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DETERMINATION OF THE CRITICAL PERIOD OF WEED CONTROL IN MAIZE GROWN UNDER DIFFERENT PLANT DENSITIES

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ABSTRACT

Tow field experiments were carried out during the two successive summer seasons of 2010 and 2011 at the Agric. Res. and Exp. Center of Fac. Of Agric. Moshtohor to study the effect of five plant population densities (20, 22, 24, 26 and 28 thousand maize plants per fed.) and seven periods for weed control (un-weeded control (1), weed control at 20 (2), 20+35 (3), 20+35+50 (4), 20+35+50+65 (5), 20+35+ 65+80 (6) and 20+35+80+95 days after sowing (7)) on growth, yield and its components of maize, associated weeds as well as the net economic return of maize. The obvious results of this investigation can be summarized as follows:

Increasing plant population density from 20 to 28 thousand plants /fed. significantly decreased total number and fresh weight of removed weeds in the first season, total fresh and dry weights of weeds at harvest, number of green leaves / plant, leaf area / plant, stem diameter, ear length, number of grains / ear, ear weight, shelling %, 100-grain weight and grain yield / plant in both seasons. On the other hand, plant height, leaf area index, number of ears /fed., Stover yield, nitrogen up-take and protein yield / fed. were significantly increased. Generally, the greatest grain and biological yields / fed. were results from maize planting by 26000 plants/ fed. This was true in the two growing seasons.

Un-weeded check significantly decreased all these characters except total fresh and dry weights of weeds at harvest compared with weed removal even once after maize emergence. The maximum grain and biological yields/ fed. were produced from planting maize under weed control at 20, 35, 50 and 65 days after sowing. The critical period of weed control (CPWC) in maize crop based on 5% acceptable yield loss was 20 - 35 days after sowing.

The highest values of leaf area index and stover yield / fed. were recorded from planting maize at the highest density under weed control by treatment 5. While, the lowest plant density under the same weed control gave the maximum values for No. of green leaves / plant, leaf area / plant, ear length, No. of grains /ear, 100-grain weight, ear weight and grain yield / plant in the two growing seasons. Meanwhile, the greatest maize grain and biological yields / fed. were resulted from maize planting by 26000 plants / fed. under the same weed control (weed control at 20 +35 + 50 + 65 days after sowing).

The best treatment was that planting 24000 maize plants / fed. under weed control by either treatment 5 or 6 in the first season and planting 26000 maize plants /fed. with weed control by treatments 5 in the second season, where the net farm return valued 1945.2 and 2981.0 L.E. / fed. in the first and second seasons respectively.

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereal crops in the world and ranks the third of the most important cereal crops in the world which surpassed by wheat and rice. In Egypt, Maize is essential for livestocks and human consumption as an available source of carbohydrate, oil and slightly for protein. The growing area of maize in Egypt during 2009 year is about 1,988,095 feddan with a total grain yield of 6,600,000 ton. The average grain yield production per feddan was about 3,319.8 kg. The total production supplies 80 % of the require consumption with a reduction gap of 20 % which has to be filled via importation.

As maize do not have tillering capacity to adjust to variation in plant stand, optimum plant population for grain production is important. Thus to increase grain yield, it must be planted maize at proper plant population density. Increasing plant density significantly increased plant height and leaf area index Al-Agamy *et al*., (1999), El-Koomy (2000) Sharief (2001) and Abd El-Raouf *et al*., (2008 a), grain and stover yields per fed. Tantawy *et al*., (1998), El-Bana and Gomaa (2000), Al-Shebani (2006) and Lashkari *et al*., (2011), biological yield per fed. Abd-El-Samie (2001) and Abouzienia *et al*., (2008), protein yield per fed. Tantawy *et al*., (1998), nitrogen up-take per fed. Agasibagil (2006). Vice-versa, significantly decreased total fresh and dry weights of weeds in maize field Mosalem and Shady (1996), Maqbool et al., (2006), and Bakhtiar Gul *et al*., (2011), dry weights of broad-leaved, grassy and total weeds Abouzienia *et al*., (2008), fresh and dry weight of broad-leaved weeds Abd-El-Samie (2001), stem diameter and grain yield per plant Atta Allah (1996) and El-Far (2001), plant leaf area and ear length Mosalem and Shady (1996) and Al-Shebani (2006), number of green leaves per plant and 100-grain weight Shams El-Din and El-Habbak (1996) and Abd El-Raouf *et al*., (2008 a and b), number of grains per ear and shelling % Tantawy *et al*., (1998) and Abd El-Raouf *et al*., (2008 a and b) and ear weight Tantawy *et al*., (1998) and Abouzienia *et al*., (2008).

Weed competition among the major constrains to crop production. Estimates of the worldwide loss potential in due to weeds, pathogens and animal pests in maize totaled by 40.3, 9.4 and 16.0 %, respectively (Oerke, 2006). However, other researchers reported that losses in maize grain yield due to weed competition ranged between 74-90 % (Kozlowski, 2002 and Villasana *et al*., 2004). The length of time a crop must be keeping weed free after planting so that weeds emerging later do not reduce yield. This component represents the minimum period for which a residual pre-plant incorporated or pre-emergence herbicide must remain effective (Woolley *et al*., 1993). The allowing weeds to grow for whole growing season in maize significantly decreased leaf area per plant Bonilla (1984), Yang *et al.*, (1993) and Naeeny and Ghadiri (2000), steam diameter El-Morsy and Badawi (1998), ear weight Yang *et al*., (1993) and Ahmed *et al*., (2008), plant height and leaf area index Yang *et al*., (1993) and Soliman and Gharib (2011), ear length and shelling % El-Morsy and Badawi (1998), Shekari *et al*., (2010) and Soliman and Gharib (2011), number of grains per row and 100-grain weight Yang *et al.*, (1993), karimmojeni *et al.,* (2010) and Shekeri *et al*., (2010), biological yield per fed. Abd-Elsamie (2001) and grain yield per fed. Zimdahl (1980), Yang *et al*., (1993), Fischer *et al*., (2004), Dogan *et al*., (2006), Ahmed *et al*., (2008), Mahmoodi and Rahimi (2009) and Shekeri *et al*., (2010) compared with weed removal even once after maize emergence. Vice-versa, total fresh and dry weights of maize weeds were significantly increased Yang *et al.,* (1993), Maqbool et al., (2006), Ahmed *et al*., (2008) and Mahmoodi and Rahimi (2009).While, the critical period of weed control was 20 to 35 days after emergence Zimdahl (1980), Yang *et al*., (1993) and Fischer *et al*., (2004).

