DETERMINATION OF CRITICAL PERIOD OF WEED COMPETITION WITH SUGAR BEET (*Beta vulgaris* L.) AND WEED CONTROL

BY

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B.Sc. Agric. Sci., South Valley Univ. Sohag, 2003
M. Sc. Agric. Sci. (Agronomy) Fac. of Agric., El-Minia Univ., 2008

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رَبِّ أَوْزِعْنِي أَنْ أَشْكُرَ نِعْمَتَكَ
الَّتِي أَنْعَمْتَ عَلَيَّ وَعَلَى وَالِدَيَّ
وَأَنْ أَعْمَلَ صَالِحًا تَرْضَاهُ
وَأَدْخِلْنِي بِرَحْمَتِكَ فِي عِبَادِكَ
الصَّالِحِينَ

الآية 19 سورة النمل

DEDICATION

I would like to dedicate this thesis to my brother ***Hamada*** *who passed away.*

I also dedicate this work to whom my heart felt thanks; to my father, my mother, my brothers, my sisters my wife for their patience , help and for all support they lovely offered along the period of my post-graduation.

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INTRODUCTION

Sugar beet (*Beta vulgaris* L.) is considered as an important sugar crop in Egypt and it is considered the second crop after sugarcane for sugar production. It can be grown in northern regions of the country and in the new reclaimed area. Recently, the contribution of sugar beet to sugar production increased to reach about 48.1% of the total sugar production in 2012 season. Sugar beet is cultivated in Egypt 423 thousand fed. (**Agricultural Statistics 2012**). High yield and quality of sugar beet is the end product of many factors including weed control treatments.

Weed competition is considered one of the major obstacles in preventing the achievement of maximum sugar beet yield. Weeds not only compete with sugar beet for the necessary elements of growth such as light, water and nutrients, but also harbor insects and increase the incidence of diseases and harvest losses.

Sugar beet is a poor competitor with weeds from emergence until the sugar beet leaves shade the ground. Emerging sugar beet plants are small, lack vigor and take approximately two months to shade the ground. Thus, weeds have a long period to become established and compete with sugar beet. Sugar beet plants are relatively short even after they shade the ground so many weeds that become established in a sugar beet field prior to ground shading will become taller than the sugar beet, shade the sugar beet, and cause severe yield losses. To avoid yield loss from weed competition, weeds should be totally controlled by four weeks

after sugar beet emergence and weed control should be maintained throughout the season.

Sugar beet plants are characterized by their slow rate of growth during the early stages from emergence to thinning time. Lack of weed control caused about 50% losses in the yield**.**

Salehi *et al*. (2006), indicated that the presence of weeds during the entire growing season decreased sugar beet root yield by 92.9% and 61.2% in 1999 and 2000, respectively. Also, **Deveikyte and Seibutis (2006)** found that uncontrolled weeds typically cause 50 to 100 % yield losses. **Zargar *et al*. (2010),** showed that times of mechanical control and herbicides have the most reduction on density and biomass of weeds (*Chenopodium album* and *Amaranthus retroflexus*)

The highest cost of hand weeding and their damaging effect on sugar beet plants showed that using herbicides is more economic practice. Sugar beet cultivated in fields with little weed infestation and correct agricultural practices only needed post-emergence application of herbicides. However, sugar beet grown in fields with heavy weeds infestation and improper agricultural practices required both pre- and post-emergence application of herbicides.

The present investigation was carried out to determine the critical period of weed competition with sugar beet (*Beta vulgaris* L.) and weed control.

REVIEW OF LITERATURE

The review of literature will be presented under the following main headings:-

1. Effect of weed competition on sugar beet.
2. Effect of weed control treatments on weeds.
3. Effect of weed control treatments on sugar beet.

1- Effect of weed competition on sugar beet:

Farahbakhsh and Murphy (1986), stated that wild oat (*Avena fatua*) competition caused significant loss in growth and yield of sugar beet. Time of wild oat emergence and its plant density were both important factors in determining the severity of crop yield loss.

Meyer and Widmer (1986), cleared that the plots, which unweeded throughout the growing season, gave much lower root yield of sugar beet than weed controlled during establishment.

Er and Inan (1987), pointed out that poor weed control in the early stages of sugar beet development accounted for 60-80% of the yield reductions due to competition for minerals, water and light. Significant linear correlation was evident between weed weight before harvesting and root yield.

Kropff *et al.* (1987), found that common lambsquarters (*Chenopodium album* L.) was stronger competitor than chick weed (*Stellaria media* L.) because common lambsquarters grow taller than sugar beet crop.

Zlobin (1987), found that 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.

Osman *et al.* (1989), noted that the sugar beet plots kept weed free throughout the season gave the highest yields of roots, sucrose and foliage.

Ivashchenko (1990), recommended that weeding should be continued for 60-80 days after sugar beet emergence.

Mesbah *et al.* (1991), showed that root yield and top yield of sugar beet decreased with increasing wild mustard densities. Each 0.3 plants/m in row of wild mustard allowed competing sugar beet for 0.9 weeks can be reduced sugar beet root yield by 5% due to wild mustard competition with sugar beet for light.

Kropff *et al.* (1992), reported that the critical period of weed-sugar beet competition and amount of sugar beet yield losses due to weed competition differed by differing the time appeared of these weeds after sugar beet emergence, which ranged from 0 to 31 days as well as the temperature in the period between crop and weed emergence, which considered an important factors for determining the critical period of weed-sugar beet competition.

Rola and Rola (1992), indicated that root yields of sugar beet decreased with increasing density of red root pigweed (*Amaranthus retoflexus* L.), reductions ranging from 18% with a

weed density of 5 weed plants/m^2 to 31% with 20 weed plants/m^2. Red root pig weed at 20 weed plants/m^2 reduced N, P and K uptake by sugar beet roots by 39.5, 44.0 and 43.3%, respectively.

Weaver *et al.* (1992), suggested that under greater weed densities sugar beet crop can tolerate shorter period in early-season competition as well as need longer period weed removal (weed free) period to prevent yield losses.

Ferrero (1993), recorded that sugar beet sucrose yield reduction was directly related to the duration of weed competition. Assuming a sucrose yield loss of 10%, the critical periods of weed competition of 17-26 and 10-38 DAE in 1990 and 1991 seasons, respectively.

Gutierrez and Mulero (1993), found that the critical period for weed competition was from the 2- 16 leaf stage in dry land sugar beet and from the 4- 16 leaf stage in irrigated sugar beet.

Mesbah *et al.* (1994), reported that increased density of kochia and green foxtail and duration of interference after sugar beet emergence decreased sugar beet root yield.

Rzozi *et al.* (1994), indicated that delayed weed control in sugar beet until 44 days after planting affected the plant population, leaf area index and caused a reduction in root yield of sugar beet by 50%.

Mesbah *et al.* (1995), indicated that 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. Where, 3 wild oats and 0.8 wild mustard plants/m^2 of row, grown separately, reduced root yield by 22 and 26%, respectively and by 38%, when these two densities were mixed. Sugar beet root yield decreased with increasing duration of interference. Sucrose content of sugar beet was not altered by competition. 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.

El-Zeny (1996), revealed that 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.

Norris (1997), found that sugar beet yield loss increased with increasing density of common purslane (*Portulaca oleracea* L.), between 0.5 and 3.0 common purslane plants/m of crop row caused an economic loss of 70%.

Abdollahian *et al.* (1998), revealed that root yield of sugar beet was more affected than sugar contents by weed competition.

Covarelli *et al.* (1998), reported that weed control in the first stage of sugar beet crop reduced weed competition with

sugar beet and reduced losses in root yield of sugar beet. Emerged weeds later than 138-192 days after emergence caused 2.5% reduction in root yield, compared to weed free for whole season.

Fayed *et al.* (1999), recorded that sucrose percentage, total soluble solids (T.S.S.) and nutrient (N, K and Na) concentration values of sugar beet root juice were higher in weed-free plots than in weedy ones. The highly competitive *(Beta maritima, Phalaris minor* and *Cynodon dactylon*) weeds were also the most effective competitors for N, K and Na uptake, but, T.S.S. and sucrose % didn't significantly affected by weed competition period.

Wille and Morishita (1999), showed that sugar beet fields which were infested with weeds such as kochia (*Kochia spp*. L.), red root pig weed (*Amaranthus retroflexus* L.), common lambsquarters (*Chenopodium album* L.) and hairy nightshade (*Solanum nigrum* L.) resulted in root yield losses by 11 ton/acre, compared weed control by using herbicides.

Bosak and Mod (2000), compared the influence of different weed species on yield and quality of sugar beet against unweeded plots when the density of weeds was 2-5 plants /m^2, including common lambsquarters (*Chenopodium album* L.), velvetleaf weed (*Abutilon theophrasti* L.) and spreading pigweed (*Amaranthus blitoides* L.), the yield of sugar beet was

reduced by 20-30%. While common ragweed (*Ambrosia artemisiifolia* L.) decreased root yield by 40-50%.

Shaban *et al.* (2000), found that reduction value in sugar beet yield in unweeded treatment (leaving weeds without removal) in the first season was 53.1% and in the second season was 56.3%, compared to hand-hoeing treatment.

Dararas (2001), showed that root yield and total nitrogen uptake were significantly decreased by weed competition period, which gave reduction percentage of 44 and 43%, respectively, in unweeded treatments compared to weed control treatments.

Krousky (2001), showed that the presence of one wild beet plant/m^2 could reduce root yield of sugar beet by 12 %.

Alaoui *et al.* (2003), found that sugar beet sucrose yield was reduced by 99 to 100% by full-season weed interference and by 5 or 10% if weeds were allowed to interfere with sugar beet for 2 to 2.5 or 5 to 5.5 weeks after sugar beet emergence (WAE).

Mekky *et al.* (2005), defined the economic critical period as the time interval when the marginal income of weed control is higher than the cost of control

Deveikyte and Seibutis (2006), showed that the sugar beet plants are a poor competitor with weeds. Uncontrolled weeds which emerge with the crop typically could cause from 50 to 100% yield loss.

Salehi *et al.* (2006), indicated that the presence of weeds during the entire growing season decreased sugar beet root yield by 92.9% and 61.2% in 1999 and 2000, respectively. He added that the end of the critical period of weed control was 78 days in the first year and 88 after planting for the second year.

Jursik *et al.* (2008), recorded that top dry weight and LAI of sugar beet was keys identical in the effect of weed control treatments and development of sugar beet plants, weed removal until 8-10 leaf stage and weed removal for whole vegetation period gave top yield 500 and 900 g/m^2, and LAI 4-7 m^2/m^2, respectively.

Kemp *et al.* (2009), recorded that the critical weed-free period for glyphosate- and glufosinate-resistant sugar beet was 4.5 to 5 weeks after planting WAP in the first and second season, the critical weed-free period at the Michigan Sugar location was 1.5 WAP in glyphosate-resistant sugar beet, and 6.5 WAP in glufosinate-resistant sugar beet for the Michigan Sugar site.

Odero *et al.* (2009), showed that sugar beet root yield decreased as the duration of Venice mallow interference increased. The critical timing of weed removal to avoid 5 and 10% root yield loss was 30 and 43 DAE after sugar beet emergence, respectively.

Mirshekari *et al.* (2010), reported that the decreased root yield of sugar beet from 75 t/ha to 58 t/ha when 16 redroot

pigweed/m of row allowed to interfere for whole season, compared to weed free for whole season as well as increased sugar yield losses.

Odero *et al.* (2010), found that the wild buckwheat had greater interference on sugar beet. It had a negative effect on root and sucrose yields of sugar beet this may be due to wild buckwheat strength competitive ability with sugar beet. The critical period of weed control under infestation by wild buckwheat was 32 and 48 days after sugar beet emergence DAE to avoid 5 and 10% root yield losses, respectively.

2- <u>Effect of weed control treatments on weeds:</u>

Kolbe (1984), found that the pre-emergence application of Goltix at the rate of 5 kg/ha, provided the highest level of weed control, compared with unweeded or weeded mechanically.

Knights *et al.* (1991), mentioned that the new formulation of Betanal progress, contained 0.062 g phenmedipham + 0.016 g desmedipham + 0.128 g ethofumesate/L, gave good selective control of all major weeds presented with a low net dose rate. In addition the split application of 4 liters/ha gave excellent results in sugar beet weed control.

Sysmanas *et al.* (1991), studied the application of low rates of post-emergence herbicides with or without a pre-emergence treatment. They found that a pre-emergence

treatment with Metamitron or Chloridazon was necessary for good control of weeds in sugar beet fields.

Kotting and Zink (1992), mentioned that applying low rate (75% lower than full rate) from Betanal progress which was a mixture of phenmedipham + ethofumesate + desmedipham, gave excellent weed control in sugar beet than full rate of Betanal tandem (phenmedipham + ethofumesate).

Rola and Rola (1992), revealed that good control of *Amaranthus retroflexus* was obtained with Betanal Compact [desmedipham + phenmedipham] in sugar beet**.**

Dexter (1994), reported that a half rate of phenmedipham and/or desmedipham applied twice at 5 – 7 days interval controlled weeds better and caused less sugar beet injury than a single full-rate application, at 2-4 leaves of sugar beet stage.

Gamuev *et al.* (1994), found that split applications of Betanal Progress [desmedipham + ethofumesate + phenmedipham], each at 1.5 at the germination of dicotyledons and the 2nd of them in combination with Poast [sethoxydim] at 2 l/ha. for the control of grassy weeds gave the best control of grassy and broad leaved weeds in sugar beet.

Hermann (1994), showed that triflusulfuron-methyl allows a reduction of the required rates of residual compounds and phenmedipham.

Wilson (1994), revealed that combining ethofumesate with desmedipham + phenmedipham increased sugar beet injury over that obtained with desmedipham + phenmedipham alone, but weed control and sugar beet injury from herbicides generally were unaffected by application of 0.097 or 0.182 liters/ha in water carrier.

Brautigram (1995), indicated that weed control with Betanal Tandem [ethofumesate + phenmedipham] at 1.25 L + Goltix [metamitron] at 1 kg/ha was most effective on weed control and prevent early weed competition to sugar beet.

Deveikyte (1996), reported that applied mixture of Betanal Tandem at 2 l/ha. + Pyramin FL at 4.6 l/ha. or + Fenazon and Lenacil or + Goltix (1.4 kg/ha) gave better control of weed in sugar beet than Betanal Tandem at 2 l/ha. alone.

Gabibullaev (1996), showed that Betanal Progress AM (containing phenmedipham, desmedipham and ethofumesate) at 1.5 l/ha. was on average 93.3% effective against weeds in sugar beet fields.

Gamuev (1996), indicated that a tank mixture of Pyramin F1 (chloridazon) and Betanal progress AM (desmedipham + ethofumesate + phenmedipham) at 4 + 6 liters/ha. applied in two half-doses after emergence of annual dicotyledonous weeds, resulted in 97% weed control.

Gamuev and Gamuev (1996), found that the mixture of triflusulfuron-methyl at 30 g/ha with phenmedipham at 1 l/ha. applied twice was the most effective treatment on reducing weed mass by 98.3%, followed by triflusulfuron-methyl applied twice at 30 g/ha, which reduced weed mass by 97.8%.

Gonik and Val'ko (1996), reported that application of Betanal Progress AM [desmedipham + ethofumesate + phenmedipham] (4 l/ha.) when the 1st pair of true leaves of sugar beet appeared, followed by the application of Centurion [25% EC clethodim] (0.3 l/ha.) in a tank mix with Lontrel (clopyralid) at 0.4 l/ha. sprayed after 7-12 days from the application of Betanal resulted the best control of grassy weed and many dicotyledons, including Ambrosia and creeping thistle [*Cirsium arvense*].

Kositornia (1996), stated that Goltix was the best herbicide for use in mixtures to enhance the efficacy of Betanal and Nortron against dicotyledonous weeds [red root pig weed (*Amaranthus retroflexus* L.) and hairy nightshade (*Solanum nigrum* L.)] in sugar beet cultivation without any phytotoxicity on sugar beet plants.

Rola and Zawadzki (1996), indicated that the triflusulfuron-methyl tank mixed with other herbicides (phenmedipham, lenacil, desmedipham, ethofumesate, chloridazon and metamitron) gave good control of most noxious weeds such as *Galium aparine*, *Amaranthus retroflexus*,

Matricaria inodora [*M. perforata*], *Anthemis arvensis, Aethusa cynapium* and volunteer rape.

Tyla and Petroviene (1996), observed that the application of Fusilade Super 12.5% (fluazifop-p-butyl) at 3.2 – 4.0 l/ha. against quackgrass (*Elymus repens* L.) in fodder beet fields at the 3 to 6 leaf stage, controlled weeds up to 90% in the middle of growing season and reduced weed dry matter up to 98%.

Yukhin and Absatrov (1996), revealed that a mixture of Betanal tandem (ethofumesate + phenmedipham) and Zellek (haloxyfop) at 3.3 + 0.5 kg/ha, caused 88% reduction of dicotyledonous weeds when applied at the stage of 1-2 pair of true leaves of sugar beet.

Zoghlami *et al.* (1996), indicated that triflusulfuron-methyl has promise for control of problem weeds such as *Aethusa cynapium, Amaranthus retroflexus, Ammi majus, Matricaria spp., Mercurialis annua* and *Solanum nigrum.*

Bosak and Janos (1997), found that the most effective treatment against *Chenopodium* sp., *Matricaria* sp. and *Polygonum* sp. in sugar beet fields was Dual 960 EC [metolachlor] at 2.2-2.5 l/ha. + Goltix 70 WP [metamitron] at 2-3 kg/ha, which reduced weed by 99%, compared to unweeded check.

Deveikyte (1997a), revealed that all the herbicides tested - 6 l/ha. Betanal (159 g/L phenmedipham), 6 l/ha. Betanal AM

(157 g/L desmedipham), 4 l/ha. Betanal Kompakt (106 + 56 g/L phenmedipham + desmedipham), 4 l/ha. Betanal Tandem (97 + 94 g/L phenmedipham + ethofumesate) and 8 l/ha. Norton (200 g/L ethofumesate) reduced weed population in sugar beet fields until sugar beet leaves covered inter rows. Goltix (700 g/kg metamitron) gave significantly better weed control (64.0%). Compared to unweeded check, Goltix and Norton mixtures with Betanal gave the best weed control.

Deveikyte (1997b), revealed that Betanal Tandem [ethofumesate + phenmedipham], compared to other Betanal compounds reduced weed infestation and increased yield. Goltix [metamitron] gave better weed control than Nortron [ethofumesate], but when mixed with 3 l/ha. Betanal their efficiencies became more effective on weeds and increased yields of sugar beet.

Hakoyama *et al.* (1997), found that the most weeds in sugar beet fields (except *Chenopodium album*, *Commelina communis* and *Echinochloa spp*.) were controlled by applications of phenmedipham or lenacil + pyrazone [chloridazon].

Ievlev *et al.* (1997), recorded that the most effective treatment in all years of this study was Betanal Progress AM [a mixture of phenmedipham, desmedipham and ethofumesate] at 2 l/ha., as well as Betanal Progress AM + Furore Super

[fenoxaprop] + Lontrel [clopyralid] at 1.5 + 1.3 + 0.3 l/ha. gave reduction percentage in total weeds by 85-97%.

Rapparini (1997), indicated that triflusulfuron-methyl gave good control of a broad spectrum of weed species belong to Cruciferae and Umbelliferae [Apiaceae] and of many species from Compositae [Asteraceae], but did not give adequate control of others including Chenopodiaceae, *P. aviculare* and *F. convolvulus.*

Tezuka *et al.* (1997), showed that the most effective treatment for weed control in sugar beet fields was by application of phenmedipham with lenacil followed by sethoxydim and then a second application of phenmedipham with lenacil.

Toth and Peter (1997), found that triflusulfuron alone did not control *Chenopodium album, Fallopia convolvulus, Polygonum aviculare, Amaranthus retroflexus, Sinapis arvensis, Abutilon theophrasti, Hibiscus trionum* and *Echinochloa crus-galli.* Control of *C. album, F. convolvulus, P. aviculare and Stellaria media* was possible with triflusulfuron (30 g/ha) combined with phenmedipham (2 l/ha.), or phenmedipham/ desmedipham (1 l/ha.), or phenmedipham/ethofumesate (1.5-2 l/ha.). triflusulfuron + phenmedipham/ ethofumesate + metamitron (30 g/ha + 2 l/ha. + 0.7 kg/ha) gave excellent results against *C. album, H. trionum* and *A. theophrasti.*

Tula *et al.* (1997), showed that Betanal progress at rate of 1.0 – 1.25 l/ha. against dicotyledonous weeds, the best results were obtained from spraying Betanal progress 3 times at a rate of 1.0 l/ha.. after weeds had germinated was gave 85% weed control.

Vurbanova (1997), revealed that mixtures of Dual with Betanal or Betanex 15.7%, or of Betanal with Betanex, were highly effective with both types of ploughing, which gave reduction percentage in number of weeds by 88-94% in the variant with normal ploughing and by 97-99% in the variant with two-layer ploughing.

El-Zouky (1998), found that chemical weed control by metamitron + phenmedipham + ethofumesate (post-emergence) and chloridazon + ethofumesate (pre-emergence) was insufficient to control all weed species during the whole crop cycle, but chemical weed control + hand-weeding at 100 days after sugar beet emergence resulted in the effectiveness for weed control and increased sugar beet yields.

Montemurro *et al.* (1998), indicated that phenmedipham + cycloate + chloridazon applied 2 or 3 times, and 3 applications of Betanal Progress OF [desmedipham + ethofumesate + phenmedipham] (0.75 l/ha.) mixed with metamitron was effective on broad leaved weed control. haloxyfop-ethoxyethyl at full dose was highly effective in controlling grass weeds.

