VARIOUS METHODS FOR DETERMINING THE CRITICAL PERIOD OF WEED COMPETITION TO SUGAR BEET

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Abstract

Sugar beet (*Beta vulgaris L.*) crop suffer strongly from weed competition, So estimation of the critical period of weed control is very important for planning weed control strategies. For this purpose, an experiment was carried out at Mallawy Agric. Res. Station, ARC during 2009/2010 and 2010/2011 winter seasons in sugar beet. The experiment included 14 treatments of weed competition which seven of them weed – free period at 2, 4, 6, 8, 10, 12 weeks after emergence (WAE) and weed free all season and seven treatments of weed competition at 2, 4, 6, 8, 10, 12 (WAE) and weed competition for all seasons. Results of the treatments effect on weeds and sugar beet crop were used to determine the critical period of weed competition to sugar beet by using ANOVA, regression models, classical biological and economic approach.

The obtained results showed that the maximum root yield (ton/fed.) & Sugar yield (ton/fed) losses due to sugar beet-weed competition in the whole season were 86.8 & 87.1 and 84.6 & 86.3 percentage from weed free plot due to weed infestation by 10.0 and 9.7 ton/fed. in 2009/2010 and 2010/2011 seasons, respectively. The relationship between sugar beet root yield (ton/fed), sugar yield (ton/fed) and weed free, weed competition periods were studied using linear, quadratic and logistic functions. The relationship between dry weight of total weed g/m2 at end growing season and period of weed free was significantly negative and prediction equation with R2 value 84.9%, but, the relationship between this traits were positive and prediction equation with R2 value 18.3% without any significant between all weed competition treatments.

To maintain 95% of maximum root and sugar yields of sugar beet the maximum time allowed to let weeds grow after crop emergence is 0.86 weeks. The same level could be achieved if the crop kept free from weeds until at least 15.1 weeks after sugar beet emergence. Results showed that the critical period of sugar beet/weeds competition between 2 to 12 weeks after emergence and weed control strategies should be used to prevent weed competition in this period to maintain maximum sugar beet yields. The early and late income period threshold was estimated by 4- 10 weeks after emergence as the time interval when the gross income of sugar beet yields are higher than the total cost include cost of weed control treatments.

Key Words: Sugar beet (Beta vulgaris L.), weed competition, critical period of weed control.

INTRODUCTION

Sugar beet (*Beta vulgaris* L.) is considered as one of an important sugar crop in the world and its second crop after sugarcane for sugar production in Egypt. Sugar beet (*Beta vulgaris* L.) is an important sugar crop in Egypt. It is considered the second crop after sugarcane for sugar production. It is grown in northern regions of the country and in the new reclaimed area. The critical period for weed control (CPWC) is a period in the crop growth cycle during which weeds must be controlled to prevent yield losses. Knowing the CPWC is useful in making decision on the need for timing of weed control and achieving efficient herbicide use from both biological and economic perspectives. Many studies presented various methods for data analysis and reported CPWC on the basis of crop variety and weed related parameters such as ANOVA, regression approach, classical biological approach and economic approach, (Dunan *et al.*, 1995, Singh *et al.,* 1996, Knezevic,, *et al* 2002, and Mekky, *et al.*, 2005). They defined the economic critical period in sugar beet as the time interval when the marginal income of weed control is higher than the cost of control. The limits are called early and late income period thresholds. The threshold limit for sugar beet was estimated at density of about 5.5 weeds/m^2 corresponding to yield of 40.3 t/ha, the number of days between sugar beet crop and weed emergence, which ranged from 0.0 to 31 days appeared to be the main factor responsible for the differences in yield loss as reported by Zlobin, 1987, Kropff *et al.,* 1992. Root yields of sugar beet decreased with increasing density of red root pig weed (*Amaranthus retoflexus* L.), the reductions ranged from 18% with a weed density of 5 weed plants/m^2 to 31% with 20 weed plants/m^2. Weed control delayed beyond 44 days after planting, the yields of sugar beet reduced by 50% to 85% root yield of sugar beet was decreased as wild mustard (*Brassica kaber* L.) and wild oat (*Avena fatua* L.) densities increased, alone or in combination. When 3 wild oats and 0.8 wild mustard plants/m of row, grown separately, reduced root yield by 22 and 26%, respectively. However, sugar beet root yield was reduced by 38%, when those two densities were mixed. Sugar beet root yield decreased with increasing duration of weed competition, sucrose content of sugar beet was not altered by competition, (Rola and Rola, 1992). Based on regression analysis, the minimum time that a mixed density of 0.8 wild mustard and 1 wild oat plant/m of row can interfere with sugar beet before causing an economic root yield loss is approximately 1.6 weeks after sugar beet emergence Osman *et al.,* 1989, Weaver *et al.,* 1992, Rzozi *et al.,* 1994 and Mesbah *et al.,* 1995. The critical period for weed – sugar beet competition was 4-16 leaf stage, sugar beet sucrose yield reduced directly related to the duration of weed competition, root yield of sugar beet was more affected than sugar contents by weed competition, sucrose percentage and total soluble solids (T.S.S.) of sugar beet root juice were higher in weed-free plots than in weedy ones, the influence of different weed species on yield and quality of sugar beet under the density of weeds 2-5 plants/m^2, including common lambsquarters (*Chenopodium album* L.), velvetleaf weed (*Abutilon theophrasti* L.) and spreading pigweed (*Amaranthus blitoides* L.) yield of sugar beet reduced by 20-30%, While common ragweed (*Ambrosia artemisiifolia* L.) decreased root yield by 40-50%, sugar beet plants poor competitor than weeds, uncontrolled weeds which emerged with the same emergence of sugar beet plant could be caused 50-100% yield loss, Abdollahian *et al.,* 1998, Gutierrez and Reina 1993, Mesbah *et al.,* 1994, Fayed *et al.,* 1999, Wille and Morishita, 1999, Bosak and Mod, 2000, Deveikyte and Seibutis, 2006, Salehi *et al.*, 2006 and Mirshekari *et al.,* 2010. Sugar beet plants suffered more from the presence of canary grass (*Phalaris minor* L.) and wild beet (*Beta vulgaris* L.) than from other weed plants, sugar beet sucrose yield was reduced by 99 to 100% by full-season weed interference and by 5 and 10% if weeds were allowed to interfere with sugar beet for 2 - 2.5 and 5 to 5.5 weeks after sugar beet emergence (WAE), respectively, El-Zeny, 1996, Alaoui *et al.,* 2003 and Odero *et al.*., 2010. The critical timing of weed removal to avoid 5 and 10% root yield loss was 30 and 43 days after sugar beet emergence, respectively, Odero *et al.,* 2009. The relationship between yields and the duration of weed-free or weed-interference could describe by a linear, quadratic and logistic function. Neito *et al.,* 1968, Prado *et al.,* 1990 and Whish *et al.,* 2002.