Our objective in establishing this study was to determine the effects of different plant population density and weed control treatment on weeds, growth and grain yield of maize as well as economic evaluation of studied treatments.

MATERIALS AND METHODS

Experiments were carried out in 2010 and 2011 seasons at the Agricultural Research and Experiment Center, Faculty of Agriculture Moshtohor, Benha University, Toukh Directorate, Kalubia Governorate, Egypt, to determination of the critical period of weed control of maize under different plant densities on weeds and growth, yield and its components in maize (white single cross hybrid 2031 for Misr hytech Seed Int.,) as well as economic evaluation of studied treatments.

Soil texture of the experimental site was clay with pH 8.11 and 2.3 % organic matter content. Each experiment included 35 treatments which were the combination of five plant densities and seven periods of weed control treatments.

Factors under study were as follows:

Plant density treatments:

Five plant densities, i.e. 20, 22, 24, 26 and 28 thousand plants of maize /fed. obtained from planting in hills, nearly at 30, 27, 25, 23 and 21 cm between hills.

Periods of weed control:

1- Un-weeded (control). **2-** Weed control at 20 days from planting. **3-** Weed control at 20 and 35 days from planting. **4-** Weed control at 20, 35 and 50 days from planting. **5-** Weed control at 20, 35, 50 and 65 days from planting. **6-** Weed control at 20, 35, 65 and 80 days from planting. **7-** Weed control at 20, 35, 80 and 95 days from planting.

Weed control at 20 and 35 days after planting by hoeings and weed control at 50, 65, 80 and 95 with hand weeding.

The experimental design was split plot design (Gomez and Gomez, 1984) in four replications. Each of the five plant densities treatments were distributed in the main plots, whereas the seven periods of weed control treatments were arranged at random in sub plots. The sub plot area was 10.5 m^2 and contained five ridges of 3 m long and 70 cm apart. The preceding winter crop in the two seasons was Egyptian clover. Experiments were planted on 13^{th} and 5^{th} of May in the first (2010) and the second (2011) seasons, respectively. Phosphorous fertilizer was applied in form of Calcium super phosphate (12.5 % P_2O_5) at a rate of 100 kg /fed. during soil preparation in each season. Mineral nitrogen fertilizer was applied in form of Ammonium nitrate (33.5% N). Nitrogen fertilizer regime was divided into two equal parts and applied before the first and second irrigations with a rate of 134 kg N / fed. in each season. Maize plants were thinned before the first irrigation to one plant / hill. Irrigation was applied for 7 times during the growing season. Maize plants were harvested on 14^{th} and 4^{th} of September in the first and the second seasons, respectively.

Data recorded:

Weed data:

Removed weeds:

Weeds were manually pulled in a central area of square meter area randomly placed from each sub plot at period of weed control treatments in each seasons to estimate (total number and total fresh and dry weights of removed weeds).

weeds survey:

Weeds were manually pulled in a central area of square meter area randomly placed from each sub plot at harvest maize in each seasons to estimate (total fresh and dry weights of weeds).

Growth characteristics:

Ten plants selected randomly from each sub plots to determine some growth characters {Plant height (cm) at harvest, Number of green leaves / plant, leaf area / plant (cm^2) and Leaf area index at 100 days after planting according to Stickler (1964), stem diameter (cm) at harvest at 4^{th} internode and number of ears / fed.}.

C- Yield and yield components:

Ten ears were selected from each sub plot at harvest to determine, the yield components {ear length (cm), number of grains / ear, 100–grain weight (g), ear weight (g) and shelling % $= \frac{\textit{Grains}\text{ weight per ear (g)}}{\textit{ear}\text{ weight (g)}} \text{ x } 100$}.

Whereas, the grain yield / plant and stover, grain and biological yields / fed. (kg) were estimated from the whole yield for plot.

Chemical analysis

Maize grains samples were taken after harvest at random from each sub plot to determine (nitrogen up-take = Grain yield kg x total nitrogen %. A.O.A.C. (1990) and protein yield / fed. = Grain yield kg x crude protein content).

Economic evaluation:

In the present study, the economic evaluation included three parameters that were estimates as follows:

1- Average input variables as well as total costs of maize production as affected by different plant density, weed control treatments and the applied different culture practices during the different stages of growth in each season.

2- Net farm income of maize production as affected by the different studied treatments. Net farm income is the values of grain yield according to the actual marketing price.

3- Net farm return of maize production as affected by the different studied treatments. It is the difference between grain yield value according to the actual price and the total costs including land rent. All of the above estimations are based on the official and actual market prices determined by the Ministry of Agriculture and the Agricultural Credit and Development Bank. Costs of seedbed preparation treatments were estimated according to prices given by the local Agricultural Mechanization Service center of (Toukh directorate).

Statistical analysis:

The analysis of variance was carried out according to the procedure described by Gomez and Gomez (1984). L.S.D. test at 5% level was used to compare between means.

RESULTS AND DISCUSSION

Effect of plant density:

Removed weeds:

Results in Table 1 indicted that the total fresh weight as well as total number of removed weed at periods of weed control were significantly affected by plant population densities in the first season. While, total dry weight of removed weeds was no significant. However, a slight depression in these characters was found in maize plot as growing by 28000 plants/ fed. Whereas, the highest values of these characters for weeds produced by growing 20000 plants/fed. . The results indicate also that the smothering effect of maize plants and their role in depressing weeds are greatly increased at higher population densities.

Weed biomass:

Total fresh and dry weights of weeds at harvest were significantly reduced by increasing rate of plant density up to 28000 plants /fed. in both seasons (Table 1). But, no significant difference was shown between 20000 and 22000 plants densities on previous traits in both seasons.