Paradowski (1998), revealed that Expander Top 400 SC (chloridazon + phenmedipham + desmedipham) at 2 or 3 l/ha. in combination with the adjuvant Olbras 88 EC at 0.5 l/ha. or 1 l/ha. resulted reductions in weed density by 87-100%. Expander Top at 2 l/ha. combined with Olbras at 0.5 or 1 l/ha. or with Pyramin Turbo 520 SC [chloridazon] at 4 l/ha. gave a reduction in weed density by 76-100%.

Wilson (1998), revealed that when desmedipham + phenmedipham and desmedipham + phenmedipham + ethofumesate were applied at the 2 true leaf growth stage resulted reduction in total weeds by (92 and 95%, respectively).

Campagna *et al.* (1999), found that the application of post emergence herbicides triflusulfuron-methyl in combination with mineral oil, (phenmedipham + desmedipham or phenmedipham + ethofumesate) reduced velvetleaf weed (*Abutilon theophrasti* L.) and other common weeds such as barnyardgrass (*Echenochloa crus-gali* L.) to limit acceptable levels without any competition or less competition with sugar beet as well as less reduction in sugar beet yield, using pre-emergence herbicide metamitron alone, metamitron + ethofumesate + lenacil gave best results in controlling these weed species and increase sugar beet yields.

Chodova *et al.* (1999), recorded that the efficacy of Betanal [phenmedipham] could be improved by combining with Venzar or Goltix. These treatments gave the best control of

weeds and prevent sugar beet yield reduction due to weed competition.

Ostrowski and Adamczewski (1999), showed that Saherb 232 EC [a mixture of phenmedipham, desmedipham, ethofumesate and trifluralin] was applied at 1.5 l/ha. in combination with Goltix 70 WP [metamitron] at 1 l/ha. treatments resulted reduction percentage by 85 to 98%.

Tyr *et al.* (1999), revealed that the herbicide mixtures combinations of Safari [triflusulfuron-methyl], Betanal Progress [phenmedipham + desmedipham + ethofumesate], Betanal Trio, and Venzar [lenacil] gave the best weed control in sugar beet crop due to combination between contact and residual herbicides.

Banaszak (2000), showed that Saherb [a mixture of phenmedipham, desmedipham, ethofumesate and trifluralin] was effective against all weeds, except *Rumex* spp. in sugar beet fields.

Deveikyte (2000), recorded that metamitron increased the effectiveness of mixture phenmedipham, desmedipham and ethofumesate by 57-76% in controlling annual weeds, without any phytotoxicity on sugar beet plants.

Deveikyte (2002), found that reduced sugar beet weed infestation by 20.3-91.9%, using 5 l/ha. Fiesta T [quinmerac], 5/ha L Pyramin Turbo [chloridazon], 3 l/ha. Betanal Progress OF [desmedipham + ethofumesate + phenmedipham] and 1.5-

2.0 L Pantera [quizalofop-P]/ha in dependant on dominant weed species in sugar beet field.

Galyakevich and Gritsenko (2002), recorded that the application of Regio (chloridasole + 50 g phenmedipham/L + 50 g desmedipham/L), twice at 3 l/ha. and thrice at 2 l/ha., decreased weed fresh weight by 61% compared to the unweeded check.

Herceg (2002), revealed that trifusulfuron, applied alone, gave good control of *Amaranthus retroflexus, Matricaria chamomilla, Polygonum persicaria* and *Sinapis arvensis*, but, when applied in combination with Betanal Progress , Betanal Progress [phenmedipham + desmedipham + ethofumesate], Goltix 70 [metamitron], Betanal AM [phenmedipham], Venzar [lenacil] and Trend [ethoxylated isodecyl alcohol], increase the range of weed spectrum controlled such as *Amaranthus retroflexus, Anagallis arvensis, Ambrosia elatior, Capsella bursa-pastoris, Chenopodium polyspermum, Galinsoga parviflora, Matricaria chamomilla, Polygonum aviculare, P. persicaria, Sinapis arvensis* and *Solanum nigrum* in sugar beet fields and increased sugar beet yields.

Padionov and Gadzhieva (2003), reported that the application of Betanex (desmedipham) and Betanal Progress [desmedipham+ ethofumesate + phenmedipham] at the rate of 3.0 l/ha. applied on time when sugar beet stage were four-leaf or

splitting this rate 1.5 L each time gave reduction in weeds by 85.0-100%.

Ashcheulov (2004), found that use of Betanal Expert OF (phenmedipham + desmedipham+ ethofumesate) provided 97.3% control of grassy weeds, sugar beet productivity of 50-51.5 t/ha and a sugar yield of 8.38-8.65 t/ha.

Farzin and Hossein (2004), found that maximum reduction of weed biomass in sugar beet field was observed with desmedipham + phenmedipham + ethofumesate at rate of 0.23+0.23+0.23 kg a.i./ha and desmedipham plus phenmedipham plus propaquizafop at 0.46+0.46+0.1 kg a.i./ha.

Ishikawa *et al.* (2004), showed that applying both phenmedipham emulsion (600 ml/10 a) and lenacil powder was the most effective way for weed control in sugar beet field.

Padenov and Gadzhieva (2004), suggested that mixed use of Betanal Progress OF (90g/l phenmedipham, 70 g/l desmedipham and 110 g/l ethofumesate with Pilot [quizalofop-p-ethyl] increased control of many weed species in sugar beet fields.

Paradowski and Praczyk (2004), indicated that the use of chloridazon and metamitron mixture can be improving the weed control system in sugar beet.

Deveikyte (2005), reported that Betanal Expert (phenmedipham + desmedipham + ethofumesate) was more

effective in controlling the weeds when mixed with Goltix (metamitron) in sugar beet fields.

Holec *et al.* (2005), indicated that nightshades Solanum species (*S. nigrum, S. decipiens and S. physalifolium.*) in sugar beet fields can be controlled by chloridazon, metamitron, phenmedipham or triflusulfuron.

Jursik *et al.* (2005), found that high efficacy of controlling shepherd's-purse (*Capsella bursa-pastoris* (L.) Medic.) in sugar beet by using phenmedipham, triflusulfuron, chloridazon, lenacil, metamitron, desmedipham and ethofumesate.

Dale *et al.* (2006), revealed that the control of *Chenopodium album* and *Amaranthus* spp. by desphen (desmedipham + phenmedipham at 0.045 + 0.045 kg a.i. /ha) and desphenetho (desmedipham + phenmedipham + ethofumesate (1:1:1 ratio) without any effect on sugar beet plants.

Deveikyte and Seibutis (2006), found that weed control by applying triflusulfuron prior to phenmedipham + desmedipham + ethofumesate at (15, 91+71+112 g a.i. /ha) respectively, reduced the amount of broad-leaf weeds and increased weed control percentage from 55.0 to 85.0% by the addition of metamitron, chloridazon and chloridazon +quimarac.

Yukhin (2006), showed that pre-sowing application of Dual Gold [metolachlor] + application of Betanal Progress AM [desmedipham + phenmedipham + ethofumesate] in mixture with Fusilade Forte [fluazifop-P-butyl] during the vegetative period of sugar beet gave the best weed control.

Deveikyte *et al.* (2007), found that phenmedipham, desmedipham, ethofumesate was more effective for controlling *Chenopodium album*, *Lamium purpureum*, *Polygonum aviculare* and *Tripleurospermum perforatum* [*Matricaria perforata*] by applying in mixture with metamitron than by applying in mixture with chloridazon and chloridazon+quinmerac.

Dvoryankin (2007), showed that Betanal 22 applied twice per growing season (1.25 and 1.5 l/ha, respectively) was highly effective against all weed types of sugar beet crop with reduction percentage of 90.1% to 92.0%.

Jursik *et al.* (2007), noted that in sugar beet fields using triflusulfuron was partial efficacy in controlling *Convolvulus arvensis* L. after application, chlorosis of the leaves can be found with decrease of growth, but the weed plants regenerate soon.

Chetin *et al.* (2008), showed that good control for *Salvia reflexa* in sugar beet with Betanal Expert OF [ethofumesate + desmedipham + phenmedipham] (1.7-2.1 l/ha.) + Caribou

[triflusulfuron] (40-50 g/ha) + Lontrel Grand [clopyralid] (0-80 g/ha).

Deveikyte and Seibutis (2008), recorded that all herbicide treatments (phenmedipham + desmedipham + ethofumesate, metamitron and triflusulfuron-methyl) gave more consistent control of *Chenopodium album* L., *Tripleurospermum perforatum* (Merat), *Polygonum aviculare* L. and *Thlaspi arvense* L. in sugar beet.

Olsson (2008), concluded that in sugar beet using the normal dose (0.65 l/ha. Goltix [metamitron], 1.0 Betanal [desmedipham]) gives the best weed control without significant reduction in sugar yield.

Rapparini (2008), cleared that Betaren Extra [desmedipham + phenmedipham + ethofumesate] proved to be a very wide spectrum herbicide, highly effective against annual dicotyledonous weeds, giving 95.1-95.8% control at doses of 3-4 liters/ha, a triple application (1 + 1 + 1 l/ha.) was particularly effective for weed control.

Jursik and Holec (2009), stated that high efficacy on *Euphorbia helioscopia* can be reached by using herbicides with active ingredients quinmerac, triflusulfuron, and in early growth stages also desmedipham.

Zargar *et al.* (2010), showed that times of mechanical control and herbicides have the most reduction on density and weeds biomass of (*Chenopodium album* and *Amaranthus*

retroflexus) best results were achieved in mechanical control at 4-6 leaves stage or using herbicide was Goltix + Betanal progress.

Abo El-Hassan Rasha (2010), reported that weed control treatments significantly decreased the dry weight of weeds as compared with unweeded after 60 and 90 days from planting in both seasons. She added that decreasing the rate of Betanal Progress when applied twice at rate of (135 g a.i. / fed.) followed by Fusilade Super at (94.75 g a.i. / fed.) in tank mixed with vegetable oils showed good results on total annual weeds as compared to Betanal Progress when applied twice at rate of (135 g a.i. / fed.) followed by Fusilade Super to (94.75 g a.i. / fed.) tank mixed with mineral oils in both seasons

3- <u>Effect of weed control treatments on sugar beet:</u>

Smith *et al.* (1982), concluded that root weight, sucrose and purity were slightly reduced by herbicides application, post-emergence application of the mixture of desmedipham plus phenmedipham suppressed foliar growth in all cases less than either pre-plant herbicide treatment.

Chauhan and Motiwale (1985), found that the presence of weeds in sugar beet decreased root yields by 35 – 54%, compared with hand weeding, while herbicide application of 2 kg Nortron [ethofumesate], 3 kg cloridazon and 2 kg alachlor /ha gave yields of 52.1, 46 and 48 t/ha. respectively compared

with 45 ton with hand weeding and 27 ton without weed control.

Shady and Mosalam (1993), indicated that phenmedipham was the most potent compounds, in both seasons at the average of yield (20.15 and 23.5 ton/fed). However, phenmedipham had the same positive effects on sugar percent, total soluble solids (T.S.S. %), fresh weight of sugar beet, purity, sugar yield (ton/fed) root diameter and root length.

Abd El-Aal (1995), indicated that total soluble solids (T.S.S. %) values did not significantly differ between weeded and unweeded sugar beet plots.

Gagro and Dadacek (1996), indicated that best results were achieved with post-emergence herbicide + hoeing treatments, and highest crop yields were obtained with 2 l/ha. Betanal [phenmedipham] + 2 kg Goltix [metamitron].

Gamuev (1996), indicated that a tank mixture of Pyramin F1 (chloridazon) and Betanal progress AM (desmedipham + ethofumesate + phenmedipham) at 4 + 6 liters/ha. applied in two half-doses after emergence of annual dicotyledonous weeds, increased sugar beet root yields.

Tyla and Petroviene (1996), observed that the application of Fusilade super 12.5% (fluazifop-p-butyl) at 3.2 – 4.0 l/ha. against quackgrass (*Elymus repens* L.) in fodder beet fields at the 3 to 6 leaf stage, increased root yield by 31-40%.

Deveikyte (1997a), revealed that Goltix and Norton mixtures with Betanal gave the best root and sugar in sugar beet.

Tezuka *et al.* (1997), showed that root yields of sugar beet were 15.4-38.9 t/ha without weed control and 38.7-49.5 with weed control.

Dotsenko and Myakishev (1998), found that Application of Caribou [triflusulfuron] + Betanal Progress AM [desmedipham] increased sugar beet yields to 39.7 t/ha, thus 6.5 t/ha higher than on control fields.

Gonik and Val'ko (1998), recorded that Centurion [clethodim] at 300 ml/ha. used in combination with Betanal AM [desmedipham] at 1 l/ha. increased root yield of sugar beet by 19.3 t/ha over that of the un-weeded control.

Paradowski (1998), revealed that Expander Top 400 SC (chloridazon + phenmedipham + desmedipham) at 2 or 3 l/ha. in combination with the adjuvant Olbras 88 EC at 0.5 (with 2 L Expander Top) or 1 l/ha. (3 L Expander Top) increased yield over the control by 28.1%. Expander Top at 2 L combined with Olbras at 0.5 or 1 l/ha. and used with Pyramin Turbo 520 SC [chloridazon] at 4 l/ha. gave an increase in yield of 20.9%.

Yukhin *et al.* (1999), applied Betanal Progress AM (phenmedipham, desmedipham and ethofumesate) at 1.5 l/ha., then 7 – 12 days later 1.5 L Betanal Progress AM + 1 L Furore Super (fenoxprop) + 0.3 L Lontrel (clopyralid) were applied and

then 7–10 days later 1.0 l/ha. Betanal Progress AM. was applied gave sugar beet root yield 8.1 ton/ha greater than the untreated control.

Deveikyte (2000), recorded that metamitron in mixture with phenmedipham, desmedipham and ethofumesate significantly increased the sugar beet root yield as compared with mixtures without metamitron.

Shaban *et al.* (2000), recorded that Phenmedipham (0.34 kg a.i./fed.) + one hoeing at 4 WAS under sowing on one side of ridges spaced 50 cm apart provided the highest sucrose percentage.

Banaszak *et al.* (2002), recorded that the root yield of sugar beet in the control plots was 82.7% lower than in the plots sprayed with phenmedipham, desmediphamam, ethofumesate, metamitron, triflusulfuron methyl and lenacil).

Deveikyte (2002), found that all herbicides, i.e. 5 l/ha. Fiesta T [quinmerac], 5 li/ha Pyramin Turbo [chloridazon], 3 l/ha. Betanal Progress OF [desmedipham + ethofumesate + phenmedipham] and 1.5-2.0 l/ha. Pantera [quizalofop-P], increased sugar beet yield by 1.8-3.8 times.

Galyakevich and Gritsenko (2002), recorded that the application of Regio (chloridasole + 50 g phenmedipham/l + 50 g desmedipham/l), twice at 3 l/ha. and thrice at 2 l/ha., increased sugar beet yield.

Frabboni and Zuffrano (2003), revealed that the highest gross marketable yield of sugar beet was obtained with the treatment involving 3 post-emergence applications of Betanal Expert 0.7 (phenmedipham + desmedipham + ethofumesate) + Erbil 0.6 (metamitron) + Pyramin DF 0.6 (chloridazon) + Venzar 0.2 (lenacil) + Dual Gold 0.2 (S-metolachlor), Overall, the results indicated the importance of both pre- and post-emergence treatments for good weed control and increased sugar beet yields.

Kondratenko *et al.* (2003), found that the maximum sugar beet yield was obtained with Centurion [clethodim] + Caribu [triflusulfuron] + Trend (adjuvant).

Kucharski (2003), recorded that residues of active ingredient of herbicides (phenmedipham, desmedipham, ethofumesate, chloridazon, metamitron, quizalofop-P-ethyl [quizalofop], fluazifop-P-butyl [fluazifop-P]) increased sugar beet yields without any problems for the following crops.

Ulina *et al.* (2003), indicated that 3 post-emergence applications of Betanal Progress [desmedipham + phenmedipham] at 1l/ha. in combination with Lontrel-300 [clopyralid] and Furore Super [fenoxaprop] increased yield and sugar content of sugar beet

Farzin and Hossein (2004), found that the highest sugar beet yields were resulted from desmedipham plus phenmedipham plus propaquizalofop at 0.46+0.46+0.1 kg/ha in 2001 and with desmedipham plus phenmedipham plus ethofumesate at 0.23+0.23+0.23 kg/ha in 2000, sucrose content

and other sugar beet characteristics were not affected by the herbicide treatments.

Bulawin *et al.* (2006), concluded that combined application of Frontier [dimethenamid] and Betanal expert [phenmedipham + desmedipham + ethofumesate] gave the highest yield, and the best indicators of economic and energy efficiency.

Deveikyte and Seibutis (2006), found that applying triflusulfuron-methyl prior to phenmedipham + desmedipham + ethofumesate at (15, 91+71+112 g a.i. /ha) respectively, metamitron, chloridazon and chloridazon +quimarac produced higher sugar beet root and sugar yield than (phenmedipham + desmedipham + ethofumesate) alone, but sugar percentage was not affected by the herbicide treatments.

Domaradzki (2007), reported that all weeding systems based on mixtures (3 herbicides Betanal Progress [desmedipham +ethofumesate +phenmedipham] + Safari [triflusulfuron]+ Goltix [metamitron] + adjuvant) increased sugar beet yields compared to the standard systems (Betanal Progress [desmedipham + ethofumesate + phenmedipham] applied 3 or 4 times)

Rapparini (2008), cleared that triple application of Betaren Extra [desmedipham + phenmedipham + ethofumesate] (1 + 1 + 1 l/ha.) gave the highest sugar beet root yield (45.6 t/ha), compared to unweeded check.

Abo El-Hassan Rasha (2010), found that root length, root diameter, root weight, top fresh weight, top yield, root yield, sucrose percentage, sugar yield of sugar beet plant had significantly affected by weed control treatments in both growing seasons. Where as T.S.S. % and purity % did not significantly affect by weed control treatments.

MATERIALS AND METHODS

Filed experiments were carried out at Mallawi Agricultural Research Station, Agricultural Research Center, El-Minia Governorate (Middle Egypt) in both successive winter growing seasons of 2009/10 and 2010/11 to:

1- Determine the critical period of weed competition to sugar beet.
2- Determine the effect of some weed control treatments on yield, yield components, quality of sugar beet (and its associated weeds.

The scope of this work can be classified into two parts as follows: -

Part I: Determination of the critical period of weed competition to sugar beet:

Two filed experiments were carried out at Mallawi Agricultural Research Station in 2009/10 and 2010/11 winter growing seasons the experiment included fourteen treatments which were:

1. Weed free for whole season.
2. Weed free for 2 weeks after sugar beet emergence.
3. Weed free for 4 weeks after sugar beet emergence.
4. Weed free for 6 weeks after sugar beet emergence.
5. Weed free for 8 weeks after sugar beet emergence.
6. Weed free for 10 weeks after sugar beet emergence.
7. Weed free for 12 weeks after sugar beet emergence.
8. Weed infestation for 2 weeks after sugar beet emergence.

9. Weed infestation for 4 weeks after sugar beet emergence.
10. Weed infestation for 6 weeks after sugar beet emergence.
11. Weed infestation for 8 weeks after sugar beet emergence.
12. Weed infestation for 10 weeks after sugar beet emergence.
13. Weed infestation for 12 weeks after sugar beet emergence.
14. Weed infestation for whole season.

The randomized complete blocks design with four replications was used in these experiments. Plot area was 10.5 m^2 (1/400 fed.), include 5 rows and the row length was 3.5 m and wide 60 cm apart between the ridge.

Sugar beet cultivar "Kwamera" (*Beta vulgaris* L.) was sown on 20^{th} and 24^{th} of October in 2009 and 2010, respectively, on one ridge in hill and 15 cm apart between the hills. Harvested on 1^{st} and 5^{th} of May in 2010 and 2011, respectively. The preceding summer crop was maize (*Zea mays* L.) in both seasons.

Phosphorus fertilizer was added at land preparation at the rate of 31 kg/fed P_2O_5 in the form of calcium super phosphate 15.5% P_2O_5, Nitrogen fertilizers were applied in the form of urea (46.5 % N) at rate of 80 kg N /fed, in two equal portions the first dose before the first irrigation and the second dose before the second irrigation, potassium was added with first of nitrogen dose at the rate of 50 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

I- Effect of early and late weed removal times on weeds:-

At harvest weeds were hand pulled from one square meter chosen at random in each plot, identified and classified to annual broad and grassy weeds to record the following traits:-

1- Dry weight of grassy weeds (g/m^2).

2- Dry weight of broad-leaved weeds (g/m^2).

3- Dry weight of total annual weeds (g/m^2).

Weeds were air-dried for seven days and then were oven dried at 70º C for 48 hr, until a constant weight was reached. The dry weight of weeds for each group (g/m^2) was recorded.

Table (1) Family, scientific and common names for weeds recorded in sugar beet crop during 2009/10 and 2010/11.