The objective of this study is determination the critical period for weed control in sugar beet by common methods to standardize the process of data analysis.

MATERIALS AND METHODS

Two filed experiments were conducted at Mallawy Agricultural Research Station, Agricultural Research Center, El-Minia Governorate (Middle Egypt) in both successive growing seasons of 2009/10 and 2010/11. The aim of this study was to determine the critical period of weed competition to sugar beet (*Beta vulgaris* L.).

The experiment included fourteen treatments as follows:

Weed free treatments included the removal of weeds at 2, 4, 6, 8, 10 and 12 weeks after emergence (WAE). In weed infested treatments, weeds were allowed to compete with sugar beet crop 2, 4, 6, 8, 10 and 12 weeks after emergence (WAE).

Two control treatments (full-season removal of weeds and full-season competition of weeds) were also included.

Sugar beet cultivar "Kwamera" (*Beta vulgaris* L.) was sown in 20th and 24th of October in the first and second seasons, respectively, and harvested in 1st and 5th of May in the first and second seasons, respectively. The preceding summer crop was maize (*Zea mays* L.) in both seasons.

The randomized complete blocks design with four replications was used in these experiments. Plot area was 10.5 m^2 (1/400 fed.), number of ridges was 5 and the row length was 3.5 m.

Nitrogen fertilizer was applied in the form of urea (46.5 % N) at rate of 80 kg N /fed, in two equal portions, the 1st at thinning and the 2nd four weeks later. Phosphorus fertilizer was added at land preparation at the rate of 30 kg P_2O_5 /fed in the form of calcium super phosphate 15.5% P_2O_5 , potassium was added with first of nitrogen dose at the rate of 48 kg K_2O/fed in the form of potassium sulfate 48% K_2O.

The other normal agricultural practices of sugar beet cultivation were done as recommended. Weed removal were done by hand pulling and hand hoeing at the estimated period.

Data recorded

At harvest, the following data were recorded:-

I. Weed survey

Weeds were hand pulled from one square meter chosen at random in each plot at harvest, identified and classified to annual broad and narrow leaved weeds. Weeds were air-dried for seven days and then were oven dried at 70° C for 48 hr, until a constant weight was reached. The dry weight of weeds for broad-leaved weeds (g/m^2), narrow-leaved weeds (g/m^2) and total annual weeds (g/m^2).

2. Yield components

All sugar beet plants in each plot were harvested and weighted to determine the following traits:-

1- Root yield (Ton/fed).
2- Gross sugar yield (Ton/fed), calculated according the following equation:

Sugar yield= Root yield (Ton/fed) X Sucrose (%)

General Approach for Statistical Analysis: -

1 – Basic analysis of variance (ANOVA): - All data were statistically analyzed according to technique of analysis of variance (ANOVA) for the randomized complete block design with four replications as mentioned by Gomez and Gomez (1984) by means of "SAS" and SPSS computer software packages Duncan multiple range test was used for compare among treatment means Duncan 1955.