Table 1: Effect of plant population density on maize weeds removal at periods of weed control and weed biomass at harvest during the two growing seasons.

Plant density (plant/fed.)	Total number of removed weeds		Total fresh weight of removed weed (g/m^2)		Total dry weight of removed weed (g/m^2)		Total fresh weight of weed (g/m^2)		Total dry weight of weed (g/m^2)	
	At period of weed control					At harvest				
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
20000	99.79	80.17	65.54	67.70	10.790	11.284	808.21	939.89	190.50	212.88
22000	93.46	78.92	62.55	66.54	10.303	11.087	785.55	912.61	185.17	206.27
24000	87.83	77.75	58.81	65.75	9.705	10.950	761.45	879.69	179.59	199.52
26000	85.38	76.71	55.98	64.48	9.238	10.755	729.91	803.36	172.22	183.87
28000	82.67	76.21	53.34	63.56	8.815	10.585	689.18	768.19	162.63	176.24
L.S.D. at 5 %.	2.65	n.s	2.12	n.s	n.s	n.s	23.71	31.25	5.93	8.27

Results in Table 1 show that, the more denser maize plants leads to reduce weed biomass. The greatest reduction in weed density was achieved by sowing 28000 maize plants / fed. compared with 26000, 24000, 22000 and

20000 plants / fed. in both seasons. These results are in agreement with those reported by Abd-El-Samie (2001), Maqbool *et al*., (2006) and Bakhtiar Gul *et al*., (2011). The gradual depression in weed biomass as plant population density of maize increased up to 28000 plants /fed. may be due to the inter- specific competition between maize and weed plants for environmental factors.

Growth characters:

Results in Table 2 showed that the growth characters i.e. plant height, leaf area index and No. of ears /fed. were significantly increased by increasing plant density up to 28000 plants / fed. in both seasons. On the other hand, No. of green leaves /plant, plant leaf area and stem diameter were significantly decreased in the two seasons. Such results are in accordance with those obtained by Atta Allah (1996), Shams El-Din and El-Habbak (1996), Al-Agamy *et al*., (1999), El-Koomy (2000), El-Far (2001), Sharief (2001), Al-Shebani (2006) and Abd El-Raouf *et al*., (2008 a). These results are mainly due to the intra-specific competition among maize plants due to higher population for light, nutrients, place, water, and other environmental factors which are required for enhancing these characters.

Table 2: Effect of plant population density on growth characters of maize during the two growing seasons.

Plant density (plant/fed.)	Plant height (cm)		No. of green leaves /plant		Leaf area / plant (cm^2)		Leaf area index		Stem diameter (cm)		No. of ears/fed. (1000 ears)	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
20000	304.1	343.8	13.99	14.99	11095	11718	5.28	5.58	3.52	3.75	20.30	21.37
22000	311.6	351.3	13.89	14.87	10581	11248	5.54	5.89	3.44	3.65	22.06	22.60
24000	319.3	360.2	13.30	14.26	9975	10590	5.70	6.05	3.28	3.51	23.76	24.23
26000	323.6	364.5	13.11	14.10	9480	10103	5.87	6.25	3.01	3.23	25.00	25.74
28000	330.9	370.9	12.80	13.79	9049	9720	6.03	6.48	2.74	2.96	26.57	27.30
L.S.D. at 5 %.	4.1	4.0	0.11	0.14	413	323	0.24	0.19	0.15	0.12	0.87	0.73

Yield components

Maize yield components characters i.e. ear length, number of grains per ear, ear weight, 100-grain weight, shelling % and grain yield per plant were significantly decreased by increasing plant density up to 28000 plants/fed. in both seasons as shown in Table 3. This result is mainly due to that the plants grown at higher densities are less vigorous than plants in low density. The present results are in general agreement with those obtained by Abd El-Raouf *et al*., (2008 b) and Abouzienia *et al*., (2008). Maize planting by 20000 plants /fed. gave the highest values of these characters in both seasons. However, the lowest values were obtained from planting 28000 plants /fed. Length and weight of ear, No. of grains / ear , 100-grain weight and shelling % showed no significant differences between growing 20000 and 22000 plants /fed. Also no significant differences were detected between 20000, 22000 and 24000 plants / fed. on grain yield /plant in both seasons.

Table 3: Effect of plant population density on yield components of maize during the two growing seasons.

Plant density (plant/fed.)	Ear length (cm)		No. of grains / ear		Ear weight (g)		Shelling %		100-grain weight (g)		Grain yield / plant (g)	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
20000	21.07	22.96	503.7	524.2	205.2	229.1	78.85	82.04	31.88	35.73	145.86	159.44
22000	20.36	22.21	487.5	501.9	197.8	218.2	78.33	81.70	31.55	35.41	144.71	157.11
24000	19.11	21.00	464.9	478.3	185.4	204.7	77.76	81.04	30.79	34.57	139.86	152.43
26000	18.24	20.11	441.0	453.4	170.8	188.8	77.08	80.33	29.70	33.39	129.53	148.47
28000	17.27	19.17	400.3	432.4	154.1	178.3	74.91	77.68	28.26	31.80	99.77	109.26
L.S.D.at 5 %.	0.81	0.83	16.9	22.5	10.9	12.2	0.59	0.51	0.35	0.36	7.51	7.48

Maize yield and chemical properties:

Biological yield / fed. (kg) significantly increased by increasing plant density from 20000 to 26000 plants / fed. in both seasons (Table, 4). The maximum biological yield/fed. obtained by 26000 plants / fed. in both seasons. Whereas, planting maize by 20000 plants /fed. gave the lowest values in the two seasons. The results reported here are in harmony with those obtained by Abd-El-Samie (2001) and Abouzienia *et al*., (2008).

Stover yield / fed. was greatly increased with increasing plant population density up to 280000 plants /fed in both seasons (Table, 4). Increasing population density from 20 to 22, 24, 26 and 28 thousand plants /fed. significantly increased stover yield by 4.10, 9.14, 15.24 and 21.75 %, respectively in the first season, corresponding to 4.28, 8.73, 14.88 and 20.19, respectively in the second season. These results agree with those obtained by Tantawy *et al*., (1998), El-Bana and Gomaa (2000) and Al-Shebani (2006).

