00	218.00	13.00	13.00	49.00	48.25
72 days	237.50	257.50	2.38	2.45	22.95	22.18	4.49	4.38	205.00	211.00	12.50	12.50	46.25	47.75
84 days	233.00	253.75	2.36	2.38	22.73	21.30	4.32	4.20	190.00	204.00	12.50	12.00	45.74	46.25
96 days	232.00	240.0	2.35	2.33	21.13	19.90	4.14	4.11	187.00	192.00	12.00	11.50	42.75	44.00
108 days	232.00	235.00	2.22	2.21	20.38	19.00	4.05	4.00	175.00	179.00	11.50	11.00	42.25	44.25
Weed free check	290.00	280.00	3.50	3.02	25.25	24.88	5.00	5.04	275.00	270.00	14.50	15.00	54.50	53.00
Unweed check	228.75	220.00	2.10	2.17	18.25	18.05	3.90	3.83	163.00	165.00	11.00	10.50	34.50	40.50
F-Test	**	**	**	**	**	**	**	**	**	**	**	**	**	**
LSD 0.05	12.84	15.36	0.22	0.20	1.63	1.15	0.20	0.11	12.72	12.41	1.47	1.39	6.30	4.93
LSD 0.01	17.29	20.68	0.29	0.27	2.20	1.55	0.27	0.15	17.13	16.71	1.97	1.87	8.48	6.64

Table (4): Average of ear grains weight (g), 100 grains weight, shelling percentage and grain yield (ardab/fed) as well as chemical composition of maize grains at harvest time as affected by different weed removal periods during 2000 and 2001 growing seasons.

Characters Treatments	Ear grains weight (g)		100 grains weight (g)		Shelling %		Grain yield *(arad/fed)		Grain protein %		Grain oil %	
	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
Weed removal at												
12 days	206.89	206.25	43.90	43.00	82.10	82.50	22.65	21.67	9.84	9.75	4.60	4.63
24 days	212.38	209.87	44.00	44.20	82.00	82.30	23.14	22.37	9.70	9.68	4.54	4.57
36 days	196.90	201.990	43.60	42.46	81.70	82.11	21.37	20.19	9.61	9.52	4.50	4.55
48 days	193.27	187.32	42.80	42.50	81.55	81.80	19.56	18.60	9.48	9.38	4.41	4.50
60 days	185.54	177.89	42.68	41.78	81.02	81.61	18.33	17.77	9.30	9.19	4.35	4.42
72 days	167.59	171.37	40.87	41.20	80.75	81.22	17.67	16.98	9.11	9.03	4.30	4.38
84 days	152.80	165.26	40.49	40.28	80.42	81.01	16.16	16.11	8.97	8.88	4.24	4.33
96 days	149.81	154.79	39.80	38.72	80.11	80.62	15.29	15.12	8.83	8.70	4.19	4.27
108 days	140.00	143.29	38.08	38.60	80.00	80.33	13.30	13.53	8.60	8.56	4.15	4.20
Weed free check	228.30	223.86	45.54	45.69	83.02	82.91	27.48	26.57	9.95	9.87	4.73	4.69
Unweed check	129.91	131.93	33.70	35.95	79.70	79.96	11.49	11.75	8.84	8.40	4.03	4.08
F-Test	**	**	**	**	NS	NS	**	**	**	**	**	**
LSD 0.05	10.29	12.12	2.75	2.13	---	---	1.71	1.34	0.22	0.23	0.24	0.20
LSD 0.01	13.86	16.32	3.71	2.87	---	---	2.13	1.80	0.29	0.31	0.33	0.27

* **ardab = 140 kg shelled grain**