2 – Regression approach: - According to Singh *et al.,* (1996) the relationship between crop yields (Y) and duration of weed-free or weed-competition period (X) by either function $Y = \beta_0 + \beta_1 X$, where the parameters β_0 and β_1 represent intercept and slope of regression of yield on the duration, respectively. Or by the quadratic function $Y = \beta_0 + \beta_1 X + \beta_2 X^2$ and a logistic function $Y = A + C/(1 + e^{-B(X-M)})$, where X is duration of weed-competition period, parameter M is the point of inflection of the logistic curve, B shape parameter, A or A+C is asymptotic yield depending on whether B is negative or positive and C is twice the difference of yield at the point of inflection and asymptotic yield. These function are the special cases estimation of CP (critical period) model. Under this model, the regression of yield on weed free time (Y_{wf}) and yield on weed competition (Y_{wc}) duration can be described as:

$$Y_{wf} = \beta_{01} + \beta_{11}X + \epsilon_1 \qquad (1)$$

and

$$Y_{wc} = \beta_{02} + \beta_{12}X + \epsilon_2 \qquad (2)$$

Where X is the duration of weed-free or weed competition and $\beta_{01}, \beta_{11}, \beta_{02}, \beta_{12}$ are intercepts and slope parameters, respectively for model 1 and 2. ε_1 and ε_2 are assumed to be independent, normally distributed, random errors with a mean of zero and variances σ^2_{e1} and σ^2_{e2}, respectively. The threshold points denoted by X_{wf} corresponding to a specified yield loss of Y_{wf} times the maximum modeled yield under equation (1) and X_{wc} corresponding to a specified yield loss of Y_{wc} times the maximum modeled yield under equation (2).

The maximum modeled yield using equation (1) would be at or after the maximum of the experimental time (X_{max}) and is given by $\beta_{01} + \beta_{11} X_{max}$. Therefore

$$\beta_{01} + \beta_{11}X_{wf} = y_{wf}\,(\beta_{01} + \beta_{11} X_{max})$$

or

$X_{wf} = y_{wf} X_{max} - (1 - y_{wf})\,\beta_{01}/\beta_{11}$, and the maximum modeled yield using equation (2) would be β_{02} at $x=0$. Therefore

$$\beta_{02} + \beta_{12}X_{wc} = y_{wc}\,(\beta_{02} + \beta_{12} X_{max})$$

or

$X_{wc} = y_{wc} X_{max} - (1 - y_{wc})\,\beta_{02}/\beta_{12}$, the evaluation of confidence limits for the X_{wf} and X_{wc} can be done using the Fieller's theorem (Cox, 1990).

The estimates of variances and covariances of $\beta_{01}, \beta_{11}, \beta_{02}, \beta_{12}$ are

$Var(\beta_{01}) = \sigma^2[1/n_1 + \Sigma x^2 / \Sigma (x - \bar{x}_1)^2]$, $Var(\beta_{11}) = \sigma^2 / \Sigma (x - \bar{x}_1)^2$

$Cov(\beta_{01}, \beta_{11}) = \sigma^2 \bar{x}_1 / \Sigma (x - \bar{x}_1)^2$

$Var(\beta_{02}) = \sigma^2[1/n_2 + \Sigma x^2 / \Sigma (x - \bar{x}_2)^2]$, $Var(\beta_{12}) = \sigma^2 / \Sigma (x - \bar{x}_2)^2$

$Cov(\beta_{02}, \beta_{12}) = \sigma^2 \bar{x}_2 / \Sigma (x - \bar{x}_2)^2$, Where x_1 and x_2 are means of periods used in the experiment under weed-free and weed-competition conditions, respectively.

3 – Classical biological approach: -

The critical period has been defined as the period during which weeds must be controlled to prevent yield losses. Since the concept of critical period was introduced, it has been used to determine the period when control operation should be carried out minimize yield losses for sugar beet crop (Zimdahl, 1988). The critical period for weed control as a "window" in the crop cycle during which weeds must be controlled to prevent unacceptable yield losses (Knezevic, 2000).

4 - Economic evaluation:-

According to Dunan *et al.,* (1995) economic critical period (ECP) is defined as the period when benefit from controlling weeds is greater than the cost of control. The limits of ECP are the early economic period threshold (EEPT) and the late economic period threshold (LEPT). Determination of ECP can be help to decide when early and late weed control operations should be performed. For this reason economic evaluation for root of sugar beet yield (t/fed), total costs, Gross income (GI) and total income according to Heady and Dillon (1961), was done where: -

Gross income (GI) = 340 L.E x Root yield (t/fed)

Net income (NI) = gross income – total costs.

RESULTS AND DISCUSSION

The homogeneity of variance test was adopted indicated statistical evidence for homogeneity. Thus the treatment means were presented as average over the two seasons.

During the growing seasons of sugar beet crop the major weed species at the experimental, sites were *Avena* spp., *Phalaris* spp. As annual grassy weeds, *Brassica nigra* L., *Beta vulgaris* L., *Chenopodium* sp., *Sonchus oleraceus* L., *Medicago polymorpha* L., *Melilotus indica* L., *Anagillus arvensis, Ammi majus* L., *Euphorbia helioscopia* and *Rumex dentatus* L. as annual broad leaved weeds.