Data in Table 4 showed that the optimum plant population density (26000 plants / fed.) produced the highest grain yield / fed. compared to the higher plant population (28000 plants / fed.) or the lower plants population (24000, 22000 and 20000 plants/ fed.) in both seasons. These results reflect the important role of competition between maize plants as plant density increased to reduce the yield till the optimum plant density is reached. Such results are in accordance with those obtained by Tantawy *et al*., (1998), El-Bana and Gomaa (2000), Al-Shebani (2006) and Lashkari *et al*., (2011).

Table 4: Effect of plant population density on yield and chemical properties of maize during the two growing seasons.

Plant density (plant/fed.)	Grain yield (kg/feddan)		Stover yield (kg /feddan)		Biological yield (kg /feddan)		Nitrogen uptake (kg/ feddan)		Protein yield (kg /feddan)	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
20000	2899	3182	3948	4175	7611	8036	58.33	60.94	364.58	380.84
22000	3162	3452	4111	4354	8131	8558	62.83	65.36	392.69	408.44
24000	3336	3642	4309	4539	8580	9009	65.78	68.53	411.13	428.31
26000	3348	3831	4550	4796	8874	9541	65.31	70.56	408.17	441.00
28000	2782	3045	4807	5018	8510	8924	52.88	54.68	330.51	341.75
L.S.D. at 5 %.	160.7	160.0	188	181	381	391	2.86	3.09	17.91	19.30

The highest protein yield and nitrogen up-take per feddan were detected with maize planting by 24000 plants / fed. in the first season, and planting

26000 plants / fed. in the second season,(Table,4). However, the highest plant density (28000 plants / fed.) gave the lowest protein yield and nitrogen up-take / fed. in both seasons. The results reported here are in harmony with those obtained by Tantawy *et al*., (1998) and Agasibagil (2006).

Effect of periods of weed control treatments:

Removed weeds:

Results in Table 5 revealed that total number of removed weeds /m^2, total fresh and dry weights of removed weeds (g/m^2) were significantly increased by increasing control times and weeds age in the maize field in both seasons. Controlling weeds at 20, 35, 80 and 95 days after sowing , gave the highest values of total number of removed weeds/m^2, total fresh and dry weights of removed weeds (g/m^2) which were 105.25, 123.50 and 21.610 respectively, in the first season and 90.90, 134.10 and 24.614 respectively, in the second season. While, the lowest values of total number of removed weeds/m^2, total fresh and dry removed weeds (g/m^2) being 63.35, 24.22 and 3.632, respectively in the first season, and 53.20, 28.54 and 4.322 respectively, in the second season were obtained from controlling weeds at 20 days only. The results showed also that no significant differences were detected between controlling weeds at the treatments 4 and 5 on total fresh and dry weights of removed weeds in both seasons and also there were no significant differences between controlling weeds at the treatments 5, 6 and 7 as well as between the treatments 4 and 5 on total number of removed weeds in both seasons. From this result, the critical period of weed control in maize was controlling weeds at the treatment 4 (20, 35 and 50 days from sowing).

Weed biomass:

Total fresh and dry weights of weeds were significantly affected by periods of weed control in maize in both seasons (Table, 5). Results indicated that keeping maize plants free from weeds at the treatments 2, 3, 4, 5, 6 and 7 decreased weed biomass by 40.41, 86.64, 96.78, 99.22, 99.90 and 99.93%, for total fresh weight of weeds and by 40.41, 87.77, 97.05, 99.37, 99.92 and 99.94 % respectively for total dry weight, in the first season. The respective decrements percentages in the second season were 56.64, 87.06, 97.65, 99.34, 99.81 and 99.83 % for total fresh weight and 56.52, 88.85, 97.95, 99.41, 99.84 and 99.86 %, for total dry weight. These results are in agreement with those reported by Yang *et al*., (1993), Maqbool *et al*., (2006), Ahmed *et al*., (2008) and Mahmoodi and Rahimi (2009). Results revealed that there were no significant differences among the treatments 4, 5, 6 and 7 in the two seasons, on total fresh and dry weights of weeds. From this result, the critical period of weed control in maize was controlling maize weeds at 20, 35 and 50 days from sowing (Treatment 4).

Table 5: Effect of periods of weed control on weed removal at periods of weed control and weed biomass at harvest maize during the two growing seasons.

periods of weed control	Total No. of removed weeds		Total fresh weight of removed weed (g/m^2)		Total dry weight of removed weed (g/m^2)		Total fresh weight of weed (g/m^2)		Total dry weight of weed (g/m^2)	
	At control period						At harvest			
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
1	--	--	--	--	--	--	2983.30	3773.46	709.91	869.66
2	63.35	53.20	24.22	28.54	3.632	4.322	1777.74	1636.19	423.03	378.09
3	80.30	69.55	32.50	38.44	4.874	5.821	398.51	488.37	86.84	96.93
4	90.05	79.65	41.37	47.01	6.205	7.117	95.96	88.56	20.91	17.85
5	98.05	85.75	45.20	53.21	6.779	8.059	23.29	25.04	4.47	5.15
6	101.95	88.65	88.68	92.34	15.520	15.660	3.01	7.14	0.58	1.37
7	105.25	90.90	123.50	134.10	21.610	24.614	2.20	6.46	0.42	1.23
L.S.D.at5 %.	8.84	6.76	6.21	8.11	0.930	1.216	282.55	344.81	64.99	75.56

Growth characters:

Results in Table 6 indicated that growth characters of maize under study except plant height and stem diameter in the first season as well as number of ears / fed. in both seasons were significantly increased by weed control periods as compared with maize growth under un-weeded control in both seasons . The highest values of studied characters for maize growth were recorded by the treatment 5 (at 20, 35, 50 and 65 days from sowing). While, the lowest values of studied characters for maize growth were recorded from maize planting under un-weeded control (Treatment 1). The differences in plant height, steam diameter in the second season and no. of green leaves / plant, leaf area/ plant and leaf area index in the two seasons were below the level of significance between the treatments 4, 5, 6 and 7. Such results are in accordance with those obtained by Yang *et al*., (1993), karimmojeni *et al.,* (2010), Shekari *et al*., (2010) and Soliman and Gharib (2011). These reductions in maize growth characters might be due to increased in inter-specific competition between maize and weeds plants in utilizing environmental factors i.e. light, nutrients, place and water and other environmental.