No	Family	Scientific name	Common name
		Annual grassy weeds	
1	Gramineae	*Avena spp.*L.	Wild oat
2	Gramineae	*Phalaris spp.*L.	Canary grass
		Annual broad-leaved weeds	
3	Euphorbiaceae	*Euphorbia helioscopia*	Libbein
4	Chenopodiaceae	*Beta vulgaris* L.	Sea beet
5	Chenopodiaceae	*Chenopodium sp.*	Lamb squarters
6	Compositae	*Sonchus oleraceus* L.	Annual sowthistle
7	Compositae	*Cichorum pumpilum*	Shikoria
8	Cruciferae	*Brassica nigra* L.	Kaber mustrad
9	Leguminosae	*Melilotus indica* L.	Sweet clover
10	Leguminosae	*Medicago polymorpha* L.	Toothed medik
11	Polygonaceae	*Rumex dentatus L.*	Sheep sorrel
12	Primulaceae	*Anagallus arvensis*	Ain el-gamal
13	Umbelliferae	*Ammi majus* L.	Common bishop

II- Effect of early and late weed removal times on some growth characters of sugar beet plants

At harvest, a sample of 10 plants was randomly taken from each plot to determine the following traits:-

1- Root length (cm).
2- Root diameter (cm).
3- Number of leaves/plant.
4- Leaves fresh weight (g/plant).
5- Root weight (g/plant).

III- Effect of early and late weed removal times on sugar beet yields:

Four guarded rows from each plot were taken to determine the following traits:-

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

Gross sugar yield = Root yield (ton/fed) x Sucrose (%)

IV. Effect of early and late weeds removal times on sugar beet juice quality:

1- Total Soluble Solids (T.S.S) % was determined using "hand refrectometer".
2- Sucrose% was determined as described by **Le-Docte (1927).**
3- Purity % was calculated according to the following equation:

$$\text{Purity \%} = \frac{\text{Sucrose \%}}{\text{T.S.S.\%}} \text{ X } 100$$

V- The relationship between dry weight of total annual weeds at the end growing season and root yield of sugar beet (ton/fed).

VI- The correlation between root yield, gross sugar yield and dry weight of total annual weeds in weed free and weed infestation:

Statistical analysis:

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" computer software package Duncan multiple range test was used for compare among treatment means **Duncan (1955).**

For determine critical period of weed competition in sugar beet, three approaches used as: -

1– 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).**

2- <u>Regression approach (mathematical models): -</u>

According to **Singh *et al.*, (1996)** the relationship between crop yields (Y) and duration of weed-free or weed-competition period (x) by either with liner function:

$$\tilde{y} = a + b\,x$$

where the parameters $\tilde{y}$ = expected yield, a and b represent intercept and slope of regression of yield on the duration, respectively, or by the quadratic function:

$$\tilde{y} = a + b\,x + c\,x^2$$

where the parameters b and c represent intercept and slope of regression of yield on the duration, $\tilde{y} = a + b\,x$ and a logistic function

$$\tilde{y} = A + C\,((1 + e\text{-}B(X - M))$$

where x is the 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.

3 - 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 variable cost, Gross income (GI), profitability and Benefit/cost ratio (B/C) according to **Heady and Dillon (1961),** where: -

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

Net income (NI) = Gross income – Total costs.

Profitability (P) = (Net income/Total costs) x 100.

Benefit/Costs Ratio (B/C) = Gross income/Total costs.

Part II: Effect of some weed control treatments on yield, yield components, quality of sugar beet and its associated weeds:

Two filed experiments were carried out at Mallawi Agricultural Research Station in 2009/10 and 2010/11 winter growing seasons includes fourteen weed control treatments were used as follows:

1. Triflusulfuron methyl (methyl 2-[4-dimethylamino-6-(2,2,2-trifluoroethoxy)-1,3,5-triazin-2-ylcarbamoylsulfamoyl]-m-toluate) known commercially as Safari 50 % WG[1] at the rate of 12 g/fad. applied at 21 days after planting (DAP) followed by clethodium ((E,E)-(±)-2-[1-[[(3-chloro-2-propenyl)oxy]imino]propyl]-5-[2-(ethylthio) propyl] -3-hydroxy-2-cyclohexen-1-one) known commercially as Select Super 12.5 % EC [2] at the rate of 300 cm^3/fed. applied at 24 DAP.

[1] WG = Wetable Granules
[2] EC = Emulsifiable Concentare

2. Phenmedipham (3-[(methoxycarbonyl) amino]phenyl (3-methylphenyl) carbamate + desmedipham (ethyl [3-[[(phenylamino) carbonyl]oxy] phenyl] carbamate) + ethofumesate ((±)-2-ethoxy-2,3-dihydro-3,3-dimethyl-5-benzofuranyl methane sulfonate) known commercially as Tegro 27.4% EC at the rate at the rate of 1L/fed applied at 21 DAP followed by Select Super 12.5 % EC at the rate of 300 cm^3/fed. applied at 24 DAP.
3. Phenmedipham ([3-[(methoxycarbonyl)amino] phenyl (3-methylphenyl) carbamate) known commercially as Beet Up 16% EC at the rate of 1L/fed applied at 21 DAP followed by Select Super 12.5 % EC at the rate of 300 cm^3/fed. applied at 24 DAP.
4. Metamitron (4-amino-4,5-dihydro-3-methyl-6-phenyl-1,2,4-triazin-5-one; 4-amino-3-methyl-6-phenyl-1,2,4-triazin-5(4H)-one) known commercially as Goltix 70% SC at the rate of 2L /fad. applied pre-planting.
5. Goltix 70% SC [3]at the rate of 2L /fad. pre planting followed by Beet Up 16% EC at the rate of 1L/fed applied at 21 DAP.
6. Goltix 70% SC at the rate of 2L /fad. pre-planting followed by Safari 50 % WG at the rate of 12 g/fad. applied at 21 DAP.
7. Goltix 70% SC at the rate of 2L /fad. pre-planting followed by Tegro 27.4% EC at the rate at the rate of 1L/fed applied at 21 DAP.

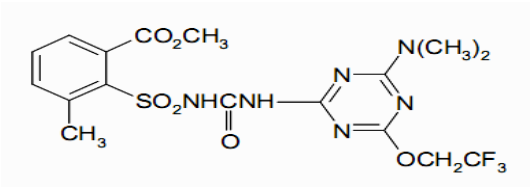
[3] SC = Soluble concentrate

8. Acetochlor (2-chloro-N-(ethoxymethyl)-N-(2-ethyl-6-methylphenyl) acetamide known commercially as Harness 84 % EC at the rate of 750 cm^3/fed. applied pre-planting.
9. Harness 84 % EC at the rate of 750 cm^3/fed. pre-planting followed by Beet Up 16% EC at the rate of 1L/fed applied at 21 DAP.
10. Harness 84 % EC at the rate of 750 cm^3/fed. pre-planting followed by Safari 50 % WG at the rate of 12 g/fad. applied at 21 DAP.
11. Harness 84 % EC at the rate of 750 cm^3/fed. pre-planting followed by Tegro 27.4% EC at the rate of 1L/fed applied at 21 DAP.
12. Hand hoeing twice at 20 and 40 days after planting.
13. Hand hoeing thrice at 20, 40 and 60 days after planting.
14. Un-weeded (control).

The experimental design and plot area as the first experiment.

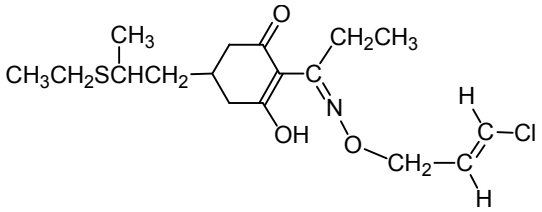
Herbicides chemical structure and mode of action Pesticide manual(2003):

Triflusulfuron-methyl



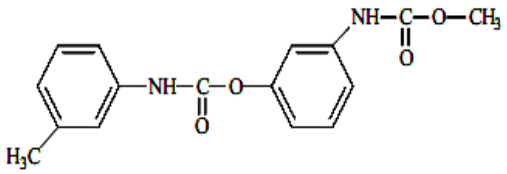
Inhibition of acetolactate synthase (ALS), an enzyme in branched-chain amino acid biosynthesis (Sulfonylurea) metabolized rapidly in sugar beet (half-life of 1 hour).

Clethodim



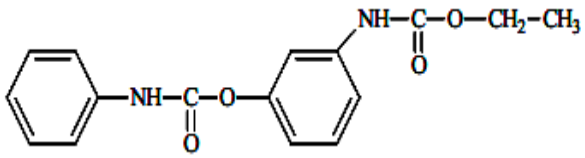
Inhibition of acetyle co-enzyme A caboxylase (ACCase), the first step in biosynthesis of fatty acids (CHD).

Phenmedipham



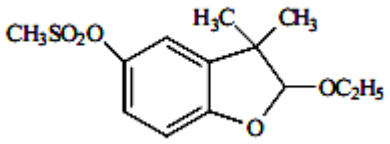
Inhibition of photosystem II by blocking electron transfer. This stops carbon dioxide fixation and production of ATP and NADPH2, which are needed for plant growth (phenylcarbamate).

Desmedipham



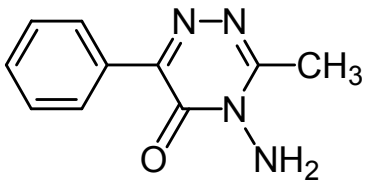
The same as Phenmedipham (phenylcarbamate).

Ethofumesate



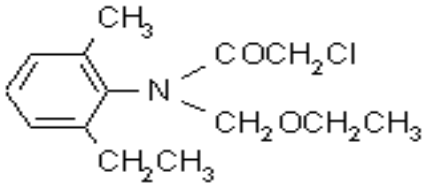
Inhibition of growth of meristems, retards cell division, and limits cuticle formation (Benzofuran).

Metamitron



Selective systemic herbicide, absorbed predominantly by the roots, but also by the leaves, with translocation acropetally

Acetochlor



Selective herbicide, absorbed mainly by the shoots and secondarily by the roots of germinating plants.

Sugar beet cultivar "Kwamera" (*Beta vulgaris* L.) was sown in 20th and 24th of October in 2009and 2010, respectively, on one ridge in hill and 15 cm apart between the hills. Harvested in 1st and 5 th of May in 2010 and 2011, respectively. The preceding summer crop was maize (*Zea mays* L.) in both seasons.

All agricultural practices of sugar beet cultivation were done as recommended as in the first experiment.

All herbicides treatments were sprayed with a knapsack sprayer equipped with one nozzle boom and the water volume was 200 L/fed.

Data recorded

During the growing seasons, the following data were recorded:-

I- Effect of weed control treatments on weeds:-

Weeds were hand pulled from one square meter chosen at random in each plot after 75 and 105 days After planting, identified and classified to annual broad and narrow leaved weeds to record the following traits:-

1- Dry weight of annual grassy weeds (g/m^2).
2- Dry weight of annual broad-leaved weeds (g/m^2).
3- Dry weight of total annual weeds (g/m^2).

Weeds were air-dried for seven days and then were oven dried at 70º C for 48 hr, until a constant weight was reached. The dry weight of weeds for each group (g/m^2) was recorded.

II- Effect of weed control treatments on some growth characters of sugar beet plants:

At harvest, a sample of 10 plants was randomly taken from each plot to determine the following traits:-

1- Root length (cm).
2- Root diameter (cm).
3- Number of leaves/plant.
4- Leaves fresh weight (g/plant).
5- Root weight (g/plant).

III- Effect of weed control treatments on sugar beet yields:

Four guarded rows from each plot were taken to determine the following traits:-

1. Top yield (ton/fed.)
2. Root yield (ton/ fed.).
3. Gross sugar yield (ton/fed.) was calculated according to the following equation:

   Gross sugar yield = Root yield x Sucrose %.

IV. Effect of weed control treatments on sugar beet juice quality:

1- Total Soluble Solids (T.S.S) % was determined using "hand refractmeter".

2- Sucrose% was determined as described by **Le-Docte (1927).**

3- Purity % was calculated according to the following equation:

$$\text{Purity \%} = \frac{\text{Sucrose \%}}{\text{T.S.S.\%}} \times 100$$

V- Residues analysis of tested herbicides:

Extraction of herbicides:

The residues of Safari (Triflusulfuron-methyl), Select Super (Clethodium), Tegro (Phenmedipham + Desmedipham + Ethofumesate), Beet up (Phenmedipham), Goltix (Metamitron) and Harness (Acetochlor) herbicides in roots of sugar beet were extracted according to the method of **EL-Beit *et al.* (1978)**. Fifty gram of each samples were homogenized in a blender and transferred into a shaking bottle (250 ml) with 150 ml of methylene-chloride. The bottles were shaken for one hour, then

the solvent was filtered through filter paper watman No. 1, and dried over anhydrous sodium sulphate. The filtrate was evaporated till dryness, and the residues were quantitatively transferred into small vials with (5 ml) acetone and kept at 10 °C for clean up. The resulting extract of root of sugar beet was cleared according to **Jarczyk (1983)**. The residues of Safari, Select Super, Tegro, Beet up, Goltix and Harness residues were measured by High Performance Liquid Chromatography (HPLC).

Clean up of herbicides

The clean up of Safari, Select Super, Tegro, Beet up, Goltix and Harness in extraction were carried out according to **Jarczyk (1983)**. Small amount of glass wool was placed into the bottom of a chromatographic column of 1.5 cm diameter, and half of the tube was filled methanol . 10 grams of silica gel were slurred with the solvent into the chromatographic column. Air bubbles were removed by a glass rod, and the 50 ml solvent were allowed to drain down until just covered the silica gel. The herbicides residues were dissolved in 10 ml of the solvent methanol and added to the top of the column. The residues of herbicide placed into measuring flasks of 10 ml of methanol.

Determination of active ingredient of tested herbicides:

The active ingredient for Safari, Select Super, Tegro, Beet up, Goltix and Harness were determined by HPLC instrument**.** A reverse phase high – performance liquid chromatographic was used for quantitative analysis Agilent Technologies 1260 infinity HPLC instrument equipped with degasser, quaternary pump, UV – DAD (Diodarray) Detector with rheodyne injection system and a computer (model vectra)

was used for analysis. The stationary phase consisted of Agilent Zorbax SB – C 18 packed stainless steel column (5µm (4.6 X 250 mm)).

VI- Correlation analysis between dry weight of weed classes (g/m^2) and yields of sugar beet:

Correlation between weed characteristics and sugar beet yields (root yield and gross sugar yield) were studied.

Statistical analysis

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" computer software package Duncan multiple range test was used for compare among treatment means **Duncan (1955).**

RESULTS AND DISCUSSION

The results of this study will be presented in two main parts and discussed as follows: -

Part I: Determination of the critical period of weed competition to sugar beet.

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., *Anagallus arvensis*, *Ammi majus* L., *Euphorbia helioscopia* and *Rumex dentatus* L. as annual broad-leaved weeds.

I- Effect of early and late weed removal times on weeds:

Table (3) reported that the dry weight of grassy, broad-leaved and total annual weeds g/m^2 at the end of growing season significantly affected by period of weed free (early weed removal) and weed infestation treatments (late weed removal), compared with weed infestation for whole season (weedy check). In weed free periods treatments allowed sugar beet free from weeds by removing all weed species in the first stage, then allowed weeds to grow with sugar beet plants until the end growing season (late weed competition), but in weed infestation treatment, (early weed competition) allowed weeds grow with sugar beet plant in the first stage, then weeds removal until the end growing season.

Table (2): Effect of early and late weed removal times on dry weight of grassy, broad-leaved and total annual weeds (g/m^2) in 2009/10 and 2010/11 winter seasons.

Treatments	Grassy weeds	Broad-leaved weeds	Total annual weeds
2009/10			
Weed free for whole season	0.67 e	6.67 e	7.33 f
Weed free for 2 WAE [(1)]	322.33 b	1190.0 b	1512.33 b
Weed free for 4 WAE	298.33 b	1061.0 bc	1359.67 b
Weed free for 6 WAE	221.00 c	833.33 c	1054.33 c
Weed free for 8 WAE	212.00 c	559.00 d	771.00 d
Weed free for 10 WAE	108.22 d	265.33 e	373.67 e
Weed free for 12 WAE	42.67 de	103.00 e	145.67 ef
Weed infestation for 2 WAE	0.0 e	0.33 e	0.33 f
Weed infestation for 4 WAE	1.67 e	2.77 e	4.43 f
Weed infestation for 6 WAE	27.00 e	1.93 e	28.93 f
Weed infestation for 8 WAE	0.0 e	29.67 e	29.67 f
Weed infestation for 10 WAE	0.0 e	6.57 e	6.56 f
Weed infestation for 12 WAE	18.00 e	10.17 e	28.17 f
Weed infestation for whole season	498.67 a	1883.33 a	2382.00 a
2010/11			
Weed free for whole season	6.67 f	14.00 d	20.67 h
Weed free for 2 WAE	510.67 b	721.00 b	1231.67 b
Weed free for 4 WAE	358.67 c	661.33 b	1020.00 c
Weed free for 6 WAE	259.67 d	286.67 c	546.33 d
Weed free for 8 WAE	136.00 e	284.00 c	420.00 e
Weed free for 10 WAE	98.00 e	134.00 d	232.00 f
Weed free for 12 WAE	78.67 ef	73.33 d	152.00 fg
Weed infestation for 2 WAE	12.33 f	18.33 d	30.67 h
Weed infestation for 4 WAE	0.67 f	17.00 d	17.67 h
Weed infestation for 6 WAE	6.77 f	63.00 d	69.77 gh
Weed infestation for 8 WAE	0.00 f	46.67 d	46.67 gh
Weed infestation for 10 WAE	13.00 f	53.00 d	66.00 gh
Weed infestation for 12 WAE	10.00f	90.00 d	100.00 gh
Weed infestation for whole season	684.33 a	1628.67 a	2313.00 a

([1]) WAE = weeks after emergence

Dry weight of grassy, broad-leaved weeds and total annual weeds (g/m^2) at the end growing seasons reduced significantly by increased weed free period, but the pervious traits decreased by reduce weed competition period. The difference between dry weight of grassy, broad-leaved and total annual weeds for weed infestation to 2, 4, 6, 8, 10 and 12 Weeks after sugar beet emergence (WAE) treatments and weed free for whole season was not significant in both seasons, due to removing all weeds at 12 WAE for respect of these treatments. These results may be due to weed survey after last treatments application in the experimental and increased weed infestation period then removal weeds until 12 weeks after emergence reduced dry weight of weeds at the time of survey in weed infestation treatments.

This decreased in dry weight of grassy, broad-leaved weeds and total annual weeds in weed removal and weed infestation period due to pulling all weed species in plots at different periods. In the late weed infestation removing all weed species in the first stage of sugar beet grow during the period of weed-free then allowed weed species grow with sugar beet to end of growing season, so increased dry weight of grassy, broad-leaved and total annual weeds with decreased weed free, but in case early weed competition period allow weed species grow with sugar beet plants in the first stage of sugar beet crop until the end period of weed competition then removal all weed species after this period until the end of growing season and

after 21 days after the last weed removal and last all treatments of this study application weed survey for recorded data of weeds. These results agreed with **Zlobin, (1987), Kropff *et al.* (1992) and Salehi *et al.* (2006).**

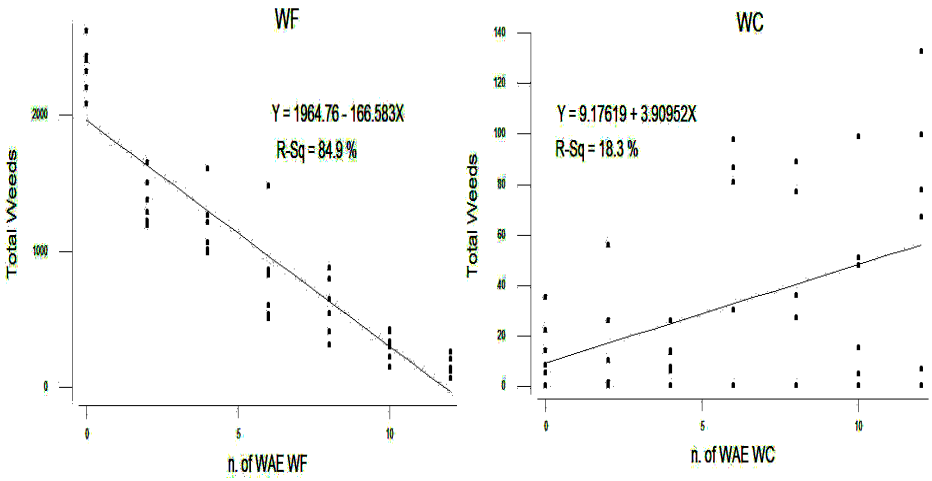


Fig. (1) The relationship between duration of weed free (WF) or weed infestation (WC) treatments and dry weight of total annual weeds (g/m^2) at end growing season.

Data presented in Fig (1) showed that the relationship between dry weight of total annual weeds g/m^2 at end of growing season in weed free treatments were linear and significant negative with prediction equation (R-sq value 84.9%), but the relationship between dry weight of total annual weeds g/m^2 at end growing season in weed infestation treatments were linear positive with prediction equation (R-sq value 18.3%) without any significance between all weed

infestation treatments except weed infestation for the whole season.

II- Effect of early and late weed removal times on some growth characters of sugar beet plants:

1- Root length (cm):

Data presented in Table (3) showed that root length (cm) significantly influenced by weed removal at different times in both seasons. The highest root length were obtained from weed free for 8 WAE and weed free for 10 WAE follow up weed infestation for 2 WAE, weed free for whole season, weed free for 12 WAE and weed infestation for 4 WAE in the first season, whereas, weed infestation for 4 WAE, weed free for 8 WAE, free for 10 WAE, weed free for whole season, weed infestation for 8 WAE, weed free for 12 WAE, weed infestation for 4 WAE and weed free for 12 WAE gave the highest values of this trait in the second season, but, the lowest value resulted from weed infestation for whole season followed by weed infestation for 12 WAE in first season and weed infestation for whole season in the second season .