Estimation of critical periods for weed competition was determined by the threshold approaches as follows: -

1 – Basic analysis of variance (ANOVA): -

The results from analysis of variance (ANOVA) (Table 1) for dry weight of grassy, broad leaved, total annual weeds (g/m^2) and root yield of sugar beet were significantly affected by removal weeds at different periods, compared with weed interference for whole season. Dry weight of grassy and broad leaved weeds (g/m^2) at the end of growing seasons were reduced significantly by increased weed free period, but, the pervious traits were not significantly decreased by increase weed interference period. These results could be due to weed survey after last treatments application in the experiment and increased weed interference period then removal weeds until 12 weeks after emergence reduced dry weight of weeds at end growing seasons in weed interference treatments. Root yield (ton/fed) increased significantly by increasing weed free period. This increase in root yield of sugar beet crop due to decreased period of weed interference on sugar beet plant in the early growing stage of sugar beet crop due to weeds in this stage was more competitor than sugar beet plant due to sugar beet plantlake growing in the first stage. These results agreed with, Zlobin, 1987, Rola and Rola 1992, Kropff *et al.*, 1992 and Salehi *et al.*, 2006.

Table 1. The effect of weed removal time on dry weight of grassy weeds, broad-leaved weeds and total annual weeds (g/m2) and root yield (ton/fed) in the mean of two seasons.

Characters / n. of Weeks AE	Broad leaved Weeds	Grassy Weeds	Total annual Weeds	Root yield (t/fed)
0 WF	1756.00a	591.50 a	2347.50 a	6.20 g
2 WF	955.50 b	416.50 b	1372.00 b	9.03 g
4 WF	861.33 b	328.50 c	1189.83 c	13.05 f
6 WF	560.00 c	240.33 d	800.33 d	17.57 e
8 WF	421.50 d	174.00 e	595.50 e	25.83 cd
10 WF	199.67 e	103.17 f	302.83 f	28.33 c
12 WF	88.17 ef	60.67 fg	148.83 g	35.29 b
0 WC	10.33 f	3.67 h	14.00 g	43.33 a
2 WC	9.33 f	6.17 gh	15.50 g	37.48 b
4 WC	9.88 f	1.17 h	11.05 g	34.71 b
6 WC	32.47 f	16.88 gh	49.35 g	27.95 c
8 WC	38.17 f	0.00 h	38.17 g	23.41 d
10 WC	29.78 f	6.50 gh	36.28 g	17.57 e
12 WC	50.08 f	14.00 gh	64.08 g	13.13 f

2– Regression approach: -

The results in Table (1) and Fig (1) reported that the relationship between dry weight of total weed g/m^2 at the end of growing season and period of weed free was linear significant negative and prediction equation with R^2 value 84.9%, but, the relationship between dry weight of total weed g/m^2 at the end of growing season and period of weed interference was positive and prediction equation with R-sq value 18.3% without any significant relation between all weed interference treatments.

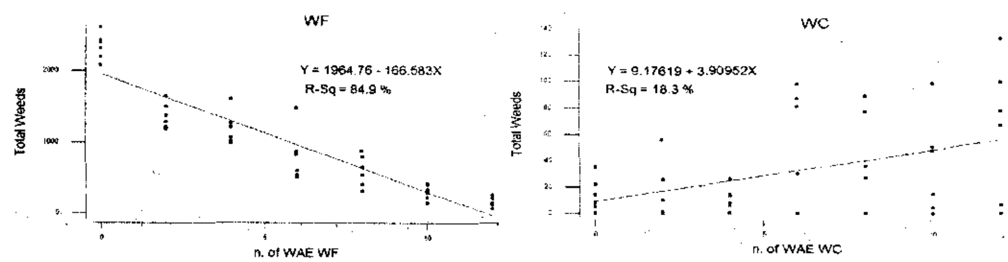

Fig . 1. The relationship between duration of weed free or weed interference and dry weight of total weeds (g/m^2) at the end of growing season.

On the other hand, the relationship between dry weight of total weeds at the end of growing season and root yield of sugar beet (ton/fed) under the experiment weed infestation by (10.0 and 9.7 ton/fed) was significantly negative in weed free and weed interference and prediction equation with R-sq value 77.1 and 11.3% , respectively, Fig (2) and Table (1).

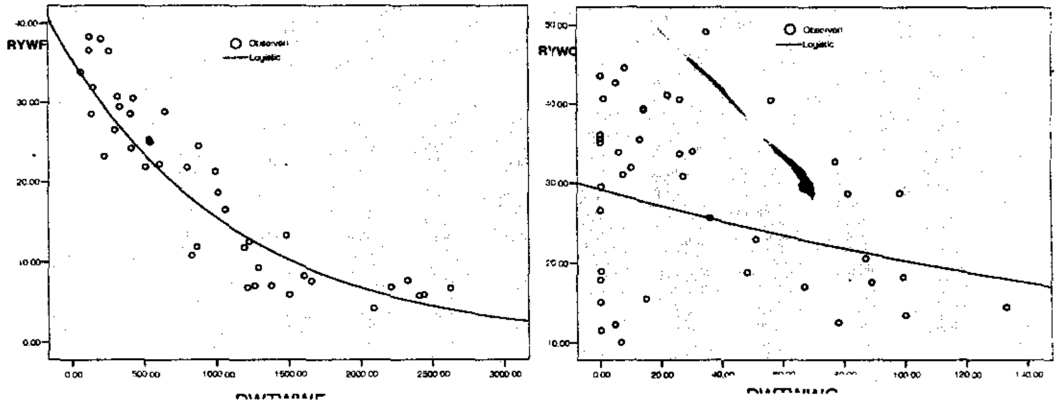

Fig. 2. The relationship between dry weight of total weeds (g/m^2) at end growing season and root yield of sugar beet (ton/fed).