Table 6: Effect of periods of weed control on maize growth characters during the two growing seasons.

Periods of weed control	Plant height (cm)		Number of green leaves per plant		Leaf area per plant (cm^2)		Leaf area index		Stem diameter (cm)		Number of ears per fed. (1000 ears)	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
1	293.0	334.5	10.72	11.72	6999	7679	3.95	4.34	2.40	2.62	22.80	23.18
2	311.8	351.5	12.02	12.96	9128	9737	5.18	5.54	2.93	3.14	23.36	23.90
3	320.3	361.3	14.02	14.92	10502	11137	5.96	6.32	3.29	3.53	23.66	24.34
4	325.0	364.8	14.30	15.30	10867	11505	6.15	6.52	3.42	3.65	23.74	24.58
5	326.3	365.8	14.32	15.34	11055	11708	6.26	6.63	3.49	3.72	23.72	24.66
6	325.8	365.3	14.32	15.34	10987	11634	6.22	6.59	3.47	3.68	23.76	24.64
7	323.3	363.8	14.22	15.22	10714	11330	6.07	6.42	3.39	3.61	23.72	24.44
L.S.D. at 5 %.	n.s	8.25	0.36	0.42	360	343	0.25	0.22	n.s	0.26	n.s	n.s

Yield components:

Results in Table 7 indicated that the maize yield components characters i.e. ear length, no. of grains /ear, ear weight, 100-grain weight, shelling % and grain yield /plant were significantly affected by the periods of weed control in both seasons. Allowing weeds to grow for the whole season markedly decreased ear characters (ear length, No. of grains / ear and ear weight), shelling %, 100-grain weight as well as grain yield / plant. The maximum values of studied characters were recorded from weed controlling in maize by treatment 5 and the lowest treatment was the un-weeded control. Whereas no significant differences in no. of grains / ear, ear weight, shelling % and 100-grain weight between the treatment 4, 5, 6 and 7. 100- grain weight between the treatment 3 and 7 as well as in ear length and grain yield / plant among treatments 3, 4, 5, 6, and 7 in both seasons. The present results are in general agreement with those obtained by El-Morsy and Badawi (1998), karimmojeni *et al.,* (2010), Shekari *et al*., (2010) and Soliman and Gharib (2011). These reductions in maize yield components characters might be due to increased in competition between maize and weeds plants in utilizing environmental factors i.e. light, nutrients, place and water.

Table 7: Effect of periods of weed control on yield components of maize during the two growing seasons.

Periods of weed control	Ear length (cm)		Number of grains / ear		Ear weight (g)		Shelling %		100-grain weight (g)		Grain yield / plant (g)	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
1	14.06	15.90	294.1	307.3	103.7	123.4	72.89	75.59	25.45	30.30	79.28	88.46
2	16.06	17.88	385.7	405.4	154.7	173.5	75.02	78.14	29.92	33.36	122.08	133.94
3	20.60	22.50	485.2	501.3	194.9	214.7	78.22	81.49	31.28	34.84	140.70	154.22
4	20.94	22.84	512.3	533.6	206.4	229.1	78.78	82.12	31.59	35.18	144.38	159.12
5	21.00	22.90	516.7	535.9	207.8	230.1	79.08	82.29	31.66	35.26	147.58	162.84
6	20.98	22.88	514.3	535.8	206.8	230.1	79.04	82.26	31.65	35.24	146.14	161.34
7	20.84	22.74	508.2	527.0	204.4	225.8	78.68	82.02	31.50	35.08	143.46	157.48
L.S.D.at5 %.	1.51	1.37	15.9	24.3	6.9	10.0	0.53	0.47	0.29	0.31	13.97	10.48

Maize yield and chemical properties:

Results presented in Table 8 show that grain, stover and biological yields / fed. (kg) as well as, nitrogen up-take (kg) / fed. and protein yield (kg) /fed. were significantly affected by weed control periods in both seasons .The treatment 5 gave the greatest values of studied characters in both seasons. Whereas, planting maize with allowing weeds to grow for the whole season gave the lowest values in both seasons. The differences among treatments 4, 5, 6, and 7 were not significant for all studied characters.

In 2010 season, the using weed control treatments of 2, 3, 4, 5, 6 and 7 significant increased grain yield / fed. over the un-weeded control (treatment 1) by 54.27, 77.86, 82.36, 85.82, 84.68 and 81.34 % respectively, corresponding to 51.87, 75.14, 80.77, 85.24, 83.66 and 78.67% in 2011 season , respectively. No significant differences were detected between the treatments 3, 4, 5, 6 and 7 in the first season and treatments 4, 5, 6, and 7 also, treatments 3, 4 and 7 in the second season in grain yield (kg) /fed. The results reported here are in harmony with those obtained by Dogan *et al.*

(2006), Ahmed *et al*., (2008) and Mahmoodi and Rahimi (2009). The severe reduction in grain yield when allowing weeds to compete maize plants could be attributed to competition with the crop for light, water, nutrients and space which affected negatively the vegetative growth of plants particularly plant leaf area, Leaf area index as well as dry matter accumulation. Moreover, some weeds shade the crop plants and then decrease the radiation that would fall on foliage of the crop. Consequently, this well affects negatively the photosynthesis efficiency and translocation of synthates to be stored in grain. As well as, may be due to the decrease in number of grains/ ear, ear weight, 100-grain weight and shelling %.