Weed infestation for whole season caused reduction percentage in root length by 36.4 and 41.2%, compared to weed free for the whole season in 2009/10 and 2010/11, respectively. These results are in harmony with those obtained by **Farahbakhsh and Murphy (1986) and El-Zeny (1996).**

Table (3): Effect of early and late weed removal times on some growth characteristics of sugar beet plants in 2009/10 and 2010/11 winter seasons.

Treatments	Root length (cm)	Root diameter (cm)	Number of leaves	Leaves fresh weight (g)	Root weight (g)
2009-2010					
Weed free for whole season	40.53 abc	11.67 b	29.93 abc	425.3 bcd	1090.8 a
Weed free for 2 WAE [(1)]	31.00 d	5.47 f	25.33 c	278.3 e	184.1 g
Weed free for 4 WAE	36.20 c	6.80 e	28.26 abc	442.5 bcd	427.4 f
Weed free for 6 WAE	37.00 bc	7.27 ed	28.20 abc	302.3 de	492.9 f
Weed free for 8 WAE	42.33 a	10.67 b	27.27 bc	409.7 bcde	742.9 de
Weed free for 10 WAE	42.30 a	10.60 b	30.20 abc	483.0 abc	892.4 bc
Weed free for 12 WAE	39.40 abc	11.17 b	29.87 abc	397.0 bcde	968.8 ab
Weed infestation for 2 WAE	41.00 ab	12.93 a	32.53 ab	586.0 a	1022.9 ab
Weed infestation for 4 WAE	38.87 abc	10.93 b	34.33 a	409.7 bcde	1006.5 ab
Weed infestation for 6 WAE	37.83 bc	10.80 b	29.07 abc	385.9 bcde	824.9 cd
Weed infestation for 8 WAE	31.53 d	8.80 c	28.87 abc	320.5 de	493.3 f
Weed infestation for 10 WAE	32.03 d	8.80 c	25.10 c	364.1 cde	662.8 e
Weed infestation for 12 WAE	28.40 de	8.43 cd	27.27 bc	511.9 ab	461.5 f
Weed infestation for whole season	25.80 e	2.47 g	13.47 d	57.2 f	34.2 h
2010/11					
Weed free for whole season	40.20 a	13.23 a	46.77 a	911.0 a	2244.3 a
Weed free for 2 WAE	32.47 c	7.43 d	34.53 bc	495.7 d	301.0 h
Weed free for 4 WAE	35.43 bc	8.87 d	36.90 b	717.7 abc	650.7 fg
Weed free for 6 WAE	38.43 ab	10.93 bc	38.23 b	643.0 cd	1044.7 e
Weed free for 8 WAE	41.20 a	11.33 ab	35.13 bc	774.7 abc	1162.3 ed
Weed free for 10 WAE	40.73 a	9.20 cd	39.90 ab	753.0 abc	1324.0 d
Weed free for 12 WAE	39.10 ab	11.10 b	37.20 b	677.3 bcd	1808.0 bc
Weed infestation for 2 WAE	32.53 c	13.23 a	36.23 bc	816.7 abc	2013.0 b
Weed infestation for 4 WAE	42.10 a	12.23 ab	35.23 bc	760.7 abc	1639.3 c
Weed infestation for 6 WAE	38.57 ab	11.67 ab	34.77 bc	868.7 ab	1350.0 d
Weed infestation for 8 WAE	39.10 ab	12.37 ab	35.97 bc	876.3 ab	1143.3 ed
Weed infestation for 10 WAE	32.47 c	9.00 d	27.37 cd	211.7 e	824.1 f
Weed infestation for 12 WAE	32.00 c	8.07 d	22.67 d	234.3 e	575.0 g
Weed infestation for whole season	23.63 d	4.00 e	19.47 d	137.3 e	126.8 h

[(1)] WAE = weeks after emergence

2- Root diameter (cm):

Data in Table (3) revealed that the highest root diameter (cm) was resulted from weed infestation for 2 WAE in the first season. In the second season weed free for whole season follow by weed infestation for 2 WAE, weed infestation for 8 WAE, weed infestation for 4 WAE, weed infestation for 6 WAE and weed free for 2 WAE gave the highest values of this treat, on the other hand, the lowest root diameter were obtained from weed infestation for whole season.

Weed free for the whole season caused increased percentage in root diameter (cm) by 327.5 and 230.8%, in 2009/10 and 2010/11, compared to weed infestation for the whole season. Weed free for 2 WAE & weed infestation for 12 WAE the reduced root diameter (cm) by 53.1 & 27.8 and 43.8 & 39%, in 2009/10 and 2010/11 season, respectively, compared to weed free for the whole season.

3- Number of leaves/plant:

Table (3) presented means of number of leaves at harvest as affected by weed removal and weed infestation treatments in 2009/10 and 2010/11 seasons.

Results indicated that weed removal and weed infestation treatments could be arranged in a descending order with regard to their increasing effect in the following order:- weed infestation for 4 WAE, weed infestation for 2 WAE, weed free for 10 WAE, weed free all-season, weed free for 12 WAE, weed infestation for 6 WAE, weed infestation for 8 WAE, weed free

for 4 WAE, weed free for 6 WAE, weed infestation for 12 WAE and weed free for 8 WAE, weed free for 2 WAE, weed infestation for 10 WAE, weed infestation for whole season in 2009/10 season.

The highest increased in number of leaves were resulted from weed free whole season followed, weed free for 12 WAE, weed free for 10 WAE, weed free for 8 WAE, weed free for 6 WAE, weed free for 4 WAE and weed infestation for 2 WAE, weed infestation for 4 WAE, weed infestation for 6 WAE, weed infestation for 8 WAE, by 122,2, 121.75, 124.2, 102.44, 121.8, 109.4 and 141.5, 154.9, 115.8, 114.3 & 145.4, 91.1, 104.9, 80.4, 96.3, 89.5 and 86.1, 80.9, 78.6, 48.3 % in 2009/10 & 2010/11, respectively. The lowest number of leaves was obtained from weed infestation for whole season and weed infestation for 12 WAE in both seasons. Similar findings were obtained by **Farahbakhsh and Murphy (1986), El-Zeny (1996) and Jursik *et al.* (2008).**

4- Leaves fresh weight (g/plant):

Data in Table (3) reported that the highest leaves weight (g/plant) resulted from weed/sugar beet competition for 2 WAE in the first season and weed free for whole season in the second season, but, the lowest values were obtained from weed/sugar beet competition for whole seasons.

These increases in number of leaves/plant and leaves weight (g/plant) may be due to decreased competition between weeds and sugar beet plant and preventing shadow of weeds,

late oldness stage and late died old leaves on basic sugar beet plant and let sun light ray reaching soil surface which increased a photosynthesis process and accumulations materials resulted from photosynthetic process in root follow up increased the process of taking water and fertilizers from soil and absorption by sugar beet plants which increased plant enhance vegetative growth. Similar findings were obtained by **Farahbakhsh and Murphy (1986), El-Zeny (1996) and Jursik *et al.* (2008).**

5- Root weight (g/plant):

Results in Table (3) presented the means of root weight (g) 2009/10 and 2010/11. Results showed that weed removal treatments significantly increased the root weight of sugar beet plants in both seasons.

The highest root weight was resulted from weed free for whole seasons followed by weed infestation for 2 WAE, weed infestation for 4 WAE, and weed free for 12 WAE, while, the lowest value was obtained from weed infestation for whole season in 2009/10 season. Whereas, in the second season the highest values of this trait obtained form whole season weed free, meanwhile, the lowest root weight resulted from weed infestation for whole season followed by weed free for 2 WAE. These results may be due to increasing accumulation of elements in sugar beet root due to increased photosynthetic process at different times in weed free and weed infestation with reducing weeds dry weight. These results are in harmony with

those obtained by **Meyer and Widmer (1986), Rzozi *et al.* (1994) , Shaban *et al.* (2000) and Salehi *et al.* (2006).**

III- Effect of early and late weed removal times on sugar beet yields:

1- Top yield (ton/fed.):

Data presented in Table (4) stated the effect of weed removal and weed infestation on top yield (ton/fed) of sugar beet. Results showed that weed removal treatments significantly increased of top yield (ton/fed) in the first and second seasons. The highest top yield (ton/fed) was resulted from weed free for whole season and weed free for 4WAE in the first season, whereas, in the second season the highest vales of top yield obtained from Whole season weed free, Weed infestation for 4 WAE, Weed free for 8 WAE, Weed infestation for 8 WAE, Weed free for 6 WAE and Weed free for 10 WAE. Meanwhile, the lowest value was obtained from weed infestation for whole season in 2009/10 and 2010/11 seasons. Same findings were reported by **Osman *et al.* (1989) and Jursik *et al.* (2008).**

2- Root yield (ton/ fed.):

Root yield of sugar beet (ton/fed.) as affected by weed removal times are presented in Table (4).

Results indicated that root yield (ton/fed) significantly affected by weed removal times in both growing seasons. The weed removal and weed infestation treatments could be arranged in a descending order with regard to their increasing percentages in the following order:-

Table (4): Effect of early and late weed removal times on sugar beet yields in 2009/10 and 2010/11 winter seasons.

Treatments	Top yield (ton /fed.)	Root yield (ton /fed.)	Gross sugar yield (ton /fed.)
2009-2010			
Weed free for whole season	9.57 a	42.40 a	6.03 a
Weed free for 2 WAE [1]	8.73 a	6.83 g	1.01 fg
Weed free for 4 WAE	2.50 gh	7.33 fg	1.14 fg
Weed free for 6 WAE	2.83 fgh	12.00 e	1.68 ef
Weed free for 8 WAE	3.10 fg	25.03 c	3.69 c
Weed free for 10 WAE	5.10 d	28.50 c	4.25 c
Weed free for 12 WAE	4.77 de	36.20 b	5.58 ab
Weed infestation for 2 WAE	7.23 b	37.37 b	5.62 ab
Weed infestation for 4 WAE	6.56 bc	33.27 b	5.32 b
Weed infestation for 6 WAE	5.40 d	25.50 c	3.85 c
Weed infestation for 8 WAE	3.83 ef	17.13 d	2.40 d
Weed infestation for 10 WAE	7.6 b	15.17 de	2.24 de
Weed infestation for 12 WAE	5.77 cd	11.33 ef	1.65 ef
Weed infestation for whole season	1.8 h	5.6 g	0.78 g
2010/2011			
Weed free for whole season	11.57 a	44.25 a	7.01 a
Weed free for 2 WAE	6.87 e	11.22 hi	1.83 i
Weed free for 4 WAE	8.31 cde	18.76 fg	3.14 gh
Weed free for 6 WAE	10.13 abc	23.15 ef	3.77 efg
Weed free for 8 WAE	10.89 ab	26.63 de	4.25 def
Weed free for 10 WAE	9.69 abcd	28.16 de	4.53 de
Weed free for 12 WAE	9.08 bcde	34.37 bc	5.78 bc
Weed infestation for 2 WAE	9.07 bcde	37.60 b	6.27 ab
Weed infestation for 4 WAE	10.95 ab	36.16 b	5.64 bc
Weed infestation for 6 WAE	9.00 bcde	30.40 cd	4.93 cd
Weed infestation for 8 WAE	10.50 abc	29.68 cd	4.62 de
Weed infestation for 10 WAE	7.67 de	19.97 fg	3.42 fgh
Weed infestation for 12 WAE	4.64 f	14.93 gh	2.59 hi
Weed infestation for whole season	1.53 g	6.80 i	0.97 j

([1]) WAE = weeks after emergence

Weed free for whole season, weed infestation for 2 WAE, weed free for 12 WAE, weed infestation for 4 WAE, weed free for 10 WAE, weed infestation for 6 WAE, weed free for 8 WAE, weed infestation for 8 WAE, weed infestation for 10 WAE, weed free for 6 WAE, weed infestation for 12 WAE, weed free for 4 WAE and weed free for 2 WAE its increase percentages were 657.1, 567.3, 564.4, 494.1, 408.9, 355.4, 347.0, 205.9, 170.9, 114.3, 102.3, 30.9 and 22.0 %, respectively, as compared to weed infestation for whole season. Whereas, in 2010/11 season these the treatments could be arranged as follows: weed free for whole season, weed infestation for 2 WAE, weed infestation for 4 WAE, weed free for 12 WAE, weed infestation for 6 WAE, weed infestation for 8 WAE, weed free for 10 WAE, weed free for 8 WAE, weed free for 6 WAE, weed infestation for 10 WAE, weed free for 4 WAE, weed infestation for 12 WAE and weed free for 2 WAE its increment percentages were 550.7, 452.6, 431.8, 405.4, 347.1, 336.5, 314.1, 291.6, 240.4, 193.7, 175.9,119.6 and 65.0 %, respectively, as compared to whole season weed infestation. These results may be due to improved growth characters of sugar beet plants such as number and weight of leaves/plant, root length and diameter and increased root weight due to decreased weed competition for sugar beet plants. Similar results were also reached by **Abdollahian *et al.* (1998), Bosak and Mod (2000), Shaban *et al.* (2000), Dararas (2001), Salehi *et al.* (2006) and Odero *et al.* (2009).**

3- Gross sugar yield (ton/ fed.):

Data presented in Table (4) showed the effect of early and late removal of weeds on gross sugar yield (ton/fed.) in 2009/10 and 2010/11growing seasons.

The highest gross sugar yield (ton/fed.) was resulted from weed free for whole season, followed by weed infestation for 2 WAE and weed free for 12, but, the lowest value was obtained from weed infestation for whole season followed by weed free for 2 WAE and weed free for 4 WAE in 2009/10 season. In 2010/11 season the highest values of gross sugar yield (ton/fed) was obtained from weed free for whole season and weed infestation 2 WAE, whereas, the lowest value was obtained from whole season weed infestation. These results may be due to improved growth characters of sugar beet plants such as number and weight of green leaves/plant, root length and diameter and increased weight of root/plant (g/plant) and root yield (ton/fed) due to decreased dry weight of weed biomass (g/m^2) in sugar beet fields. The previous findings were in agreement with **Osman *et al.* (1989), Ferrero (1993), Alaoui *et al.* (2003) and Salehi *et al.* (2006).**

IV. Effect of early and late weeds removal times on sugar beet juice quality:

1- Total soluble solids (T.S.S. %):

Means of T.S.S. % of sugar beet as affected by various periods of weed free and weed infestation in both seasons are presented Table (5).

Results showed that in spite of non significant difference between weed removal treatments in the first season this trait was significantly affected in the second season. All weed removal treatments increased T.S.S. % without any significant difference between these treatments as compared to whole season weed competition. Similar findings obtained by **Fayed *et al.* (1999) and Bosak and Mod (2000).**

2- Sucrose %:

Means of sucrose percentage in sugar beet as affected by weed removal are shown in Table (5).

Data showed that weed removal treatments caused significantly increased sucrose % in the second season only. The highest sucrose % obtained from weed infestation for 12 WAE, weed infestation for 10 WAE, weed free for 12 WAE, weed free for 4 WAE and weed infestation for 2 WAE. These results confirmed the results obtained by **Fayed *et al.* (1999), Bosak and Mod (2000) and Alaoui *et al.* (2003).**

3- Purity (%):

Data presented in Table (5) indicated that Purity % of sugar beet increased without any significant difference between weed removal and weed infestation period in both seasons. These results are in agreement with those obtained by **Fayed *et al.* (1999) and Bosak and Mod (2000).**

Table (5) Effect of early and late weed removal times on sugar beet quality in 2009/10 and 2010/11 winter seasons.

Treatment	T.S.S. % [1]	Sucrose %	Purity %
2009-2010			
Weed free for whole season	21.33 a	16.74 a	78.68 a
Weed free for 2 WAE [2]	20.67 a	17.33 a	83.96 a
Weed free for 4 WAE	21.67 a	18.03 a	83.23 a
Weed free for 6 WAE	21.33 a	16.61 a	77.78 a
Weed free for 8 WAE	22.33 a	17.31 a	77.78 a
Weed free for 10 WAE	21.67 a	17.46 a	80.57 a
Weed free for 12 WAE	21.67 a	17.93 a	82.79 a
Weed infestation for 2 WAE	22.00 a	17.59 a	80.18 a
Weed infestation for 4 WAE	22.33 a	18.46 a	82.58 a
Weed infestation for 6 WAE	21.00 a	17.44 a	83.01 a
Weed infestation for 8 WAE	22.33 a	16.59 a	74.34 a
Weed infestation for 10 WAE	21.67 a	17.26 a	79.81 a
Weed infestation for 12 WAE	20.67 a	17.01 a	82.39 a
Weed infestation for whole season	21.67 a	16.47 a	76.08 a
2010/11			
Weed free for whole season	21.67 ab	18.41 ab	85.04 a
Weed free for 2 WAE	22.67 a	18.79 ab	82.81 a
Weed free for 4 WAE	22.67 a	19.25 a	84.93 a
Weed free for 6 WAE	21.67 ab	18.82 ab	86.85 a
Weed free for 8 WAE	21.67 ab	18.42 ab	85.10 a
Weed free for 10 WAE	22.67 a	18.58 ab	82.01 a
Weed free for 12 WAE	22.67 a	19.31 a	85.23 a
Weed infestation for 2 WAE	23.00 a	19.16 a	83.55 a
Weed infestation for 4 WAE	22.00 ab	18.14 ab	82.44 a
Weed infestation for 6 WAE	22.00 ab	18.74 ab	85.25 a
Weed infestation for 8 WAE	21.33 ab	18.09 ab	84.78 a
Weed infestation for 10 WAE	23.00 a	19.75 a	85.82 a
Weed infestation for 12 WAE	23.33 a	19.88 a	85.23 a
Weed infestation for whole season	20.00 b	16.53 b	82.46 a

[1] T.S.S % = Total soluble solids

[2] WAE = weeks after emergence.

V- The relationship between dry weight of total annual weeds at the end growing season and root yield of sugar beet (ton/fed).

The relationship between dry weight of total annual weeds at the end of growing season and root yield of sugar beet (ton/fed) under the experimental infestation by (10.0 and 9.7 ton/fed) was significantly negative in weed free and weed infestation treatments and prediction equation with R-sq value 82.3% & 73.1 % and 48.3% & 10.2% in 2009/10 season and 2010/11 season, respectively, Fig (2).

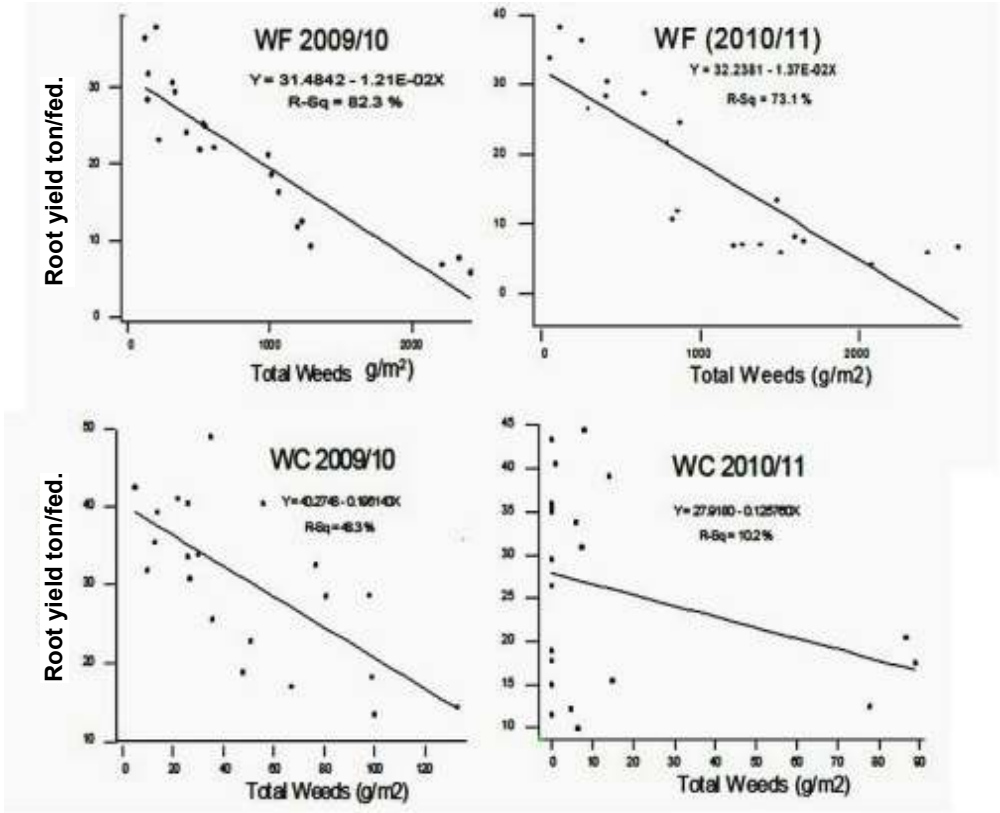


Fig. (2) The relationship between duration of weed free and weed infestation period treatments and dry weight of total annual weeds (g/m^2) at end growing season in 2009/10 and 2010/11 winter seasons.

These results may be due to increase photosynthetic process follow up increased accumulations products of photosynthesis in root of sugar beet plants at different times in weed free and weed infestation with reduced dry weight of weeds.

VI- The correlation between root yield, gross sugar yield and dry weight of total annual weeds in weed free and weed infestation:

Data in Table (6) presented that the relationship between dry weight of total annual weeds and root yield with weed free and weed infestation were significant negative in both seasons.

Table (6): The correlation between root yield (RYWF & RYWC), gross sugar yield (SYWF & SYWC) and dry weight of total annual weeds (DWTWF & DWTWC) in weed free and weed infestation treatments in 2000/10 and 2010/11 winter seasons.