Table (2), Fig (3) & Fig (4) show the effect of times duration sugar beet crop free from weeds on root and sugar yields (ton/fed). The average of root and sugar yield was examined to determine the effect of duration of weed free on these components of yield. The correlation coefficients recorded (0.925 and 0.913), respectively. The relationship between root and sugar yield with the duration of weed interference was significant negative and prediction equation with R^2 82.4 value 85.5 and %, respectively. This indicated the root yield of sugar beet and sugar yield (ton/fed) decreased with increasing the weeks of weed interference.

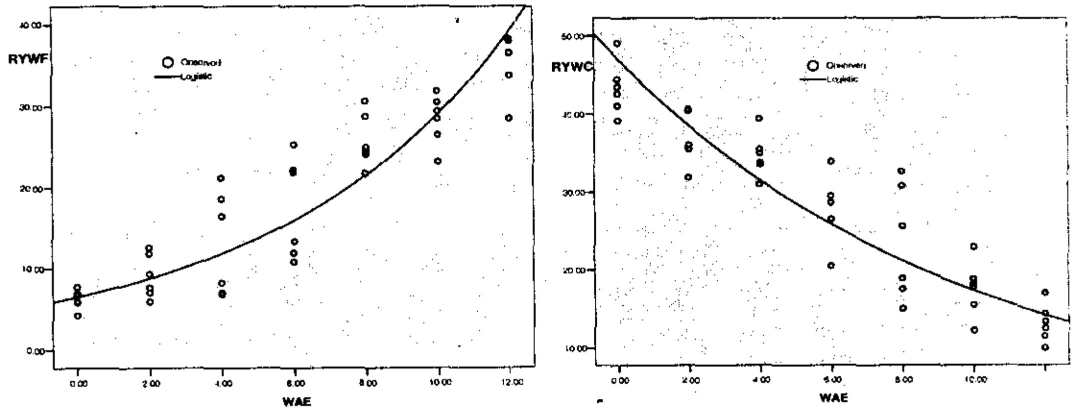

Fig. 3. The relationship between duration of weed free or weed competition and root yield of sugar beet (ton/fed).

Also, concerning the relationship between root and sugar yield with weed interference, the correlation coefficients were (-0.933 and -0.901), respectively. The relationship between root and sugar yield with the duration of weed interference was significant negative and prediction equation with R-sq value 83.2 and 75.2%, respectively. This indicated the root yield of sugar beet and sugar yield (ton/fed) decreased with increasing the weeks of weed interference.

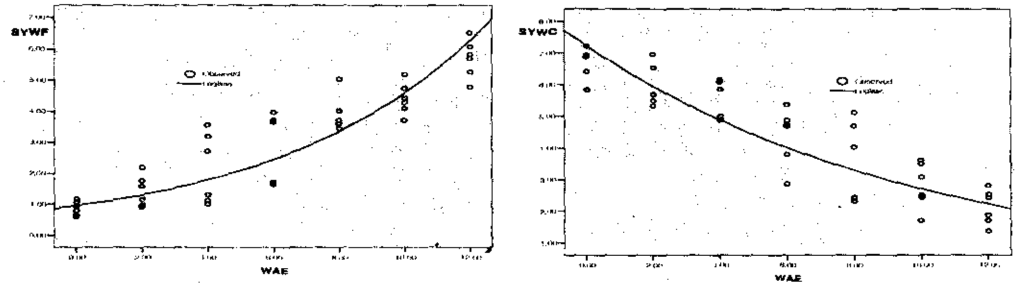

Fig. 4. the relationship between duration of weed free or weed competition and sugar yield (ton/fed).

Table 2. Correlation between root yield (RYWF and RYWC), sugar yield (SYWF and SYWC) and dry weight of total weeds (DWTWF and DWTWC) in weed free and weed competition.

	WAE	RYWF	RYWC	SYWF	SYWC	DWTWWF
DWTWWC	0.428 **	0.470 **	-0.336 *	0.511 **	-0.285	-0.464 **
DWTWWF	-0.921 **	-0.878 **	0.820 **	-0.883 **	0.760 **	
SYWC	-0.901**	-0.798 **	0.974 **	-0.766 **		
SYWF	0.913 **	0.992 **	-0.794 **			
RYWC	-0.933 **	-0.822 **				
RYWF	0.925 **					
WAE	1					

Tables (3&4) showed that the relationship between yields and the duration of weed-free or weed-interference could describe by a linear, quadratic and logistic function. These results confirm previous settles described by Neito *et al.,* 1968, Prado *et al.,* 1990 and Whish *et al.,* 2002.

To determine the critical period of weed interference to sugar beet crops, the regression approach was used. Application equation reported that to maintain 95% root yield of sugar beet earlier weed interference should not allowed exceed 0.86 weeks from emergence.

Table 3. the regression coefficient and their standard errors of three models used to determine the relationships between root and sugar yields with weed-free and weed-competition of the mean two seasons.