Critical period for weed control:

Estimation of the critical period of weed control (CPWC) was based on an acceptable yield loss level which used to estimate both the beginning and end of the critical period. 5% yield loss was used to give marginal benefit, compared with the cost of weed control. CPWC will begin at 20 days after sowing as well as the end of CPWC was at 35 days after sowing for mean of grain yield in the two seasons, (treatment 3). These results are in general agreement with those of Zimdahl (1980), Yang *et al*., (1993) and Fischer *et al*., (2004).

Table 8: Effect of periods of weed control on yield and chemical properties of maize during the two growing seasons.

Periods of weed control	Grain yield (kg/feddan)		Stover yield (kg /feddan)		Biological yield (kg /feddan)		Nitrogen uptake (kg/ feddan)		Protein yield (kg /feddan)	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
1	1863.7	2078.3	2423	2695	4981	5443	33.45	35.14	209.08	219.56
2	2875.1	3156.4	3975	4175	7808	8213	55.32	57.30	345.77	358.06
3	3314.7	3639.9	4693	4895	8931	9359	65.41	68.10	408.83	425.67
4	3398.7	3757.0	4808	5045	9122	9617	67.75	71.27	423.43	445.35
5	3463.2	3849.8	4890	5125	9269	9801	69.33	73.47	433.33	459.16
6	3441.8	3817.0	4868	5100	9223	9738	68.80	72.69	430.02	454.30
7	3379.6	3713.2	4760	5000	9055	9524	67.11	70.14	419.44	438.40
L.S.D.at5 %.	110.6	126.4	167	175	350	368	2.65	2.84	15.84	17.22

Interaction effects:

Weed growth:

It is clear from Table 9 that the interaction effects of the two experimental factors had a significant effect on total fresh weight of weeds (g/m^2) in both seasons and total dry weight of maize weeds (g/m^2) in the first season. It was clear from Table 9 that the interaction including the highest density (28000 plants /fed.) with weed control at 20, 35, 80 and 95 days after planting contained lower fresh and dry weights of weeds. The results reported here are in harmony with those obtained by Abd-El-samie (2001) and Maqbool *et al*., (2006).

Table 9: summary of significant interaction effects between the plant density and periods of weed control on fresh and dry weights of total weeds at harvesting, showing the lowest values recorded and involved combinations.

Characters	2010 season		2011 season	
	Lowest value	Combination of treatment	Lowest value	Combination of treatment
Total fresh weight of weed (g/m^2)	2.00	All plant density at treatment 6 or 7	5.48	28000 X treatment 7
Total dry weight of weed (g/m^2)	0.38	All plant density at treatment 6 or 7	-------	-------------------------

Maize growth, yield and yield components:

Table 10 shows summary of the interaction effects of the two experimental factors on leaf area / plant, leaf area index, No. of grains /ear, 100-grain weight, ear weight, grain yield /plant and grain, stover and biological yields / fed. in both seasons and No. of green leaves / plant and ear length in the second season. The results showed that this interaction significantly affected all this traits .The highest values of leaf area index and stover yield / fed. were recorded from the highest plant density under weed control at 20, 35, 50 and 65 days from sowing. While, the lowest plant density under the same weed control gave the maximum values for No. of green leaves / plant, leaf area / plant, ear length, No. of grains /ear, 100-grain weight, ear weight, grain yield /plant. Meanwhile, the greatest maize grain and biological yields / fed. were resulted from maize planting by 26000 plants / fed. under the same weed control.

Table 10: summary of significant interaction effects between the plant density and periods of weed control on the characters studied of maize plants, showing the highest values recorded and involved combinations.

Characters	2010 season		2011 season	
	highest value	Combination of treatment	highest value	Combination of treatment
No. of green leaves / plant	-----	------------------------	16.1	20000 X treatment 6
Leaf area / plant (cm^2)	12449	20000 X treatment 5	13125	20000 X treatment 5
Leaf area index	6.59	28000 X treatment 5	7.05	28000 X treatment 5
Ear length (cm)	------	------------------------	25.0	20000 X treatment 5
No. of grains /ear	572.3	20000 X treatment 5	599.4	20000 X treatment 6
100-grain weight (g)	33.30	20000 X treatment 5	37.10	20000 X treatment 5
Ear weight (g)	235.8	20000 X treatment 5	264.9	20000 X treatment 6
Grain yield per plant (g)	165.90	20000 X treatment 5	178.30	20000 X treatment 5
Stover yield /fed. (kg)	5350	28000 X treatment 5	5600	28000 X treatment 5
Grain yield /fed. (kg)	3732.5	24000 X treatment 5 or 6	4331.3	26000 X treatment 5
Biological yield /fed. (kg)	9890	26000 X treatment 5	10655	26000 X treatment 5

Economic evaluation:

Effect of planting densities and periods of weed control on the total of maize production:

Total costs including values of production tools and requirements such as seeds, fertilizers, man power, machinery and other general or miscellaneous costs as well as land rent average summer 2010 and 2011 seasons are shown in Table 11 and the costs of the different rates of seeds for different plant densities and costs of different man power under periods of weed control in maize included in the study are given in Table 12.

The price of 50 kilogram ammonium nitrate 33.5 % N was 80 L.E. The price of 50 kilogram Calcium super phosphate 12.5 % P_2O_5 was 40 L.E. the price of one kilogram seeds (white single cross hybrid 2031 for Misr Hytech Seed Int.,) was 32 L.E. Man power exit the periods of weed control treatments was calculated on the basis of 24 workers per feddan for all practices and the daily wage of 30 L.E. for the worker. The cost of land rental was estimated as 1667 L.E. on the basis of renting onethird (4 months) of a normal growing season in the area. The total costs of soil tillage included the cost for first and second plowings by chisel plow, compacting and ridging was 180 L.E. and present in Table 11.

Table 11: Average costs of the different tools and requirements of maize production over 2010 and 2011 seasons.

Treatments	Costs per feddan in L.E
Land rent	1667
Chisel plow (first way)	40
Chisel plow (second way)	40
Compacting	40
Ridging	60
134 kg mineral nitrogen fertilizer / fed.	800
12.5 kg p_2o_5	80
Insecticide	65
Man power exit the experimental (24)	720
Irrigation machine	200
1 kg seeds	32

Increasing plant density from 20 to 22, 24, 26, and 28 thousand plants per feddan increased seed rates from 7.50 to 8.25, 9.00, 9.75 and 10.50 kg per feddan, respectively. While, the workers at periods of weed control treatment increased from 0 to 8, 16, 20 , 24, 24 and 24 workers in treatment 1, 2, 3, 4, 5, 6, and 7 respectively.