Person correlation	WAE [7]	RYWF	RYWC	SYWF	SYWC	DWTWWF
2009/10						
DWTWWC [1]	0.248	-	-0.320 *	-	-0.344	-
DWTWWF [2]	-0.374 *	-0.855 **	-	-0.883 **	-	
SYWC [3]	-0.167	-	0.980 **	-		
SYWF [4]	0.300	0.9928**	-			
RYWC [5]	-0.285	-				
RYWF [6]	0.338					
2010/11						
DWTWWC	0.303	-	-0.895 **	-	-0.704 **	-
DWTWWF	-0.279	-0.907 **	-	-0.904 **	-	
SYWC	-0.414	-	0.977 **	-		
SYWF	0.285	0.994 **	-			
RYWC	-0.490 *	-				
RYWF	0.270					

[1] DWTWWC = Dry Weight of Total Annual Weed Competition
[2] DWTWWF = Dry Weight of Total Annual Weed Free.
[3] SYWC = gross Sugar Yield of Weed Competition.
[4] SYWF = gross Sugar Yield of Weed Free.
[5] RYWC = Root Yield of Weed Competition.
[6] RYWF = Root Yield of Weed Free.
[7] WAE= Weeks After Emergence.

The correlation coefficients were (-0.855 and -0.320) & (-0.907 and -0.895), in 2009/10 & 2010/11 seasons, respectively.

Data also showed that the relationship between dry weight of total annual weeds and gross sugar yield with weed free and weed infestation were significant negative in both seasons, the correlation coefficients (-0.883 and -0.344) & (-0.901 and -0.704) in 2009/10 & 2010/11 seasons, respectively.

Determining the critical period for weed/sugar beet competition:-

1– Classical biological approach:

Data presented in Fig (3) showed that the critical period of weed-sugar beet competition between 2 – 10 weeks after emergence, when the period which sugar beet can tolerate weeds only for 2 weeks from emergence and need prolonged period to be free from weeds for 10 weeks due to sugar beet crop is very weak competitor for weeds and grow slowly in the early growth stage in sugar. The optimum gross sugar yield was obtained when weeds were allowed to compete about 1 week as the gross sugar yield 6.03 and 7.01 ton/fed in 2009/10 and 2010/11 seasons.

This may be due to increased root yield (ton/fed) due to ability of sugar beet plant after 10 weeks to intercept the sunlight 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 10 weeks after emergence 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. These findings are in line with those obtained by **Deveikyte and Seibutis (2006), Odero *et al.* (2009)**, **Mirshekari *et al.* (2010)** and **Odero *et al.* (2010).**

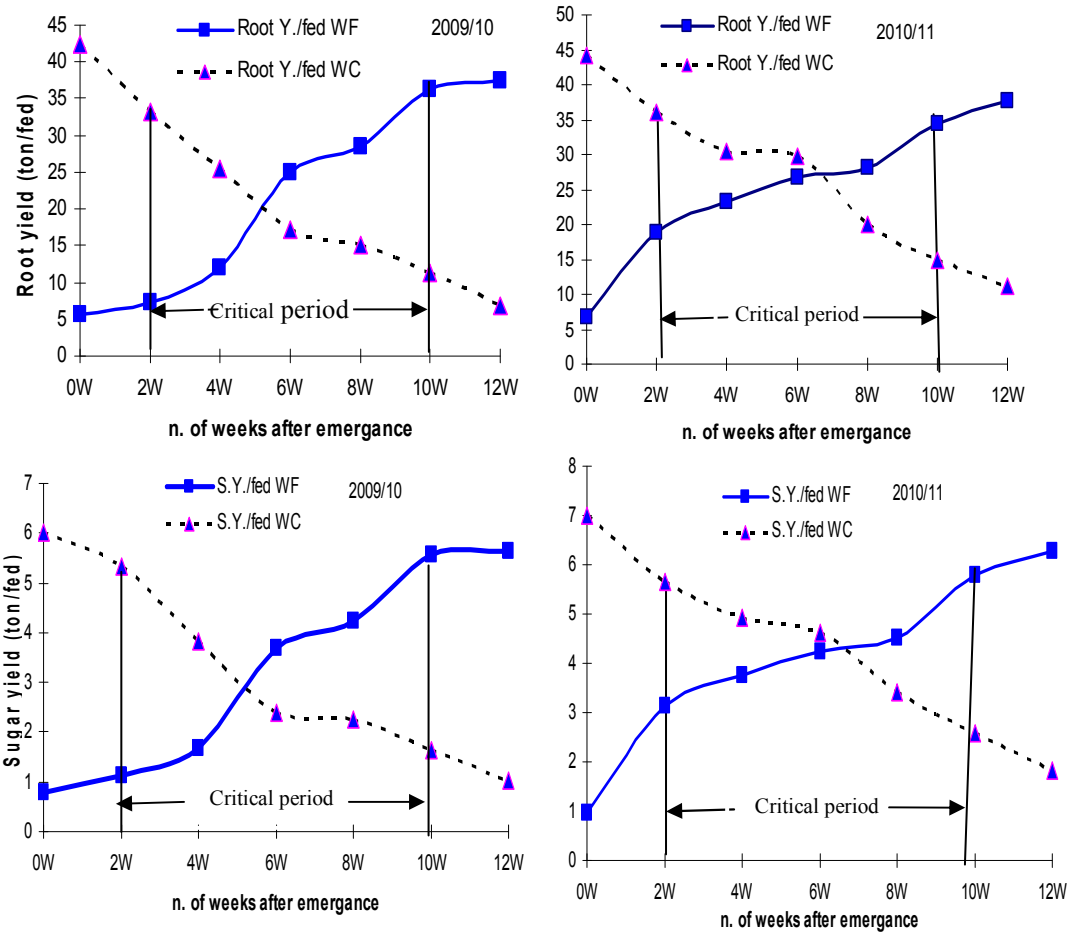


Fig. (3): The biological critical period of weed/sugar beet competition.

2– Regression approach (mathematical models):

Table (7) and Fig. (4) showed that the relationship between root yield (ton/fed) of sugar beet and period of weed removal was high significant with linear, logarithmic and quadratic models. The high value of R^2 as will as less standard error (SE) was obtained from quadratic model, under weed free & weed competition condition, respectively.

Table (7): The regression coefficient and their standard errors of three models used to determine the relationships between root yields with weed free and weed infestation treatments in 2009/10 and 2010/11 winter seasons.

Treatments	Linear		Quadratic		Logistic	
	R^2	SE	R^2	SE	R^2	SE
	2009/10 winter season					
Weed free	0.675	13.585	0.737	12.55	0.216	21.11
Weed infestation	0.501	23.15	0.663	19.533	0.040	32.109
F value weed free	41.63 **		26.618 **		5.523 *	
F value weed infestation	20.088 **		18.658 **		0.842	
	Fitted function quadratic model					
Weed free	$\acute{y} = 6.60048 + 3.03976X - 6.81E\text{-}02X^2$					
Weed infestation	$\acute{y} = 42.9446 - 1.48810X - 6.90E\text{-}02X^2$					
	2010/11 winter season					
Weed free	0.635	12.91	0.664	12.696	0.237	18.66
Weed infestation	0.490	20.77	0.617	18.47	0.025	28.723
F value weed free	34.778 **		18.815 **		6.204 *	
F value weed infestation	19.212 **		15.297 **		0.506	
	Fitted function for quadratic model					
Weed free	$\acute{y} = 4.78571 + 0.447024X + 0.190179X^2$					
Weed infestation	$\acute{y} = 43.4159 - 3.29762X + 4.60E\text{-}02X^2$					

Examining Table (7), it could be noticed that the best model fitted to the yield of weed free and weed infestation was quadratic. It had coefficient of determination (R^2) greater than those of the linear model and logistic. Moreover, values of

standard error estimate (SE) of quadratic equation were smaller than those of linear and logistic equation. Therefore, the quadratic model worked well for describing the relation between root yield of sugar beet and weeds under weed free and weed infestation in first and second seasons.

The relationship between root yield and duration of weed free was significant positive and prediction function with value R^2, (SE) 0.737 (12.55) and 0.663 (19.533) & 0.664 (12.696) and 0.617 (18.47) in the first and second seasons, respectively. These results confirm previous settles by contrast in the effect of weed interference period could be described by **Neito *et al.* (1968), Pardo *et al.* (1990)** and **Whish *et al.* (2002).**

Table (8) reported the expected root yield (ton/fed) under different times of weed free and weed infestation period in sugar beet crop. To determine the critical period of weed/sugar beet competition, the regression approach was used. Application equation reported that to maintain 95% of root yield (ton/fed) should be not allowed weeds to exceed 1- 2 one week after emergence. The same situation the late duration of weed free period should be not allowed weed to exceed 13-14 weeks after emergence. The relationship between root yield (ton/fed) and weeds/sugar beet competition and root yield was significantly negative effect in weed free and weed infestation treatments and prediction equation with R-sq value 94.6% & 98.8% and 94.2% & 89.6% in 2009/10 &2010/11 seasons, respectively. These results agreed with **Osman *et al.* (1989), Weaver *et al.* (1992**), **Rzozi *et al.* (1994)** and **Mesbah *et al.* (1995).**

Table (8): Estimation expected root yield under different weed free and weed infestation period treatments.

Period (Weeks)	Root yield (ton/fed.)			
	Weed free		Weed infestation	
	Root yield (ton/fed)	%	Root yield (ton/fed)	%
	2009/10			
	$\acute{y} = 6.601 + 3.038X - 6.81E\text{-}02X^2$		**$\acute{y} = 42.9446 - 1.49X - 6.90E\text{-}02X^2$**	
0	6.6	18.33	42.94	99.86
1	9.57	26.58	41.39	96.26
2	12.41	34.47	39.69	92.3
3	15.11	41.97	37.86	88.05
4	17.67	49.08	36.89	85.79
5	20.1	55.83	33.78	78.56
6	22.39	62.19	31.53	73.33
7	24.54	68.17	29.15	67.79
8	26.56	73.78	26.62	61.91
9	28.44	79.00	23.96	55.72
10	30.19	83.86	21.16	49.21
11	31.8	88.33	18.23	42.4
12	33.27	92.42	42.94	35.23
13	34.61	96.13	41.39	27.77
14	35.81	100	39.69	19.98
	2010/11			
	$\acute{y} = 4.786 + 0.447X + 0.1902X^2$		**$\acute{y} = 43.4159 - 3.298X + 4.60E\text{-}02X^2$**	
0	4.79	9.91	43.42	97.59
1	5.42	11.22	40.16	94.06
2	6.44	13.33	37	90.07
3	7.84	16.25	33.94	86.05
4	9.62	19.91	30.96	83.84
5	11.78	24.38	28.08	76.77
6	14.31	29.62	25.27	71.66
7	17.23	35.66	22.59	66.25
8	20.53	42.48	19.98	60.5
9	24.21	50.1	17.46	54.45
10	28.27	58.51	15.07	48.09
11	32.71	67.69	12.71	41.43
12	37.53	77.45	10.47	34.43
13	42.74	88.45	8.32	27.14
14	48.32	100	6.27	19.52

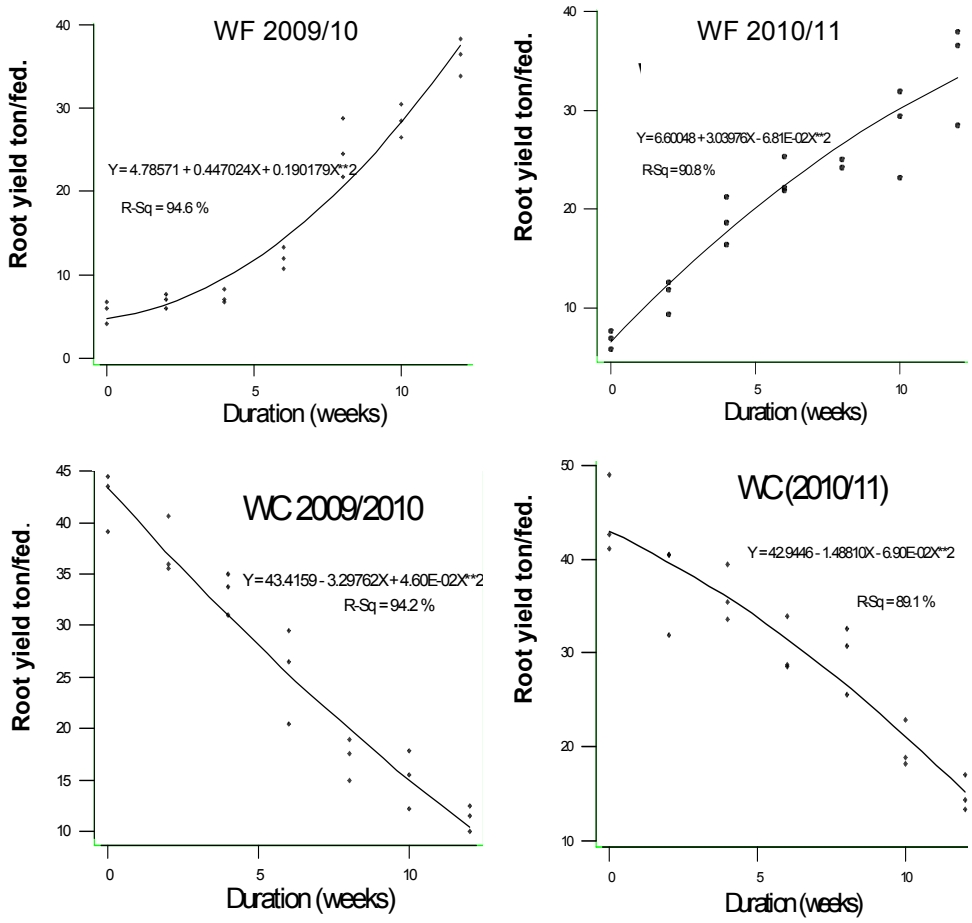


Fig. (4): The relationship between duration of weed free (WF) as well as weed infestation (WC) treatments and root yield of sugar beet (ton/fed).

Table (9) showed that the relationship between gross sugar yield (ton/fed) of sugar beet and period of weed removal was high significantly with linear, logarithmic and quadratic models. The high value of R^2 as will as less stander error (SE) was obtained from quadratic model, under weed free & weed infestation condition, respectively. The results in Table (9), showed that the best model fitted to the gross sugar yield

(ton/fed) of weed free and weed infestation was quadratic. It had coefficient of determination (R^2) greater than those of the linear model and logistic. Moreover, values of standard error estimate (SE) of quadratic equation were smaller than those of linear and logistic equation. There fore, the quadratic model worked well for describing the relation between gross sugar yield and weed complex under weed free and weed infestation in the 2009/10 and 2010/11 seasons.

Table (9): The regression coefficient and their standard errors of three models used to determine the relationships between sugar yield of sugar beet with weed free and weed infestation in 2009/10 and 2010/11 winter seasons.

Treatments	Linear		Quadratic		Logistic	
	R^2	SE	R^2	SE	R^2	SE
	2009/10 winter season					
Weed free	0.611	2.004	0.643	1.969	0.227	2.824
Weed infestation	0.522	3.003	0.643	2.662	0.04	4.256
F value weed free	31.372 **		17.114 **		5.877 *	
F value weed infestation	21.824 **		17.122 **		0.830	
	Fitted function quadratic model					
Weed free	$Y = 0.712960 + 3.86E\text{-}02X + 3.17E\text{-}02X^2$					
Weed infestation	$Y = 6.30614 - 0.402149X - 4.32E\text{-}04X^2$					
	2010/11 winter season					
Weed free	0.676	2.224	0.73	2.08	0.220	3.453
Weed infestation	0.533	3.604	0.680	3.059	0.047	5.148
F value weed free	41.769 **		25.744 **		5.625 *	
F value weed infestation	22.812 **				0.992	
Fitted function for quadratic model						
Weed free	$Y = 1.00937 + 0.500899X - 1.05E\text{-}02X^2$					
Weed infestation	$Y = 6.91466 - 0.266435X - 7.54E\text{-}03X^2$					

Data in Table (9) reported that the relationship between gross sugar yield and duration of weed free was significant positive and prediction equation with R^2 value, (SE) 0.643, (1.969) and 0.643 (2.662) & 0.73 (2.08) and 0.69 (3.059) in

2009/10 and 2010/11 seasons. These results confirm previous settles by contrast in the effect of weed interference period could be described by **Heady and Dillon (1961).**

3 – **Economic approach**:

Economic analysis data presented in Table (10) and Fig (5) 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 of weed control about 300 L.E /fed for one hand hoeing. The total cost increased with increasing number of weed removal due to cost of hand weeding. Gross income increased significantly by increasing the period of weed free or by decreased the period of weed infestation. This increased in gross income due to increasing root yield/fed by decreasing weed interference with 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 whole season, whereas, weed infestation for whole season was lower in total cost and give lower gross income due to decreased root yield, due to weed infestation on sugar beet plants under infestation level of (10 and 9.7 ton/fed dry weight of total annual weeds in 2009/10 and 2010/11 seasons). This increased of gross income and net income due to increase root yield of sugar beet due to decreased the period of weed-sugar beet interference.

Table (10): The effect of early and late removal of weeds on sugar beet juice quality on economic analysis in 2009/10 and 2010/11 winter seasons.

Treatments	Total costs	Gross income	Net income	Profitability	Benefit/cost ratio
		2009/10			
Weed free for whole season	7095	12296 a	5201.0 a	73.31 a	1.73 a
Weed free for 2 WAE (1)	5295	1981.7 g	- 3313.3 f	- 62.58 f	0.37 f
Weed free for 4 WAE	5595	2126.7 gf	- 3468.3 f	- 61.99 f	0.38 f
Weed free for 6 WAE	5895	3480.0 e	- 2415 ef	- 40.97 e	0.59 e
Weed free for 8 WAE	6195	7259.7 c	1064.7 c	17.19 c	1.17 c
Weed free for 10 WAE	6495	8265.0 c	1770.0 c	27.25 c	1.27 c
Weed free for 12 WAE	6795	10836.3 b	3703.0 b	54.5 ab	1.54 ab
Weed infestation for 2 WAE	6795	10836.3 b	4041.3 a	59.47 ab	1.60 ab
Weed infestation for 4 WAE	6495	9647.3 b	3152.3 b	48.53 b	1.48 b
Weed infestation for 6 WAE	6195	7395.0 c	1200.0 c	19.37 c	1.19 c
Weed infestation for 8 WAE	5895	4968.7 d	- 426.30 d	- 15.71 d	0.84 d
Weed infestation for 10 WAE	5595	4398.3 d	- 1196.7 ed	- 21.39 de	0.78 ed
Weed infestation for 12 WAE	5295	3286.7 ef	- 2008.3 ed	- 37.93 e	0.62 e
Weed infestation for whole season	4995	1624.0 g	- 3468.3 f	- 67.49 f	0. 32 f
		2010/11			
Weed free for whole season	7095	15046.1a	7951.1 a	112.07 a	2.12 a
Weed free for 2 WAE	5295	3814.8 hi	- 1480.2 di	- 27.95gh	0.72 gh
Weed free for 4 WAE	5595	6378.4 gf	783.40 gh	14.00 ef	1.14 ef
Weed free for 6 WAE	5895	7869.9 ef	1974.9 efg	33.5 de	1.33 ed
Weed free for 8 WAE	6195	9053.1 de	2858.1 def	46.14 cd	1.46 cd
Weed free for 10 WAE	6495	9574.4 de	3079.4 cde	47.41 cd	1.47 cd
Weed free for 12 WAE	6795	11686.9 bc	4891.9 bc	71.99 bc	1.72 bc
Weed infestation for 2 WAE	6795	12784.0 b	5989.0 b	88.14 ab	1.88 ab
Weed infestation for 4 WAE	6495	12294.4 b	5499.4 b	89.29 ab	1.89 ab
Weed infestation for 6 WAE	6195	10336.0 cd	4141 bcd	66.84 bc	1.67 bc
Weed infestation for 8 WAE	5895	10091.2 cd	4196.2 bcd	71.18 bc	1.71 bc
Weed infestation for 10 WAE	5595	6788.7 gf	1193.7 ghf	21.33 def	1.21 def
Weed infestation for 12 WAE	5295	5077.3 gh	- 217.70 hi	- 4.11fg	0.96 fg
Weed infestation for whole season	4995	2312.0 i	- 2683.0 j	-53.71 h	0.46 h

(1) WAE = Weeks After Emergence

According to these results economic critical period of weed competition was found between 4–10 Weeks after sugar beet emergence Fig (5). 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.* (1996) and Heady and Dillon (1961)**.

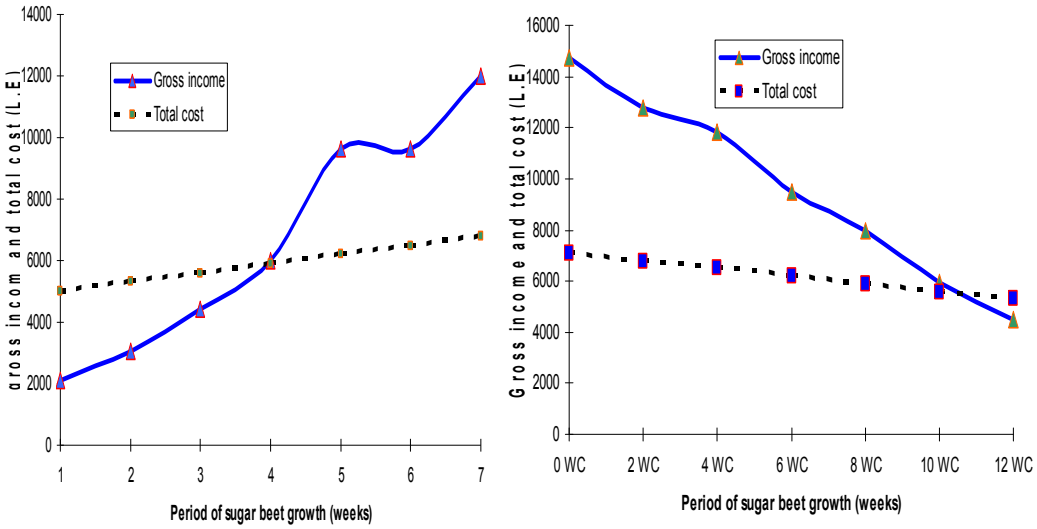


Fig. (5): The relationship between total cost and gross income under different duration of weed free or weed infestation.