Treat	Yield	Variable	Linear B	Linear SE.B	Quadratic B	Quadratic SE.B	Logestic B	Logestic SE.B
Weed-free+	Root yield	Week	2.476	0.161	1.743	0.574	0.861	0.009
		Week^2	-	-	0.061	0.046	-	-
		Constant	4.472	1.158	5.693	1.469	0.154	0.012
		R^2	0.856	4.163	0.862	4.123	0.824	0.284
		F	237.72	P = 0.0	122.024	P = 0.0	186.973	P = 0.0
	Sugar yield	Week	0.396	0.028	0.27	0.1	0.855	0.011
		Week^2	-	-	0.011	0.008	-	-
		Constant	0.65	0.202	0.861	0.257	1.047	0.094
		R^2	0.833	0.727	0.84	0.72	0.80	0.322
		F	199.911	P = 0.0	102.652	P = 0.0	159.804	P = 0.0
Weed-competition	Root yield	Week	- 2.531	0.154	- 2.393	0.563	1.105	0.008
		Week^2	-	-	- 0.011	0.045	-	-
		Constant	43.41	1.113	43.18	1.442	0.021	0.001
		R^2	0.871	4.00	0.871	4.048	0.832	0.184
		F	268.924	P = 0.0	131.36	P = 0.0	198.419	P = 0.0
	Sugar yield	Week	- 0.382	0.029	- 0.334	0.106	1.103	0.010
		Week^2	-	-	- 0.004	0.008	-	-
		Constant	6.69	0.210	6.610	0.272	0.138	0.009
		R^2	0.811	0.756	0.812	0.763	0.752	0.227
		F	171.754	P = 0.0	84.311	P = 0.0	125.067	P = 0.0

Table 4. Estimation expected root yield under different weed free and weed competition period.

period	Total yield (ton/fed.)			
	WF Y	%	W C Y	%
0	4.47	10.14	43.41	100
1	6.95	15.76	40.88	94.17
2	9.42	21.38	38.35	88.34
3	11.90	26.99	35.82	82.51
4	14.38	32.61	33.29	76.68
5	16.85	38.22	30.76	70.85
6	19.33	43.84	28.23	65.02
7	21.80	49.46	25.70	59.19
8	24.28	55.07	23.16	53.36
9	26.76	60.69	20.63	47.53
10	29.23	66.30	18.10	41.70
11	31.71	71.92	15.57	35.87
12	34.18	77.54	13.04	30.04
13	36.66	83.15	10.51	24.21
14	39.13	88.77	7.98	18.38
15	41.61	94.38	5.45	12.55
16	44.09	100	2.92	6.72

The same situation the late duration of weed free period should not exceed 15.11 weeks from emergence. These results agreed with Weaver *et al.,* 1992, Osman *et al.,* 1989, Rzozi *et al.,* 1994 and Mesbah *et al.,* 1995.

3– Biological approach: -

Table (5) and Fig (5) presented that the critical period of weed-sugar beet competition between 4–12 weeks after emergence, because the sugar beet crop is very poor competitor for weeds the period which sugar beet can tolerate weeds was only 4 weeks from emergence and need prolonged period is free from weeds arrive to 12 weeks due to.

Table 5. The effect of weed removal time on sugar yield (ton/fed.) and economic analysis of the mean seasons.

Characters / n. of Weeks AE	Sugar Yield (t/fed)	%	Total cost	Gross income	Net income
0 WF	0.87 h	13.34	4995	1968 g	- 3027,0 g
2 WF	1.42 g	21.78	5295	2898g	- 2396.8 g
4 WF	2.14 f	32.82	5595	4252.5 f	- 1342.5 f
6 WF	2.72 e	41.72	5895	5674.9 e	- 220.1 d
8 WF	3.97 cd	60.89	6195	8156.4 cd	1961.4 c
10 WF	4.39 c	67.33	6495	8919.7 c	2424.7 c
12 WF	5.68 b	87.12	6795	11092.5 b	4297.5 b
0 WC	6.52 a	100	7095	13671.1 a	6576.1 a
2 WC	5.94 b	91.1	6795	11810.2 b	5015.2 b
4 WC	5.48 b	84.05	6495	10970.9 b	4475.9 b
6 WC	4.39 c	67.33	6195	8865.5 c	2670.5 c
8 WC	3.51 d	53.83	5895	7529.9 d	1634.9 c
10 WC	2.83 e	43.41	5595	5593.5 e	- 1.5 d
12 WC	2.12 f	35.52	5295	4182.0 f	- 1113.0 e