It is cleary evident from Table 12 that the highest values of costs were obtained from planting maize by 28000 plants/fed. and weed control by treatment 5, 6 and 7 being 1056 L.E. per /feddan.

Table 12: Costs of seeds under different plant densities and man power for periods of weeds control treatments adopted in the study in L.E. / feddan (average over two studying seasons).

Weed control treatment Plant density (1000 plants)	1	2	3	4	5	6	7
20	240	480	720	840	960	960	960
22	264	504	744	864	984	984	984
24	288	528	768	888	1008	1008	1008
26	312	552	792	912	1032	1032	1032
28	336	576	816	936	1056	1056	1056

Data in Table 13 show the total costs of maize production per feddan as affected by the applied different treatments (average of 2010 and 2011 seasons). From such data, it is clear that the minimum total costs were those of maize planting by 20000 plants / fed. and un-weeded control, being 3952 L.E. and the maximum total costs were those of planting 28000 maize plants / fed. and weed control at treatments 5, 6 and 7 which was 4768 L.E.

Table 13: The total costs of maize production in L.E. per feddan as affected by different treatments (average of the two seasons).

Weed control treatment Plant density (1000 plants)	1	2	3	4	5	6	7
20	3952	4192	4432	4552	4672	4672	4672
22	3976	4216	4456	4576	4696	4696	4696
24	4000	4240	4480	4600	4720	4720	4720
26	4024	4264	4504	4624	4744	4744	4744
28	4048	4288	4528	4648	4768	4768	4768

Values of maize grain yield as affected by the different plant densities and periods of weed control:

Results presented in Table 14 show the values of maize grain yield in L.E. / fed. as affected by the applied different treatments in 2010 and 2011 seasons. In this estimation the price of maize was 1785.71 L.E. / ton as given by Extension service information (average of 2010 and 2011 seasons).

From such results, it is clear that the highest values of grain yield per feddan were detected with maize planting by 24000 plants/fed. and weed control by treatments 5 or 6 (6665.2 L.E. / fed.) in 2010 season, and planting 26000 maize plants /fed. with weed control by treatments 5 (7735.5 L.E. / fed.) in 2011 season. On the other hand, the lowest values of grain yield / fed. were obtained from maize planting by 20000 plants / fed. and weed control by treatments 1 (3225.9 L.E. / fed.) in 2010 season, and planting 28000 maize plants/fed. with weed control by treatments 1 (3516.4 L.E. / fed.) in 2011 season, with reduction of 3439.3 and 4218.1 L.E. or 51.60 and 54.54 % compared with the highest treatment in the first and second seasons, respectively.

Table 14: value of maize grain yield as affected by the interaction between plant densities and periods of weed control.

Period of weed control	The first season (2010)					The second season (2011)				
	Plant density (plants per feddan)									
	20000	22000	24000	26000	28000	20000	22000	24000	26000	28000
Control	3225.9	3391.1	3375.9	3372.0	3275.4	3632.7	3782.7	3743.4	3880.9	3516.4
20	4785.7	5193.4	5513.9	5566.1	4611.8	5290.7	5560.7	6043.4	6178.6	5109.1
35	5372.9	6005.4	6445.5	6483.0	5288.8	5872.0	6575.0	7031.3	7328.6	5692.7
50	5675.9	6217.9	6522.0	6564.3	5365.7	6233.9	6793.4	7091.6	7549.1	5876.6
65	5863.9	6285.7	6665.2	6657.1	5449.8	6368.8	6890.7	7285.7	7734.5	6093.9
80	5729.1	6241.6	6665.2	6648.8	5445.7	6280.0	6802.3	7242.0	7725.0	6030.9
95	5583.6	6188.9	6514.3	6556.3	5331.8	6093.4	6740.2	7082.7	7495.2	5742.5

net farm return of maize production and net return per one invested L.E.

Results in Tables 15 and 16 reveal that the highest net farm return was achieved from maize planting by 24000 plants / fed. and weed control by treatments 5 or 6 (1945.2 L.E. /fed. making a net return ratio of 0.412 L.E. / an invested pound) in the first season, and planting 26000 maize plants/ fed. with weed control by treatments 5 (2981.0 L.E. /fed. making a net return ratio of 0.630 L.E. / an invested pound) in the second season. On the other hand, the lowest net farm returns were -772.6 and -531.6 L.E. / fed. with the lowest a net return ratio of -0.191 and -0.131 L.E. / each invested pound which were recorded by maize planting by 28000 plants / fed. with no management to weed control treatment1 in 2010 and 2011 seasons, respectively. But, the highest net return per one invested L.E. was achieved from maize planting by 24000 or 26000 plants /fed. and weed control by treatment 3 (0.439 L.E. / an invested pound) in the first season, and planting 26000 plants / fed. with weed control by treatment 4 (0.633 L.E. / an invested pound) in the second season.

Table 15: *Net farm return in L.E. / feddan of maize as affected by the interaction between plant densities and periods of weed control.

Critical weed control	The first season (2010)					The second season (2011)				
	Plant density (plants per feddan)									
	20000	22000	24000	26000	28000	20000	22000	24000	26000	28000
Control	-726.1	-584.9	-624.1	-652.0	-772.6	-319.3	-193.3	-256.6	-143.1	-531.6
20	593.7	977.4	1273.9	1302.1	323.8	1098.7	1344.7	1803.4	1914.6	821.1
35	940.9	1549.4	1965.5	1979.0	760.8	1440.0	2119.0	2551.3	2824.6	1164.7
50	1123.9	1641.9	1922.0	1940.3	717.7	1681.9	2217.4	2491.6	2925.1	1228.6
65	1191.9	1589.7	1945.2	1913.1	681.8	1696.8	2194.7	2565.7	2990.5	1325.9
80	1057.1	1545.6	1945.2	1904.8	677.7	1608.0	2106.3	2522.0	2981.0	1262.9
95	911.6	1492.9	1794.3	1812.3	563.8	1421.4	2044.2	2362.7	2751.2	974.5

*** Net farm return (L.E. / fed.) = grain yield value – total costs.**

Table 16: *Net return per an invested L.E. of maize as affected by the interaction between plant densities and periods of weed control.