Part II: Effect of some weed control treatments on yield, yield components, quality of sugar beet and its associated weeds.

I- Effect of weed control treatments on weeds:-

The dominant weed species in field experiments in both seasons were *Avena* spp., *Phalaris* spp. as annual grassy weeds, *Brassica nigra* L., *Chenopodium* sp., *Sonchus oleraceus* L., *Medicago polymorpha* L., *Melilotus indica* L., *Anagallus arvensis*, *Ammi majus* L., *Euphorbia helioscopia* and *Rumex dentatus* L. as annual broad-leaved weeds.

1 – Dry weight of annual grassy weeds (g/m^2):

Results in Table (11) and Fig (6a and 6b) reported that all weed control treatments statistically significant reduced dry weight of annual grassy weeds (g/m^2) in both seasons at 75 and 105 DAP[(4)]. Hand hoeing thrice and twice times recorded the lowest value of dry weight of annual grassy weeds in both seasons and different surveys time (75 and 105 DAP), followed by Tegro followed by Select Super, Beet Up followed by Select Super, Safari followed by Select Super, Harness followed by Safari, Harness followed by Beet Up, Harness followed by Tegro and Harness, but, the highest value of dry weight of annual grassy weeds were resulted from unweeded check plots.

Reduction percentage in annual grassy weeds at 75 & 105 DAP due to the application of hand hoeing thrice, hand hoeing twice, Tegro followed by Select Super, Beet Up followed by Select Super, Safari followed by Select Super, Harness followed by Safari, Harness followed by Beet Up, Harness followed by Tegro, Harness, Goltix followed by Beet Up, Goltix followed by Safari, Goltix followed by Tegro and

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([4]) DAP = Days After Planting

Goltix were 98.5 & 93.6, 96.8 & 91.1, 96.3 & 95.2, 94.6 & 92.1, 92.3 & 94.1, 83.6 & 81.2, 82.6 & 82.7, 76.3 & 78.9, 71.2 & 76.1, 67.2 & 63.3, 56.3 & 51.2, 48.6 & 47.3 and 46.3 & 35.0 in first season.

Table (11): Effect of weed control treatments on dry weight of annual grassy weeds (g/m^2) at 75 and 105 days after planting in 2009/10 and 2010/11 winter seasons.

Treatments	At 75 DAP[(1)]	% control	At 105 DAP	% control
2009/ 2010				
Safari followed by Select Super	29.4 fg	**92.3**	41.9 f	**94.1**
Tegro followed by Select Super	14.1 g	**96.3**	33.9 f	**95.2**
Beet Up followed by Select Super	20.6 fg	**94.6**	55.8 f	**92.1**
Goltix	204.6 b	**46.3**	459.2 b	**35.0**
Goltix followed by Beet Up	125.0 bcde	**67.2**	259.3 d	**63.3**
Goltix followed by Safari	166.5 bcd	**56.3**	344.8 c	**51.2**
Goltix followed by Tegro	195.8 bc	**48.6**	372.3 c	**47.3**
Harness	109.7 cde	**71.2**	168.6 e	**76.1**
Harness followed by Beet Up	66.4 efg	**82.6**	122.2 e	**82.7**
Harness followed by Safari	62.5 efg	**83.6**	132.8 e	**81.2**
Harness followed by Tegro	90.3 defg	**76.3**	149.1 e	**78.9**
Hand hoeing twice	12.2 g	**96.8**	63.2 f	**91.1**
Hand hoeing thrice	5.7 g	**98.5**	45.5 f	**93.6**
Unweeded	381 .0 a	**0.0**	706.5 a	**0.0**
2010/11				
Safari followed by Select Super	18.2 e	**96.3**	85.5 g	**91.0**
Tegro followed by Select Super	33.5 e	**93.2**	51.8 g	**94.5**
Beet Up followed by Select Super	23.1 e	**95.3**	102.5 g	**89.2**
Goltix	247.0 b	**49.8**	512.7 b	**46.0**
Goltix followed by Beet Up	157.9 bcd	**67.9**	348.5 de	**63.3**
Goltix followed by Safari	185.5 bcd	**62.3**	404.5 cd	**57.4**
Goltix followed by Tegro	226.8 bc	**53.9**	452.9 bc	**52.3**
Harness	110.2 de	**77.6**	245.0 f	**74.2**
Harness followed by Beet Up	124.0 cde	**74.8**	226.0 f	**76.2**
Harness followed by Safari	90.5 de	**81.6**	207.0 f	**78.2**
Harness followed by Tegro	113.7 de	**76.9**	277.3 ef	**70.8**
Hand hoeing twice	15.7 e	**96.8**	94.6 g	**90.0**
Hand hoeing thrice	13.8 e	**97.2**	61.3 g	**93.5**
Unweeded	492.0 a	**0.0**	949.5 a	**0.0**

[(1)] DAP = Days After Planting

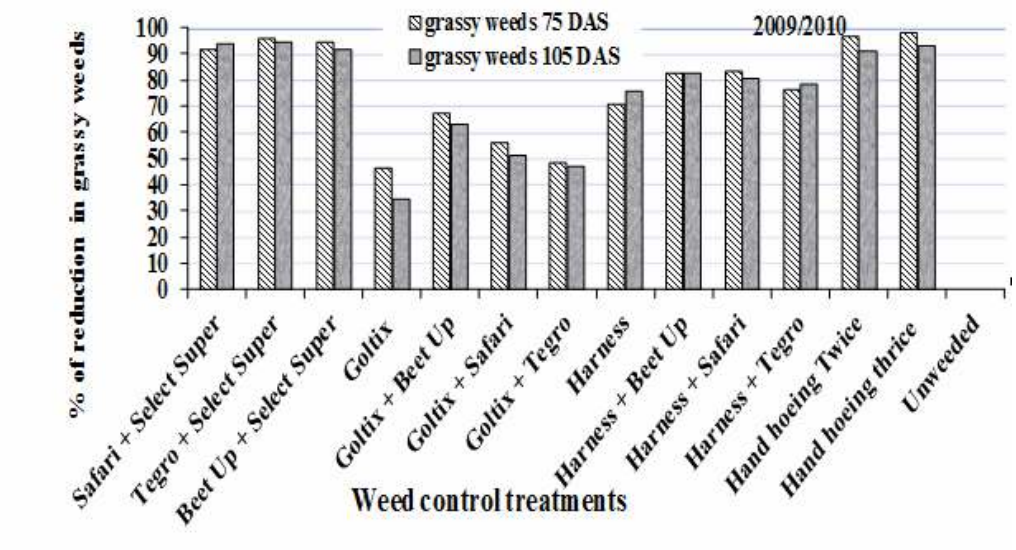

Fig (6 a): The reduction percentages in dry weight of annual grassy weeds (g/m^2) due to weed control treatments at 75 and 105 days after planting in 2009/10 winter season.

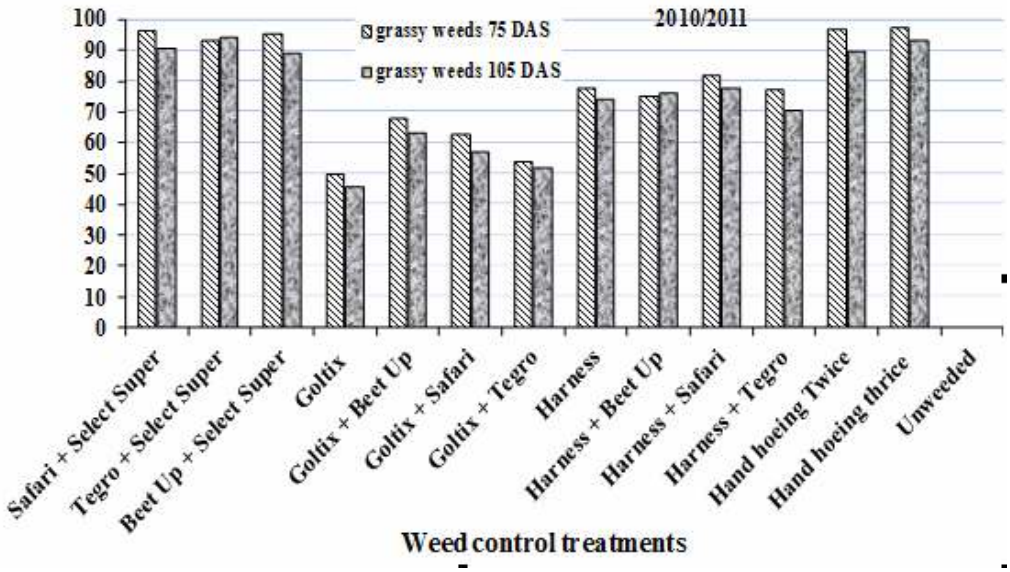

Fig (6 b): The reduction percentages in dry weight of annual grassy weeds (g/m^2) due to weed control treatments at 75 and 105 days after planting in 2010/11 winter season.

Whereas in the second season the reduction percentages were 97.2 & 93.5, 96.8 & 90.0, 93.2 & 94.5, 95.3 & 89.2, 96.3 & 91.0, 81.6 & 78.2, 74.8 & 76.2, 76.9 & 70.8, 77.6 & 74.2, 67.9 & 63.3, 62.3 & 57.4, 53.9 & 52.3 and 49.8 & 46.0, respectively, compared with unweeded check plots. The increases in control percentages of annual grassy weeds due to killing annual grassy weeds by hand hoeing twice or thrice as will as by adding herbicide (Select Super) with broad-leaved weeds herbicides such as Safari, Tegro, Beet up due to enhanced toxicity for annual grassy weeds by adding graminicide (Select Super) with broad-leaved herbicides without any significant difference between different broad-leaved herbicides under study, but, added herbicides specific for controlling total annual grassy and broad-leaved such as (Goltix and Harness) with specific broad-leaved herbicides (Beet up, Safari, Tegro) gave less enhanced toxicity for annual grassy weeds than added graminicide under study with broad-leaved weeds herbicides under study.

Using Harness alone was effective on killing annual grassy weeds than using Goltix alone or with broad-leaved weed herbicides. Using Safari broad-leaved herbicide with Harness for total annual weeds herbicide together gave enhanced toxicity on annual grassy weeds control, but, without any significant between resulted from used Harness with Beet up or Tegro or Harness alone. Similar results recorded by **Gabibullaev (1996), Gonik and Val'ko (1996), Tyla and Petroviene (1996), Deveikyte (1997b), Tezuka *et al.* (1997) and Deveikyte (2005).**

2 – Dry weight of annual broad-leaved weeds (g/m^2):

Results in Table (12) and Fig (7 a and 7 b) showed that the effect of weed control treatments on annual broad-leaved in sugar beet at 75 and 105 DAP in 2009/10 and 2010/11 winter seasons.

Presented results revealed that weed control treatments had a significant effect on dry weight of annual broad-leaved weeds (g/m^2) in both seasons at 75 and 105 DAE. In 2009/ 2010 season the lowest values of dry weight of annual broad-leaved weeds were obtained from hand hoeing thrice follow by hand hoeing twice, Harness followed by Safari, Safari followed by Select Super, Goltix followed by Tegro, Harness followed by Tegro, Goltix followed by Safari and Tegro followed by Select Super.

The highest weed control percentage at 75 DAP, 98.1 & 97.2 was resulted from hand hoeing thrice & hand hoeing twice, meanwhile, the reduction percentage with Harness followed by Safari, Safari followed by Select Super, Goltix followed by Tegro, Harness followed by Tegro, Goltix followed by Safari and Tegro followed by Select Super (90.2, 83.9, 83.6, 83.2, 82.3 and 80.1%), on the other hand the lowest weed control percentage was obtained from Goltix (44.2%), followed by Goltix followed by Beet Up, Beet Up followed by Select Super, Harness followed by Beet Up and Harness (61.2, 62.3, 68.2 and 72.3%), compared with unweeded check.

Table (12): Effect of weed control treatments on dry weight of annual broad-leaved weeds (g/m^2) at 75 and 105 DAP in 2009/10 and 2010/11 winter seasons.

Treatments	At 75 DAP [1]	% control	At 105 DAP	% control
	2009/ 2010			
Safari followed by Select Super	111.7 efg	**83.9**	320.8 fg	**80.2**
Tegro followed by Select Super	138.1 def	**80.1**	383.9 ef	**76.3**
Beet Up followed by Select Super	261.6 c	**62.3**	670.7 c	**58.6**
Goltix	387.3 b	**44.2**	950.9 b	**41.3**
Goltix followed by Beet Up	269.3 c	**61.2**	526.5 d	**67.5**
Goltix followed by Safari	122.8 ef	**82.3**	233.3 gh	**85.6**
Goltix followed by Tegro	113.8 efg	**83.6**	314.3 fg	**80.6**
Harness	192.2 cde	**72.3**	563.8 d	**65.2**
Harness followed by Beet Up	220.7 cd	**68.2**	481.1 dc	**70.3**
Harness followed by Safari	68.0 fgh	**90.2**	189.5 h	**88.3**
Harness followed by Tegro	116.6 efg	**83.2**	277.0 fgh	**82.9**
Hand hoeing twice	19.4 gh	**97.2**	72.9 hi	**95.5**
Hand hoeing thrice	13.2 h	**98.1**	35.6 i	**97.8**
Unweeded	694.0 a	**0.0**	1620.0 a	**0.0**
	2010/11			
Safari followed by Select Super	96.2 fg	**81.4**	264.1 def	**79.6**
Tegro followed by Select Super	111.2 efg	**78.5**	287.4 de	**77.8**
Beet Up followed by Select Super	216.1 c	**58.2**	565.7 c	**56.3**
Goltix	271.4 b	**47.5**	717.2 b	**44.6**
Goltix followed by Beet Up	177.8 cd	**65.6**	402.6 d	**68.9**
Goltix followed by Safari	92.0 fg	**82.2**	242.1 ef	**81.3**
Goltix followed by Tegro	101.3 fg	**80.4**	306.8 de	**76.3**
Harness	158.7 de	**69.3**	384.5 de	**70.3**
Harness followed by Beet Up	146.8 def	**71.6**	397.4 de	**69.3**
Harness followed by Safari	38.8 h	**92.5**	126.9 fg	**90.2**
Harness followed by Tegro	64.6 gh	**87.5**	265.4 def	**79.5**
Hand hoeing twice	24.3 h	**95.3**	112.3 fg	**91.3**
Hand hoeing thrice	14.5 h	**97.2**	52.0 g	**96.0**
Unweeded	517.0 a	**0.0**	1294.5 a	**0.0**

[1] DAP = Days After Planting

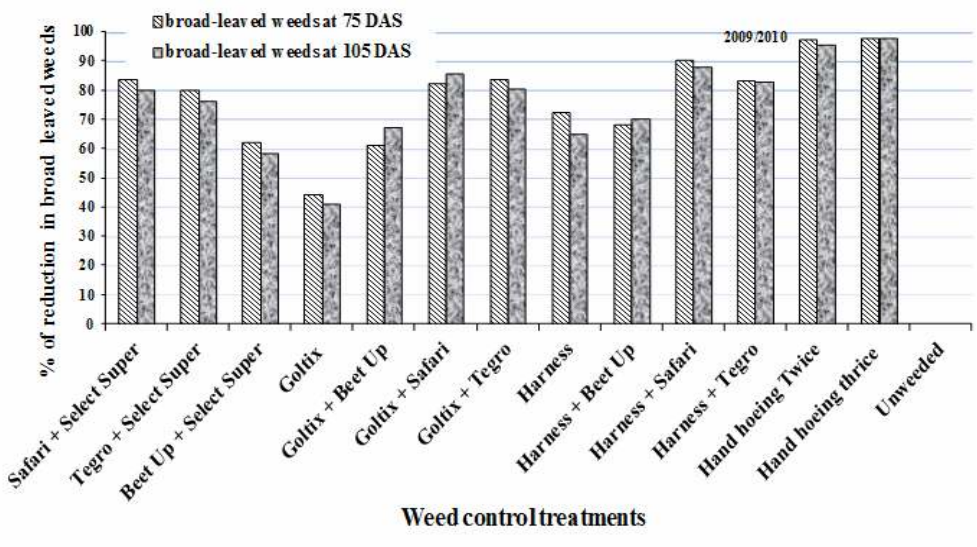

Fig (7 a): The reduction percentages in dry weight of annual broad-leaved weeds (g/m^2) due to weed control treatments at 75 and 105 days after planting in 2009/10 winter season.

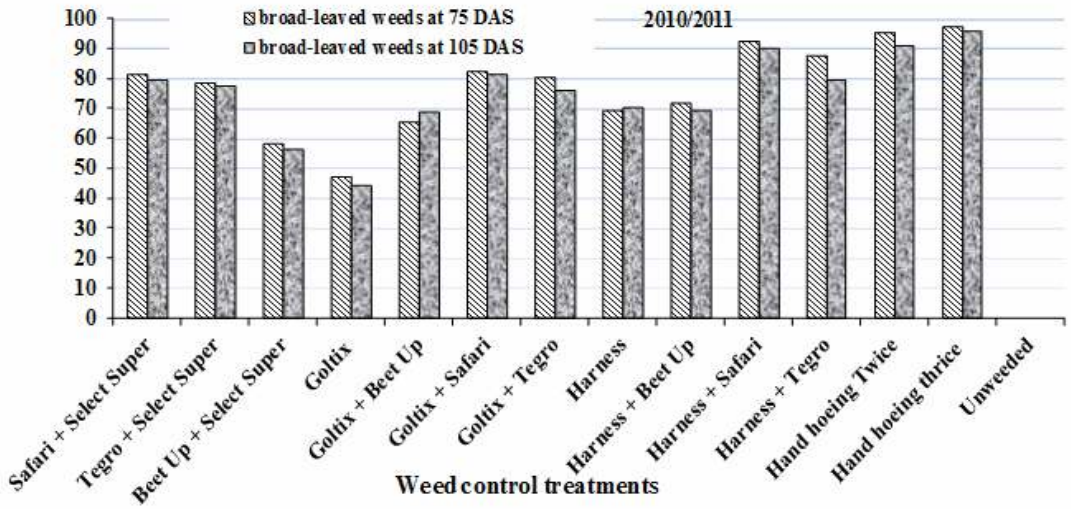

Fig (7 b): The reduction percentages in dry weight of annual broad-leaved weeds (g/m^2) due to weed control treatments at 75 and 105 days after planting in 2010/11 winter season.

The same trend in the second survey in 2009/10 season, first and second survey in 2010/11 season. The reduction in dry weight of annual broad-leaved weeds herbicides treatments may be due to pulling weeds by hand hoeing or killing weeds by using herbicides, adding annual broad-leaved weeds herbicides such as Safari or Tegro increased with specific herbicide for controlling total annual weeds enhanced toxicity of annual broad-leaved weeds, Application of Harness alone was effective than Goltix alone as will as using two herbicides together were effective than one herbicide due to less competition ability of sugar beet than weeds due to low growth of sugar beet in the first stage and the length of critical period of weed/sugar beet competition. These results are in agreement with those obtained by **Gamuev *et al.* (1994), Yukhin and Absatrov (1996), Bosak and Janos (1997), Rapparini (1997), Montemurro *et al.* (1998), Chetin *et al.* (2008) and Abo El-Hassan Rasha (2010).**

3– Dry weight of total annual weeds (g/m^2):

Data in Table (13) and Fig (8 a and 8 b) showed that the effects of weed control treatments on total annual weeds.

Results clearly indicated that weed control treatments significantly affected the dry weight of total annual weeds (g/m^2) in both seasons at 75 and 105 DAP.

Hand hoeing thrice and hand hoeing twice recorded the lowest values of dry weight of total annual weeds at different surveys time (75 and 105 DAP) in both seasons followed by Harness followed by Safari, Safari followed by Select Super,

Tegro followed by Select Super, Harness followed by Tegro, Goltix followed by Safari, Harness followed by Beet Up, Goltix followed by Tegro, Beet Up followed by Select Super, Harness, Goltix followed by Beet Up and Goltix but, the highest value in dry weight of total annual weeds were obtained from unweeded check plots.

The highest reduction percentages in total annual weeds at 75 & 105 DAP due to the application of hand hoeing thrice, hand hoeing twice, Harness followed by Safari, Safari followed by Select Super, Tegro followed by Select Super, Harness followed by Tegro, Beet Up followed by Select Super, Harness followed by Beet Up, Goltix followed by Safari, Harness and Goltix followed by Tegro, was 98.2 & 96.5, 97.1 & 94.2, 87.9 & 86.1, 86.9 & 84.4, 80.8 & 81.7, 73.7 & 68.8, 73.3 & 74.1, 73.1 & 75.2, 71.9 & 68.5 and 71.2 & 70.5, respectively. Meanwhile, the lowest reduction percentage was obtained from Goltix followed by Beet Up and Goltix, 44.9 & 39.4 and 63.3 & 66.2 in 2009/10. In 2010/11 the highest reduction percentage resulted from hand hoeing thrice, hand hoeing Twice, Safari followed by Select Super, Harness followed by Safari, Tegro followed by Select Super, Harness followed by Tegro, Beet Up followed by Select Super, Harness, Harness followed by Beet Up, Goltix followed by Safari, 97.2 & 95.0, 96.0 & 90.8, 88.7 & 84.4, 87.2 & 85.1, 85.7 & 84.9, 82.3 & 75.8, 76.3 & 70.2, 73.3 & 71.9, 73.2 & 72.2 and 72.5 & 71.2, the lowest reduction percentage was Goltix, Goltix followed by Beet Up and Goltix followed by Tegro was 48.6 & 45.2, 66.7 & 66.5 and 67.5 & 66.1, respectively, compared with unweeded control.