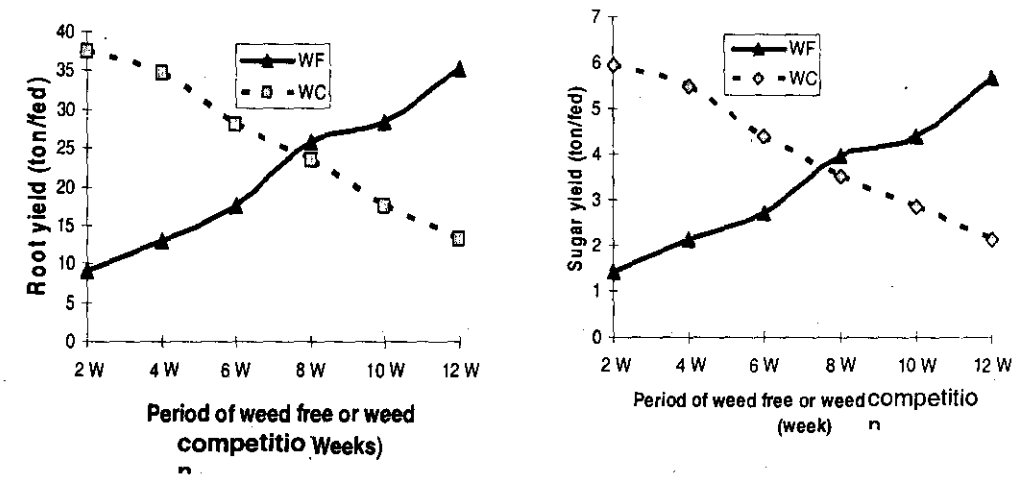

Fig. 5. Critical period of sugar beet-weed competition during 2009/10 and 2010/11 seasons.

The optimum sugar yield was obtained when weeds were allowed to compete about 1 week as the sugar yield 6.23 ton/fed in the mean of the two seasons. These results may be due to the ability of sugar beet plant after 7.8 weeks to intercept the sunlight. El-Zeny, (1996), Alaoui *et al.,* (2003), Deveikyte and Seibutis, (2006), Odero *et al.,* (2009), Mirshekari *et al.,* (2010) and Odero *et al.*, (2010). they stated that, the most important different between competed species was due to their capacity to intercept the sunlight, furthermore, if weeds are left to compete with sugar beet crop more than 7.8 weeks after planting the severity of interference will increase because the depletion of nutrients from the soil by the increased demands of both weeds and sugar beet crop.

4 – Economic approach: -

Economic analysis data presented in Table (5) and Fig (6) reported that the total cost, which calculated as 4995 L.E fixed cost (land preparation, planting, post sowing activities, fertilization, irrigation, insect control, harvesting and rental per fed.) and random cost weed control about 300 L.E /fed for one hand hoeing. The total cost increased with increase number of weed removal due to cost of hand weeding. Gross income increased significantly by increase the period of weed free or and by decreased the period of weed competition. This increased in gross income due to increased root yield/fed due to decreased weed interference of sugar beet crop. The highest total cost (7095 L.E), gross income (13671.1 L.E) and net income (6576.1 L.E) were resulted from weed free for all growing season, but, duration weed without any control (weed interference for all growing season) was lower total cost and give lower gross income as will as increased total cost than gross income due to decreased root yield, due to weed interference on sugar beet plant under the level infestation in field experiments (10 and 9.7 ton/fed dry weight of weeds at end growing seasons in 2009/10 and 2010/11 seasons). The increase of gross income and net income may be attributed to increase root yield of sugar beet due to decrease the period of weed-sugar beet interference.

According to these result economic critical period of weed competition was found between 4 – 10 Weeks after sugar beet emergence. The early income period threshold was estimated more than 4 weeks weed free after emergence as the time interval when the gross income of sugar beet yields are higher than the total cost include cost of weed control treatments.. The late income period threshold, was estimated at less than 10 weeks weed interference as the time interval when the gross income of sugar beet yields are higher than the total cost include cost of weed control treatments. These results agreed with Dunan *et al.*, (1995), Singh *et al.,* (1995), Stevan, (2002), and Mekky *et al.,* (2005).

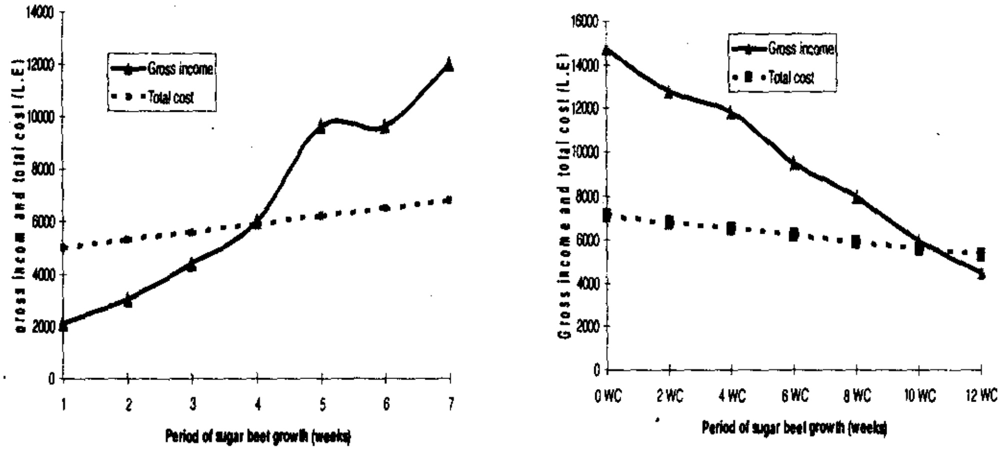

Fig. 6. The relationship between total cost and gross income under different duration of weed free or weed competition.

CONCLUSION

It could be concluded from this study that the sugar beet crop is weak in the early stage of plant growth and it can't compete with weeds such as weed species that appear with the emergence of sugar beet and this requires the maintenance of the sugar beet crop free from weeds for at least four weeks after emergence as 55-60 days after planting to cover the cost of rent of land and agricultural operations, harvesting. The critical period of weed – sugar beet interference was 2-12 weeks after emergence, which, most is need weed control during this period and left sugar beet plant free from of weeds.