Critical weed control	The first season (2010)					The second season (2011)				
	Plant density (plants per feddan)									
	20000	22000	24000	26000	28000	20000	22000	24000	26000	28000
Control	-0.184	-0.147	-0.156	-0.162	-0.191	-0.081	-0.049	-0.064	-0.036	-0.131
20	0.142	0.232	0.300	0.305	0.076	0.262	0.319	0.425	0.449	0.191
35	0.212	0.348	0.439	0.439	0.168	0.325	0.476	0.569	0.627	0.257
50	0.247	0.359	0.418	0.420	0.154	0.369	0.485	0.542	0.633	0.264
65	0.255	0.339	0.412	0.403	0.143	0.363	0.467	0.544	0.630	0.278
80	0.226	0.329	0.412	0.402	0.142	0.344	0.449	0.534	0.628	0.265
95	0.195	0.318	0.380	0.382	0.118	0.304	0.435	0.501	0.580	0.204

***Net return per one invested L.E. = Net farm return / Total costs of production (per /fed.)**

$$\text{*Net return per one invested L.E.} = \frac{\text{Net farm return}}{\text{Total costs of production (per /fed.)}}$$

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تحديد الفترة الحرجة لمقاومة الحشائش في الذرة الشامية تحت كثافات نباتية مختلفة

محمد السيد رياض جمعه ، صلاح عباس حسن علام و السعيد محمد محمود الجدوي
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أجريت تجربتان حقليتان خلال موسمي ٢٠١٠ و٢٠١١ في مركز البحوث والتجارب الزراعية بكلية الزراعة بمشتهر لدراسة تأثير خمس كثافات نباتية للذرة الشامية(٢٠ ' ٢٢ ' ٢٤ '٢٦ و ٢٨ ألف نبات/فدان) وسبع فترات لمقاومة الحشائش (بدون مقاومه – مقاومة بعد ٢٠ ' ٢٠ و٣٥ ' ٢٠و٣٥ و٥٠' ٢٠ و٣٥ و٥٠ و٦٥' ٢٠ و٣٥ و٦٥ و٨٠ و ٢٠و٣٥ و٨٠ و٩٥ يوم من الزراعة) في تصميم قطع منشقة بأربع مكررات على الحشائش والمحصول ومكوناته والعائد الإقتصادي للذرة الشامية (هجين فردي أبيض أنتاج شركة مصر هايتك الدولية للبذور ٢٠٣١) .

ويمكن تلخيص أهم النتائج فيما يلي:-

١. أدت زيادة الكثافة النباتية من ٢٠ إلى ٢٨ ألف نبات /فدان إلى نقص معنوي في العدد والوزن الكلى الغض والجاف للحشائش المزالة عند الفترات الحرجة (خلال الموسم الأول) و الوزن الكلى الغض والجاف للحشائش عند الحصاد. بينما عدد الأوراق الخضراء / نبات الذرة الشامية ومساحة أوراق النبات و دليل مساحة الأوراق وسمك الساق و طول الكوز وعدد حبوب / الكوز ووزن الكوز و نسبة التصافي ووزن ١٠٠ حبة ومحصول الحبوب /نبات (خلال موسمى النمو) - بينما زاد كل من محصول الحطب / فدان و النيتروجين الممتص / فدان ومحصول البروتين / فدان معنويا (خلال موسمي الدراسة) - كان أعلى محصول حبوب وبيولوجي / فدان من زراعة ٢٦ ألف نبات / فدان (خلال موسمي الدراسة).

٢. أدت عدم مقاومة نباتات الحشائش إلى نقص معنوي في جميع الصفات المدروسة عدا الوزن الكلى الغض والجاف للحشائش عند الحصاد مقارنة بإزالة الحشائش حتي لمرة واحدة بعد نمو الذرة الشامية. أعلى محصول حبوب وبيولوجي /فدان تم تحقيقهما عن طريق مقاومة الحشائش بعد ٢٠و٣٥و٥٠و٦٥ يوم من الزراعة (في كلا الموسمين) .

٣. وجد أن بداية الفترة الحرجة لمنافسة الحشائش في الذره الشاميه تبدأ عند٢٠ يوم و تنتهي عند ٣٥ يوم من الزراعة وذلك من نتائج متوسط محصول الحبوب (خلال موسمي الزراعة), علي أساس ان الفقد المقبول فى المحصول هو ٥ % .

٤. أستجاب دليل مساحة الأوراق و محصول الحطب للفدان معنوياً من زراعة الذرة بأعلى كثافة نباتية مع مقاومة الحشائش (المعاملة رقم ٥) - بينما أقل كثافة نباتية تحت نفس معاملة مقاومة الحشائش حققت أعلى القيم لصفات (عدد الأوراق الخضراء / نبات' مساحة اوراق النبات' طول الكوز' عدد حبوب الكوز' وزن ١٠٠ حبة' وزن الكوز ومحصول الحبوب لكل نبات) – كما تحقق أعلى محصول للحبوب و بيولوجي للفدان من زراعة ٢٦٠٠٠ نبات / فدان تحت نفس معاملة مقاومة الحشائش.

٥. أعلى صافى دخل مزرعى للفدان تحقق من زراعة ٢٤٠٠٠ ألف نبات / فدان و مقاومة الحشائش سواء بالمعاملة ٥ او ٦ (خلال الموسم الأول) و زراعة ٢٦٠٠٠ ألف نبات / فدان مع مقاومة الحشائش بالمعاملة ٥ (خلال الموسم الثاني) حيث بلغ ١٩٤٥,٢ جنية و ٢٩٨١,٠ جنية / فدان خلال موسمى الزراعة على التوالى .

قام بتحكيم البحث

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