Table (13): Effect of weed control treatments on dry weight of total annual weeds (g/m^2) at 75 and 105 days after planting in 2009/10 and 2010/11 winter seasons.

Treatments	At 75 DAP [1]	% control	At 105 DAP	% control
2009/ 2010				
Safari followed by Select Super	141.1 fg	**86.9**	362.7 e	**84.4**
Tegro followed by Select Super	152.2 efg	**85.8**	417.8 e	**82.0**
Beet Up followed by Select Super	282.2 cde	**73.7**	726.5 cd	**68.8**
Goltix	591.8 b	**44.9**	1410.1 b	**39.4**
Goltix followed by Beet Up	394.2 c	**63.3**	785.8 c	**66.2**
Goltix followed by Safari	289.3 cde	**73.1**	578.1 d	**75.2**
Goltix followed by Tegro	309.7 cd	**71.2**	686.6 cd	**70.5**
Harness	302.0 cd	**71.9**	732.4 cd	**68.5**
Harness followed by Beet Up	277.1 cde	**73.3**	603.3 d	**74.1**
Harness followed by Safari	130.5 fg	**87.9**	322.3 e	**86.1**
Harness followed by Tegro	206.9 def	**80.8**	426.1 e	**81.7**
Hand hoeing twice	31.6 g	**97.1**	136.1 f	**94.2**
Hand hoeing thrice	18.9 g	**98.2**	81.1 f	**96.5**
Unweeded	1075.0 a	**0.0**	2326.5 a	**0.0**
2010/11				
Safari followed by Select Super	114.4 fg	**88.7**	349.5 e	**84.4**
Tegro followed by Select Super	144.6 efg	**85.7**	339.2 e	**84.9**
Beet Up followed by Select Super	239.2 cde	**76.3**	668.2 cd	**70.2**
Goltix	518.4 b	**48.6**	1229.9 b	**45.2**
Goltix followed by Beet Up	335.8 c	**66.7**	751.1 c	**66.5**
Goltix followed by Safari	277.5 cd	**72.5**	646.6 cd	**71.2**
Goltix followed by Tegro	328.1 c	**67.5**	759.7 c	**66.1**
Harness	268.9 cd	**73.3**	629.5 cd	**71.9**
Harness followed by Beet Up	270.8 cd	**73.2**	623.4 cd	**72.2**
Harness followed by Safari	129.3 efg	**87.2**	333.9 e	**85.1**
Harness followed by Tegro	178.3 def	**82.3**	542.7 d	**75.8**
Hand hoeing twice	40.0 g	**96.0**	206.9 ef	**90.8**
Hand hoeing thrice	28.3 g	**97.2**	113.3 f	**95.0**
Unweeded	1009.0 a	**0.0**	2244.0 a	**0.0**

[1] DAP = Days After Planting

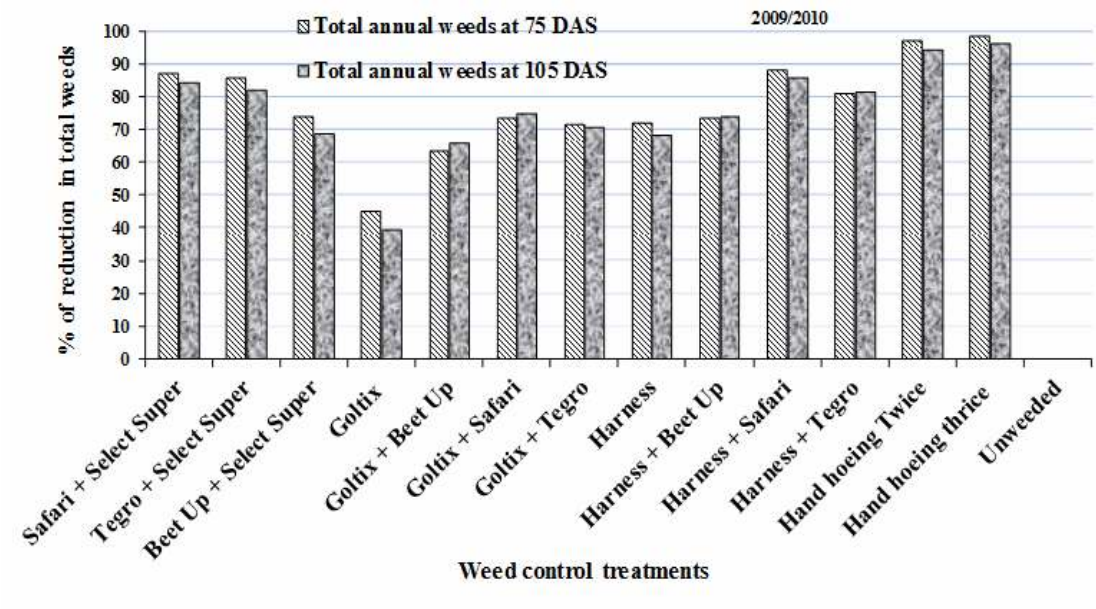

Fig (8 a): The reduction percentages in dry weight of total annual weeds (g/m^2) due to weed control treatments at 75 and 105 days after planting in 2009/10 winter season.

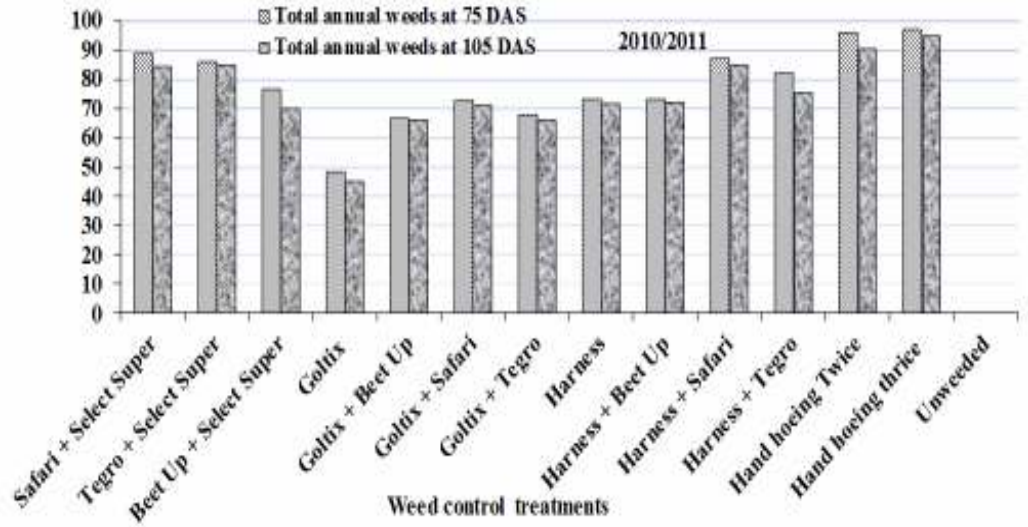

Fig (8 b): The reduction percentages dry weight of total annual weeds (g/m^2) due to weed control treatments at 75 and 105 days after planting in 2010/11 winter season.

From the above results it could be concluded that adding graminicide Select Super with annual broad-leaved herbicides such as Safari, Tegro, Beet up enhanced toxicity for total annual weeds due to Select Super reduced annual grassy weeds and annual broad-leaved herbicides effectiveness on annual broad-leaved weeds, as will as, using two herbicides together which one for controlling annual broad-leaved and grass weeds and other for controlling annual broad-leaved weeds can be increasing effectiveness for control total annual weeds due to increased reduction in dry weight of annual broad-leaved weeds. These results are in agreement with the findings of **Deveikyte (1996), Deveikyte (1997a), Ievlev *et al.* (1997), El-Zouky (1998), Tyr *et al.* (1999), Farzin and Hossein (2004) and Deveikyte (2005).**

Sugar beet crop weak growth in the first stage and plants are weak to compete with weeds such as weed species which appear with the emergence of sugar beet **Deveikyte and Seibutis (2006)** and this requires the maintenance of the sugar beet crop free from weeds for at least four to six weeks after emergence as 55 - 60 days after sowing, so used one herbicide during the period of growing sugar beet did not enough for over come on weeds problems, so must be using two herbicides or herbicide with one or two hand hoeing for conducted high productivity.

II- Effect of weed control treatments on some growth characters of sugar beet plants:

1- Root length (cm):

Data presented in Table (14) showed the effect of weed control treatments on root length (cm) in 2009/10 and 2010/11growing seasons.

Chemical and mechanical weed control treatments significantly affected on root length (cm) both seasons as compared to unweeded check. Hence Hand hoeing thrice, Harness followed by Safari, Hand hoeing Twice, Safari followed by Select Super, Harness followed by Tegro, Tegro followed by Select Super, Goltix followed by Safari, Goltix followed by Tegro and Goltix followed by Beet Up gave the highest values of this trait with out any significance between these treatments. These treatments increased root length by 76.3, 73.4, 73.0, 66.8, 61.9, 60.7, 52.5, 50.8 and 47.1%, respectively, in the first season. In the second season weed control treatments could be arranged in descending order with regard to regard to their increasing effect in the following order: Hand hoeing thrice, Harness followed by Safari, Hand hoeing Twice, Safari followed by Select Super, Tegro followed by Select Super, Harness followed by Tegro and Goltix followed by Beet Up their respective increment percentages were 91.1, 80.7,79.8, 72.6, 66.0, 62.1 and 61.6%, respectively. These results are in harmony with those obtained by **Shady and Mosalam (1993), Farzin and Hossein (2004), Bulawin *et al.* (2006) and Abo El-Hassan Rasha (2010).**

Table (14) Effect of weed control treatments on some growth characters of sugar beet plants in 2009/10 and 2010/11 winter seasons.

Treatments	Root length (cm)	Root diameter (cm)	Number of leaves/ plant	Leaves fresh weight (g)	Root weight (g)
		2009/10			
Safari followed by Select Super	40.7 a	10.0 bc	28.9 abcd	365.0 c	863.0 bc
Tegro followed by Select Super	39.2 ab	9.8 bc	31.2 abcd	359.0 c	833.0 bcd
Beet Up followed by Select Super	31.4 bcd	6.6 de	24.6 bcd	255.3 de	460.0 g
Goltix	29.7 cd	4.2 f	26.3 bcd	215.8 e	318.0 h
Goltix followed by Beet Up	35.9 abc	8.7 c	23.7 d	283.4 cde	620.0 ef
Goltix followed by Safari	37.2 abc	8.7 c	24.3 cd	321.1 cd	716.0 de
Goltix followed by Tegro	36.8 abc	7.2 d	32.1 abc	299.2 cde	603.0 ef
Harness	30.1 cd	5.3 ef	26.8 bcd	217.8 e	585.0 f
Harness followed by Beet Up	35.6 abc	7.0 d	24.9 bcd	260.1 de	502.0 fg
Harness followed by Safari	42.3 a	10.3 b	27.6 abcd	448.2 b	819.0 bcd
Harness followed by Tegro	39.5 ab	9.7 bc	25.8 bcd	339.2 cd	756.0 cd
Hand hoeing Twice	42.2 a	11.7 a	34.8 a	544.9 a	930.0 ab
Hand hoeing thrice	43.0 a	12.2 a	32.6 ab	614.0 a	1019.0 a
Unweeded	24.4 d	2.7 g	13.0 e	90.5 f	118.0 i
		2010/11			
Safari followed by Select Super	35.1 abc	9.7 de	36.4 ab	602.3 c	944.0 b
Tegro followed by Select Super	33.7 abc	10.8 bc	28.9 cde	581.9 c	789.0 c
Beet Up followed by Select Super	23.8 ef	5.8 hi	23.8 ef	378.5 de	381.0 f
Goltix	24.9 ef	5.0 i	21.4 fg	234.0 f	360.0 f
Goltix followed by Beet Up	30.2 bcde	7.2 g	24.3 ef	302.3 ef	551.0 de
Goltix followed by Safari	32.8 abcd	8.2 f	26.8 cdef	423.9 d	688.0 cd
Goltix followed by Tegro	28.4 cde	9.1 ef	31.2 bcd	404.7 d	575.0 de
Harness	26 .0 def	5.7 hi	27.9 cde	397.8 de	443.0 ef
Harness followed by Beet Up	25.5 ef	6.3 gh	25.4 def	349.6 de	463.0 ef
Harness followed by Safari	36.7 ab	11.4 b	31.9 bc	721.2 b	1020.0 ab
Harness followed by Tegro	32.9 abcd	10.1 bc	24.5 ef	381.7 de	738.0 c
Hand hoeing Twice	36.5 ab	10.8 cd	32.6 abc	775.2 ab	1080.0 ab
Hand hoeing thrice	38.8 a	12.9 a	38.1 a	846.2 a	1148.0 a
Unweeded	20.3 f	2.1 j	17.4 g	101.2 g	98.0 g

2- Root diameter (cm):

The effect of weed control treatments on root diameter of sugar beet in 2009/10 and 2010/11 seasons are presented in Table (14).

Data revealed that root diameter was significantly affected by weed control treatments in both seasons. The application of hand hoeing thrice and hand hoeing twice gave the highest values of this trait as compared to unweeded treatments. Plots received hand hoeing thrice and hand hoeing twice gave the thickest roots (12,2 and 11.7 cm) in the first season. In the second season hand hoeing thrice gave the thickest roots (12.9 cm). While the untreated plots gave the thinnest roots (2.7 and 2.1 cm) in the first and second seasons, respectively. These results are in harmony with the findings of **Shady and Mosalam (1993), Farzin and Hossein (2004), Bulawin *et al.* (2006) and Abo El-Hassan Rasha (2010).**

The reduction in the root dimensions (length and diameter) values under weedy plots (check) reflected the negative impact of weeds on crop growth which may be occurred as a result of the competition between beet and weed plants for the environmental resources (light, water and nutrients) which, are necessary for plant growth. Moreover, mechanical weed control was better in increasing root diameter of sugar beet than chemical treatments in both seasons.

3- Number of leaves/plant:

Values of number of leaves/plant as affected by weed control treatments in both seasons are recorded in Table (14).

Data indicated that number of leaves/plant significantly influenced by all weed control treatments. Applying hand hoeing twice, Hand hoeing thrice, Goltix followed by Tegro, Tegro followed by Select super, Safari followed by Select super and Harness followed by Safari produced the highest Number of green leaves/plant (34.8, 32.6, 32.1, 31.2, 28.9, and 27.6) in the first season, respectively. Whereas, in the second season, hand hoeing thrice, Safari followed by Select super and hand hoeing twice gave the highest values of this trait (38.1, 36.4 and 32.6 leaf/plant).

The lowest values of number of leaves/plant obtained from untreated plots (13.0) in the first season. In the second season the lowest values obtained from Goltix and untreated plots (17.4 and 21.4 leaf), respectively. These results are in harmony with the findings of **Shady and Mosalam (1993), Bulawin *et al.* (2006) and Abo El-Hassan Rasha (2010).**

4- Leaves fresh weight (g/plant):

Results about leaves fresh weight (g/plant) of sugar beet as affected by weed control treatments in 2009/10 and 2010/11growing seasons are presented in Table (14).

Results indicated that leaves fresh weight (g/plant) significantly affected by weed control treatments in both seasons. Hand hoeing twice and hand hoeing thrice increased

leaves fresh weight (g/plant) by 578.5 and 501.1 %, respectively. Whereas, in the second season the increment percentages were 736.2 and 666% as compared to untreated plots (90.5 and 101.2 g) in the first and second seasons, respectively. These results are in agreement with those obtained by **Shady and Mosalam (1993), Bulawin *et al.* (2006) and Abo El-Hassan Rasha (2010).**

5- Root weight (g/plant):

Data in Table (14) presented the effect of weed control treatments on root fresh weight (g/plant).

Average root fresh weight (g/plant) reacted significantly to the weed control treatments in the two growing seasons. All studied weed control treatments were superior over the unweeded control. Applying hand hoeing twice and hand hoeing thrice produced the highest root weight without any significant difference between these treatments in both seasons.

This reduction in root weight under the other treatments may be attributed to the negative effects of weeds on crop growth which occurred as a result of the competition between sugar beet and weed plants for the limited environmental resources (light, water and nutrients) which plant growth dependants upon. The previous findings were in agreement with **Smith *et al.* (1982), Shady and Mosalam (1993), Farzin and Hossein (2004), Bulawin *et al.* (2006) and Abo El-Hassan Rasha (2010).**

III- Effect of weed control treatments on sugar beet yields:

1- Top yield (ton/fed.):

The effect of weed control treatments on top yield (ton/fed.) in both growing seasons is presented in Table (15).

Results revealed significant differences between weed control treatments in both seasons. Applying hand weeding thrice, hand weeding twice, Harness followed by Safari, Safari followed by Select super and Tegro followed by Select super gave the best results of top yield (ton/fed.), with increase percentage by

388.9, 359.3, 311.1, 303.7, and 296.3 %, respectively, in the first season. In the second season, the highest top yield 459.3 and 403.7 ton/fed resulted from hand weeding thrice and hand weeding twice, respectively.

Dense weed growth with sugar beet plants during both seasons in unweeded plots resulted the lowest top yield (2.7 ton/fed.) in both seasons. However, minimizing weeds density by weed control treatments increased top yield. Similar results obtained by **Shady and Mosalam (1993), Farzin and Hossein (2004), Bulawin *et al.* (2006).**

2- Root yield (ton/ fed.):

Root yield (ton/fed.) as affected by weed control treatments in 2009/10 and 2010/11 seasons are shown in Table (15).

Data clearly showered that weed control treatments significantly increased root yield (ton/fed.) in both growing seasons.

Table (15): Effect of weed control treatments on sugar beet yields in 2009/10 and 2010/11 winter seasons.

Treatments	Top yield (ton /fed.)	Root yield (ton /fed.)	Gross sugar yield (ton /fed.)
2009-2010			
Safari followed by Select Super	10.9 ab	31.2 cd	4.33 abc
Tegro followed by Select Super	10.7 abc	28.9 cde	3.52 cdef
Beet Up followed by Select Super	6.1 efg	21.6 hi	2.76 efg
Goltix	3.9 gh	15.7 j	2.03 g
Goltix followed by Beet Up	5.4 fg	22.9 gh	3.00 edfg
Goltix followed by Safari	9.6 bcd	27.7 def	3.60 cdef
Goltix followed by Tegro	9.5 bcd	27.2 defg	3.41 cdef
Harness	8.2 cde	17.8 ij	2.59 fg
Harness followed by Beet Up	5.6 fg	23.8 fgh	3.12 def
Harness followed by Safari	11.1 ab	33.1 bc	3.79 bcde
Harness followed by Tegro	7.9 def	26.3 efg	3.91 bcd
Hand hoeing twice	12.4 a	37.2 ab	4.75 ab
Hand hoeing thrice	13.2 a	38.2 a	5.14 a
Unweeded	2.7 h	5.1 k	0.77 h
2010/11			
Safari followed by Select Super	11.7 cd	30.3 bc	4.32 ab
Tegro followed by Select Super	12.1 bc	28.4 cd	3.81 bcd
Beet Up followed by Select Super	6.6 fg	21.5 fg	2.69 ef
Goltix	4.3 hi	16.3 h	1.83 g
Goltix followed by Beet Up	8.2 f	22.6 ef	2.94 def
Goltix followed by Safari	11.4 cde	26.9 cd	3.84 bc
Goltix followed by Tegro	9.9 e	25.8 de	3.53 bcde
Harness	5.2 gh	18.6 gh	2.17 fg
Harness followed by Beet Up	7.3 f	23.4 ef	3.05 cde
Harness followed by Safari	12.8 bc	31.7 b	4.40 ab
Harness followed by Tegro	10.3 de	27.6 cd	3.65 bcd
Hand hoeing twice	13.6 ab	35.8 a	4.94 a
Hand hoeing thrice	15.1 a	36.9 a	5.15 a
Unweeded	2.7 i	5.7 i	0.59 h

Plots received hand hoeing thrice and twice gave the highest root yield in both seasons as compared to unweeded plots (5.1 and 5.7 in first and second seasons, respectively) with increasing percentages of 649 & 547.4 and 528 & 629 % respectively, in first and second season, respectively, as compared with unweeded check.

Data also revealed that spraying with Harness followed by Safari and spraying with Safari followed by Select super and resulted in higher root yield than the other chemical weed control treatments with an increasing percentages of 549 & 456.1 and 511.8 & 431.6 % respectively, in first and second season, respectively, as compared with unweeded check.

This may be due to the application of these herbicides in combination proved its efficiency in controlling weeds and decrease weed-sugar beet competition as well as giving sugar beet plants the ability to grow and use the natural resources (nutrients, water and sunlight). These result in full agreement of with those obtained by **Chauhan and Motiwale (1985), Shady and Mosalam (1993), Gagro and Dadacek (1996), Paradowski (1998), Yukhin *et al.* (1999), Deveikyte (2002), Frabboni and Zuffrano (2003) and Rapparini (2008).**

3- Gross sugar yield (ton/fed.):

Results in Table (15) revealed that the gross sugar yield (ton/fed.) increased significantly by weed control treatments in both seasons as compared with unweeded check.