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الطرق المختلفة لتحديد الفترة الحرجة لمنافسة الحشائش لمحصول بنجر السكر

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يتأثر محصول بنجر السكر بشدة بمنافسة الحشائش. وتقدير الفترة الحرجة لمنافسة الحشائش لمحصول بنجر السكر في غاية الأهمية لتخطيط إستراتيجيات مكافحة الحشائش في هذا المحصول. لهذا الغرض تم أقامة تجربتين حقليتين بمحطة بحوث ملوي – محافظة المنيا في الموسمين الشتويين ٢٠٠٩/١٠، ٢٠١٠/١١ شملت كل تجربة ١٤ معاملة من أزالة أو ترك الحشائش للمنافسة بنجر السكر وكانت معاملات فترات إزالة الحشائش هي ٢، ٤، ٦، ٨، ١٠، ١٢ إسبوع بعد إنبات بنجر السكر وكذا معاملات ترك الحشائش لمنافسة محصول البنجر لمدة ٢، ٤، ٦، ٨، ١٠، ١٢ إسبوع بعد إنبات البنجر علي التوالي بالإضافة إلي معاملتي ترك الحشائش لمنافسة المحصول طول الموسم، المحافظة علي ترك المحصول خالي من الحشائش طول الموسم. تم إستخدام النتائج المتحصل عليها من معاملات الترك والإزالة للحشائش لتقدير الفترة الحرجة لمنافسة الحشائش لمحصول البنجر ثلاث نماذج للإنحدار (الخطي، التربيعي، اللوجيستي) كما تم ايضاً عمل التقييم الإقتصادي لمعاملات إزالة وترك الحشائش وتحديد الفترة التي ينتج عنها نقص حاد في حاصلات بنجر السكر وتحديد الفترة التي يجب ترك المحصول فيها خالي من الحشائش.

أوضحت النتائج المتحصل عليها أن أعلي نقص في حاصل الجذور (طن/فدان) وحاصل السكر (طن/فدان) نتيجة منافسة الحشائش لنباتات بنجر السكر طول الموسم كان ٨٦,٨ & ٨٧,١ ، ٨٤,٦ &٨٦,٣ تحت كثافة حشائش ١٠، ٩,٧ طن /فدان مقارنة بحاصل معاملة ترك المحصول خالي من الحشائش طول الموسم خلال موسمي الزراعة ٢٠٠٩/١٠، ٢٠١٠/١١ بالترتيب. أوضحت نتائج دراسة الإنحدار أن العلاقات الرياضية بين حاصل جذور بنجر السكر وحاصل السكر للفدان مقنع لمعادلات من الدرجة الأولي والدرجة الثانية والانحدار اللوجيستي، وأنه طبقا لذلك فإنه يمكن التنبؤ بأنه للمحافظة علي ٩٥% من حاصل جذور وسكر البنجر فإن أقصي فترة لترك الحشائش هي ٠,٨٦إسبوع من إنبات البنجر، وكذا الفترة اللازمة لخلو محصول البنجر من الحشائش للحفاظ علي ٩٥% من الأنتاج الكلي تحت ظروف خلو المحصول من الحشائش هي ١٥,١١ إسبوع. العلاقة بين الوزن الغض للحشائش الكلية وفترات الإزالة كانت موجبة ومعنوية ومعامل تحديد (R-Sq ٨٤,٩%)، ولكن هذه العلاقة كانت سالبة وغير معنوية بين مختلف معاملات ترك الحشائش ومعامل تحديد (R-Sq ١٨,٣%). ومن دراسة معامل الإنحدار بين فترات إزالة الحشائش وحاصل الجذور لبنجر السكر وحاصل السكر للفدان فإن الفترة الحرجة هي من ٢ حتي ١٢ إسبوع بعد الإنبات ويجب مكافحة الحشائش في هذه الفترة لمنع أضرار الحشائش علي نباتات بنجر السكر. وتوضح نتائج التقييم الإقتصادي الحدود الإقتصادية الحرجة المبكرة والمتأخرة والتي كانت تنحصر بين ٤ – ١٠ أسابيع بعد الإنبات وهي الفترة التي يكون فيها العائد الإقتصادي أعلي من التكاليف الكلية بما فيها تكاليف عمليات المكافحة.

الخلاصة: –

نستخلص من هذه الدراسة أنه نظرا لان محصول بنجر السكر ضعيف النمو في الفترات الأولي من حياة النبات حيث يكون النبات ضعيف المنافسة للحشائش التي تظهر بمجرد إنبات البنجر وهذا يتطلب المحافظة علي محصول بنجر السكر خالي من الحشائش فترة لا تقل عن أربع أسابيع بعد الإنبات أي الفترة من ٥٥-٦٠ يوم بعد الإنبات) للحصول علي حاصل يغطي تكاليف إيجار الأرض والعمليات الزراعية والحصاد. والفترة الحرجة لمنافسة الحشائش لمحصول بنجر السكرهي الفترة من ٢ – ١٢ أسبوع بعد الإنبات لذا يجب مكافحة الحشائش في خلال هذه الفترة وترك نباتات البنجر خالية من الحشائش.