Although no significant difference between weed control treatments on sucrose percentages in the first season, gross sugar yield (ton/fed.) increased significantly by all weed control treatments due to increasing root yield (ton/fed.). Data showed that the highest increment percentages in gross sugar yield (ton/fed.) obtained from hand hoeing thrice and twice and spraying with Safari followed by Select super these percentages were 567.5, 516.8 and 462%, respectively, in the first season.

In the second season hand hoeing thrice and twice and spraying with Harness followed by Safari and Safari followed by Select super its increment percentages were 772.3, 737.3, 645.8 and 632 %, respectively, as compared to unweeded treatment. These results are in harmony with the finding of **Farzin and Hossein (2004), Bulawin *et al.* (2006)** and **Deveikyte and Seibutis (2006).**

IV. Effect of weed control treatments on sugar beet juice quality:

1- Total soluble solids (T. S. S. %):

Data presented in Table (16) indicated that the effect of weed control treatments on T.S.S. % was insignificant in both seasons.

These results are agreement with those obtained by **Abd El-Aal (1995)** and **Abo El-Hassan Rasha (2010).**

Table (16) Effect of weed control treatments on sugar beet juice quality in 2009/10 and 2010/11 winter seasons.

Treatments	T.S.S. %	Sucrose %	Purity %
2009-2010			
Safari followed by Select Super	21.0 a	17.35 a	82.68 a
Tegro followed by Select Super	19.3 a	14.96 a	77.30 ab
Beet Up followed by Select Super	20.0 a	15.42 a	77.37 ab
Goltix	19.7 a	14.57 a	74.24 b
Goltix followed by Beet Up	20.3 a	16.01 a	79.05 ab
Goltix followed by Safari	21.3 a	16.22 a	75.95 ab
Goltix followed by Tegro	21.0 a	16.67 a	79.40 ab
Harness	20.3 a	15.74 a	77.48 ab
Harness followed by Beet Up	21.0 a	16.17 a	77.08 ab
Harness followed by Safari	20.3 a	14.86 a	73.00 b
Harness followed by Tegro	20.7 a	16.10 a	77.88 ab
Hand hoeing twice	21.0 a	16.35 a	77.80 ab
Hand hoeing thrice	21.3 a	16.93 a	79.35 ab
Unweeded	19.7 a	14.65 a	74.34 b
2010/11			
Safari followed by Select Super	19.3 a	16.32 a	84.40 ab
Tegro followed by Select Super	19.3 a	15.63 ab	80.96 ab
Beet Up followed by Select Super	19.0 a	14.92 ab	78.57 ab
Goltix	18.7 a	14.22 b	76.22 b
Goltix followed by Beet Up	19.3 a	15.31 ab	79.44 ab
Goltix followed by Safari	19.3 a	16.35 a	84.64 ab
Goltix followed by Tegro	18.7 a	15.42 ab	82.74 ab
Harness	19.0 a	14.73 ab	77.72 ab
Harness followed by Beet Up	19.3 a	15.40 ab	79.73 ab
Harness followed by Safari	19.0 a	15.73 ab	82.76 ab
Harness followed by Tegro	18.7 a	16.31 a	87.33 a
Hand hoeing twice	19.3 a	15.82 ab	81.96 ab
Hand hoeing thrice	20.0 a	15.98 a	80.21 ab
Unweeded	18.7 a	14.08 b	75.43 b

2- Sucrose %:

Results in Table (16) indicated clearly that sucrose % was increased significantly with weed control treatments compared with unweeded check in the second season only.

Weed control treatments could be arranged in a descending order with regard to their increasing effect in the following order: Goltix followed by Safari, Safari followed by Select super, Harness followed by Tegro, Hand hoeing thrice, Hand hoeing twice, Harness followed by Safari, Tegro followed by Select super, Goltix followed by Tegro, Harness followed by Beet Up, Goltix followed by Beet Up, Beet Up followed by Select super and Harness, their respective increasing percentage were: 16.1, 15.9, 15.8, 13.5, 12.4, 11.7, 11.0, 9.5, 9.4, 8.7, 6.0 and 4.6% , respectively. Similar results were obtained by **Smith *et al.* (1982), Shady and Mosalam (1993), Shaban *et al.* (2000), Ulina *et al.* (2003), Deveikyte and Seibutis (2006) and Abo El-Hassan Rasha (2010).**

3- Purity (%):

Results about purity percentage of sugar beet as affected by weed control treatments in 2009/10 and 2010/11growing seasons are presented in Table (16).

Data revealed that purity percentage significantly affected by weed control treatments in both growing season. The highest value of purity percentage (82.68%) obtained from Safari followed by Select Super, whereas, unweeded treatment gave the lowest value of this trait (74.34%) in the first season. In the second season Harness followed by Tegro gave the

highest value of purity percentage (87.33%). Meanwhile, unweeded plots gave the lowest value of this trait (75.43%). The previous findings were in agreement with those obtained by **Shady and Mosalam (1993), Farzin and Hossein (2004), Bulawin *et al.* (2006) and Abo El-Hassan Rasha (2010).**

V- Residues analysis of tested herbicides:

Data in Table (17) showed that all studied active ingredients were under acceptable daily intake (ADI).

Table (17): The residues for tested herbicides in sugar beet roots (ppm).

Sample No.	Herbicides		Residual (ppm)	ADI (ppm)
1	**Safari**	Triflusulfuron-methyl	0.0004	0.05
	Select Super	Clethodium	0.0014	0.01
2		Phenmedipham	0.00148	unknown
	Tegro	Desmedipham	0.00047	0.00125
		Ethofumesate	0.00046	0.4
	Select Super	Clethodium	0.0011	0.01
3	**Beet up**	Phenmedipham	0.000008	unknown
	Select Super	Clethodium	0.0098	0.01
4	**Goltix**	Metamitron	0.00352	0.025
5	**Goltix**	Metamitron	0.00391	0.025
	Beet up	Phenmedipham	0.0015	unknown
6	**Goltix**	Metamitron	0.004	0.025
	Safari	Triflusulfuron-methyl	0.0195	0.05
7	**Goltix**	Metamitron	0.00544	0.025
		Phenmedipham	0.00021	unknown
	Tegro	Desmedipham	0.00067	0.00125
		Ethofumesate	0.00015	0.4
8	**Harness**	Actochlor	0.00068	0.01
9	**Harness**	Actochlor	0.0000064	0.01
	Beet up	Phenmedipham	0.00198	unknown
10	**Harness**	Actochlor	0.00028	0.01
	Safari	Triflusulfuron-methyl	0.0043	0.05
11	**Harness**	Actochlor	0.0033	0.01
		Phenmedipham	0.0022	unknown
	Tegro	Desmedipham	0.0068	0.00125
		Ethofumesate	0.00003	0.4

VI- Correlation analysis between dry weight of weed classes (g/m^2) and yields of sugar beet:

Table (18) reported that the relationship between dry weight of grassy (GW1), annual broad-leaved weeds (BW1) and total annual weeds (TW1) at 75 DAP & dry weight of grassy (GW2), annual broad-leaved weeds (BW2) and total annual weeds (TW2) at 105 DAP was significant positive, the correlation coefficient value 0.64, 0.75 & 0.54, 0.71 and 0.728, 0.6 & 0.656, 0.655 in 2009/10 and 2010/11 seasons, respectively. The relationship between dry weights of GW1, BW1, TW1 and GW2, BW2, TW2 was 0.714, 0.712, 0.761 and 0.719, 0.799, 0.779, but, the relationship between GW1, BW1, TW1, GW2, BW2, TW2 and root yield RY (ton/fed) was significant negative with correlation coefficient value -0.474, -0.647, -0.669, -0.457, -0.695, -0.7 and -0.486, -0.63, -0.658, -0.428, -0.662, -0.633 in first and second seasons, respectively.

On the other hand the relationship between GW1, BW1, TW1, GW2, BW2, TW2 and gross sugar yield (SY) (ton/fed) was significant negative with correlation coefficient value -0.45, -0.602, -0.617, -0.417, -0.648, -0.638 and -0.47, -0.683, -0.659, -0.405, -0.665, -0.614, but, the relationship between root yield (RY) and gross sugar yield (SY) was significant positive effect with the correlation value 0.824 and 0.903 in 2009/10 and 2010/11 seasons, respectively.

Table (18) The correlation between yields of sugar beet (ton /fed), dry weight of weeds classes (g/m^2) at 75 and 105 days after planting 2009/10 and 2010/11seasons.

Person correlation	SY [8]	RY	TW2	BW2	GW2	TW1	BW1
			2009/10				
GW1 [1] (g/m^2)	-0.450 **	-0.474 **	0.540**	0.331 **	0.714 **	0.640 **	0.415 **
BW1 [2](g/m^2)	-0.602 **	-0.647 **	0.706 **	0.712 **	0.169 **	0.750 **	
TW1 [3] (g/m^2)	-0.617 **	-0.669 **	0.761 **	0.621 **	0.55 **		
GW2 [4](g/m^2)	-0.417 **	-0.457 **	0.558 **	0.335 **			
BW2 [5](g/m^2)	-0.648 **	-0.695 **	0.77 **				
TW2 [6](g/m^2)	-0.638 **	-0.700 **					
RY [7] (ton/fed)	0.824 **						
			2010/11				
GW1 (g/m^2)	-0.470 **	-0.486 **	0.656 **	0.437 **	0.719 **	0.728 **	0.413 **
BW1 (g/m^2)	-0.683 **	-0.63 **	0.655 **	0.799 **	0.433 **	0.60 **	
TW1 (g/m^2)	-0.659 **	-0.658 **	0.779 **	0.648 **	0.663 **		
GW2 (g/m^2)	-0.405 **	-0.428 **	0.689 **	0.423 **			
BW2 (g/m^2)	-0.665 **	-0.662 **	0.734 **				
TW2 (g/m^2)	-0.614 **	-0.633					
RY (ton/fed)	0.903 **						

[1] GW1 = Grassy weeds at 75 days after sugar planting.
[2] BW1 = Broad-leaved weeds at 75 days after sugar planting.
[3] TW1 = Total annual weeds at 75 days after sugar planting.
[4] GW2 = Grassy weeds at 105 days after sugar planting.
[5] BW2 = Broad-leaved weeds at 105 days after sugar planting.
[6] TW2 = Total annual weeds at 105 days after sugar planting.
[7] RY = Root yield (ton/fed).
[8] SR = Gross sugar yield

SUMMARY

Two filed experiments were conducted at Mallawi Agricultural Research Station, Agricultural Research Center, El-Minia Governorate (Middle Egypt) during 2009/10 and 2010/11 seasons. The aims of this study were to:

3- Determine the critical period of weed infestation to sugar beet.
4- Determine the effect of some weed control treatments on yield, yield components, quality of sugar beet and its associated weeds.

Part I: Determine the critical period of weed infestation to sugar beet:

The first experiment:

The experiment included fourteen treatments which were:

15. Weed free for whole season.
16. Weed free for 2 weeks after sugar beet emergence.
17. Weed free for 4 weeks after sugar beet emergence.
18. Weed free for 6 weeks after sugar beet emergence.
19. Weed free for 8 weeks after sugar beet emergence.
20. Weed free for 10 weeks after sugar beet emergence.
21. Weed free for 12 weeks after sugar beet emergence.
22. Weed infestation for 2 weeks after sugar beet emergence.
23. Weed infestation for 4 weeks after sugar beet emergence.
24. Weed infestation for 6 weeks after sugar beet emergence.
25. Weed infestation for 8 weeks after sugar beet emergence.
26. Weed infestation for 10 weeks after sugar beet emergence.

27. Weed infestation for 12 weeks after sugar beet emergence.
28. Weed infestation for whole season.

The treatments were distributed in a randomized complete block design with four replications. The plot area was 10.5 m^2. The normal cultural practices for sugar beet in the experiments were followed.

The results can be summarized as follows:

1- Dry weight of annual grassy, annual broad-leaved weeds and total annual weeds (g/m^2) at the end of growing season reduced significantly by increased weed free periods treatments, but, the pervious traits not significantly decreased by increasing weed infestation periods treatments.

2- Root length significantly affected by weed removal treatments in both seasons, the highest root length values obtained from weed free for 8 weeks after emergence and weed free for 10 weeks after emergence as compared to weed infestation for whole season.

3- Weed infestation for 2 weeks after emergence and weed free for whole season gave the highest root diameter (cm) followed by weed infestation for 4 weeks after emergence, weed free for 12 weeks after emergence, weed free for 8 weeks after emergence and weed free for 10 weeks after emergence, on the other hand, the lowest root diameter were obtained from weed infestation for whole season in both seasons.

4- Results indicated that the number of leaves/plant significantly increased by all weed removal treatments. The highest number of leaves/plant were resulted from weed infestation for 4 weeks after emergence, weed infestation for 2 weeks after emergence, weed free for 10 weeks after emergence, weed free for whole season and weed free for 12 weeks after emergence treatments, in 2009/10 season. While, the highest values in 2010/11 season resulted from weed free for whole season, followed weed free for 10 weeks after emergence, weed free for 6 weeks after emergence, weed free for 12 weeks after emergence and weed free for 4 weeks after emergence treatments, respectively.

5- Weed infestation for 2 weeks after sugar beet emergence gave the highest leaves weight (g/plant) in the first season, whereas, in the second season the highest values obtained from weed free for whole season, the lowest values were obtained from weed infestation for whole seasons.

6- Results showed that weed removal treatments significantly increased the root weight of sugar beet plants in both seasons. The highest root weight was obtained from weed free for whole seasons followed by weed infestation for 2 weeks after emergence, weed infestation for 4 weeks after emergence, weed free for 12 weeks after emergence and weed free for 10 weeks after emergence, while, the lowest

value was obtained from weed infestation for whole season followed by weed free for 2 weeks in both seasons.

7- Results showed that weed removal treatments significantly increased top yield (ton/fed) in the first and second seasons. The highest top yield (ton/fed) was resulted from weed free for whole season, but, the lowest value was obtained from weed infestation for whole season in 2009/10 and 2010/11 seasons.

8- Results indicated that root yield (ton/fed) significantly affected by weed removal periods in both seasons. Weed free for whole season gave the highest root yield (ton/fed) followed by weed infestation for 2 weeks after emergence, weed infestation for 4 weeks after emergence, weed free for 12 weeks after emergence and weed free for 10 weeks after emergence, but, the lowest value was obtained from weed infestation for whole season in both seasons.

9- Results showed that in spite of non-significant difference between weed removal treatments on total soluble solids (T.S.S %) in the first season, this trait was significantly affected in the second season. All weed removal treatments increased T.S.S%.

10- Data showed that weed removal treatments caused significantly increased the sucrose % in the second season only.

11- Data indicated that purity % of sugar beet increased without any significant difference between different weed removal and weed infestation treatments in both seasons.

12- Results illustrated that sugar yield significantly affected by weed removal treatments. The highest sugar yield (ton/fed) was resulted from weed free for whole season, but, the lowest value was obtained from weed infestation for whole season in 2009/10 and 2010/11 seasons.

13- The relationship between dry weight of total annual weeds at the end of growing season and root yield of sugar beet (ton/fed) was significant and negative in weed free and weed infestation treatments and prediction equation with R-sq value 73.1% & 82.3% and 10.2% & 48.3% in 2009/10 &2010/11 seasons, respectively.

14 -Determination the critical period for weed/sugar beet competition:-

a– Biological approach: -

The critical period of weed-sugar beet competition was between 2–10 weeks after emergence, when the period which sugar beet can tolerate weeds only for 2 weeks after sugar beet emergence and need prolonged period to be free from weeds arrives 10 weeks.

b – Regression approach (mathematical models): -

Application equation reported that to maintain 95% of sugar beet root yield (ton/fed) weeds should be not allowed to exceed 1-2 week after sugar beet emergence and the late

duration of weed free period should be not allowed weed to exceed 13-14 weeks after sugar beet emergence.

c – Economic approach: -

Economic critical period of weed-sugar beet competition was found between 4–10 weeks after sugar beet emergence.

Part II: Effect of some weed control treatments on yield, yield components, quality of sugar beet and its associated weeds.

The dominant weed species in field experiments in both seasons were *Avena* spp., *Phalaris* spp. as annual grassy weeds, *Brassica nigra* L., *Chenopodium* sp., *Sonchus oleraceus* L., *Medicago polymorpha* L., *Melilotus indica* L., *Anagallus arvensis*, *Ammi majus* L., *Euphorbia helioscopia* and *Rumex dentatus* L. as annual broad-leaved weeds.

Fourteen weed control treatments were used as follows:

15. Safari 50 % WG[5] (triflusulfuron methyl) at the rate of 12 g/fad. applied at 21 days after planting (DAP) followed by Select Super (clethodium) 12.5 % EC[6] at rate of 300 cm^3/fed. applied at 24 DAP.
16. Tegro 27.4% EC (phenmedipham + desmedipham + ethofumesate) at the rate at the rate of 1L/fed applied at 21 DAP followed by Select Super 12.5 % EC at rate of 300 cm3/fed. applied at 24 DAP.

[5] WG = Wetable Granules
[6] EC = Emulsifiable Concentare

17. Beet Up 16% EC (phenmedipham) at the rate of 1L/fed applied at 21 DAP followed by Select Super 12.5 % EC at rate of 300 cm^3/fed. applied at 24 DAP.
18. Goltix 70% SC (metamitron) at the rate of 2L /fad. applied as pre-planting.
19. Goltix 70% SC[7] at the rate of 2L /fad. pre-planting followed by Beet Up 16% EC at the rate of 1L/fed applied at 21 DAP.
20. Goltix 70% SC at the rate of 2L /fad. pre-planting followed by Safari 50 % WG at the rate of 12 g/fad. applied at 21 DAP.
21. Goltix 70% SC at the rate of 2L /fad. pre-planting followed by Tegro 27.4% EC at the rate at the rate of 1L/fed applied at 21 DAP.
22. Harness 84 % EC (actocholor) at the rate of 750 cm^3/fed. pre-planting.
23. Harness 84 % EC at the rate of 750 cm^3/fed. pre-planting followed by Beet Up 16% EC at the rate of 1L/fed applied at 21 DAP.
24. Harness 84 % EC at the rate of 750 cm^3/fed. pre-planting followed by Safari 50 % WG at the rate of 12 g/fad. applied at 21 DAP.

[7] SC = Soluble concentrate

25. Harness 84 % EC at the rate of 750 cm^3/fed. pre-planting followed by Tegro 27.4% EC at the rate of 1L/fed applied at 21 DAP.
26. Hand hoeing twice (at 20 and 40 days after planting).
27. Hand hoeing thrice (at 20, 40 and 60 days after planting).
28. Un-weeded (control).

The results can be summarized as follows:

1. Results reported that all weed control treatments significantly reduced dry weight of grassy weeds (g/m^2) in both seasons at 75 and 105 DAP[8]. Hand hoeing thrice or twice recorded the lowest value of dry weight of grassy weeds in both seasons and different surveys time (75 and 105 DAP). followed by Tegro followed by Select Super, Beet Up followed by Select Super, Safari followed by Select Super, Harness followed by Safari, Harness followed by Beet Up, Harness followed by Tegro and Harness, but, the highest value of dry weight of grassy weeds were obtained from unweeded plots.
2. Obtained results revealed that weed control treatments had a significant effect on dry weight of broad-leaved weeds (g/m^2) at 75 and 105 DAP in both seasons. The highest broad-leaved weeds control percentage at 75 DAPS and 105 DAP, resulted from hand hoeing thrice and hand hoeing twice compared with unweeded in both seasons.

[8] DAP = Days after planting

3. Results clearly indicated that weed control treatments significantly affected the dry weight of total annual weeds (g/m^2) at 75 and 105 DAP in both seasons. Hand hoeing thrice and hand hoeing twice recorded the lowest values of dry weight of total annual weeds at different surveys time (75 and 105 DAP) in both seasons follow by Harness followed by Safari, Safari followed by Select Super, Tegro followed by Select Super, Harness followed by Tegro, Goltix followed by Safari, Harness followed by Beet Up, Goltix followed by Tegro, Beet Up followed by Select Super, Harness, Goltix followed by Beet Up and Goltix but, the highest value in dry weight of total annual weeds were resulted from unweeded plots.
4. Chemical and mechanical weed control treatments significantly affected root length (cm) in both seasons as compared to unweeded. Hand hoeing thrice, Harness followed by Safari, Hand hoeing twice, Safari followed by Select Super, Harness followed by Tegro, Tegro followed by Select Super, Goltix followed by Safari, Goltix followed by Tegro and Goltix followed by Beet Up gave the highest values of this trait with out any significance between these treatments in both seasons
5. Data revealed that root diameter was significantly affected by weed control treatments in both seasons. The application of

hand hoeing thrice and hand hoeing twice gave the highest values of this trait as compared to unweeded treatments.

6. Data indicated that number of leaves/plant significantly influenced by all weed control treatments. Applying hand hoeing twice, Hand hoing thrice, Goltix followed by Tegro, Tegro followed by Select super, Safari followed by Select super and Harness followed by Safari produced the highest number of leaves/plant in first season. Whereas, in the second season, hand hoeing thrice, Safari followed by Select super and hand hoeing twice gave the highest values of this trait. The lowest values of number of leaves/plant resulted from untreated plots in the first season. In the second season the lowest values obtained from Goltix and untreated plots.
7. Leaves fresh weight (g/plant) significantly affected by weed control treatments in both seasons. All weed control treatments increased leaves fresh weight (g/plant) as compared to untreated plots in both seasons.
8. Root weight (g/plant) reacted significantly to the weed control treatments in both seasons. All studied weed control treatments were superior over the unweeded control. Applying hand hoeing thrice and hand hoeing twice produced the highest root weight without any significant difference between these treatments in both seasons.

9. Results showed a significant differences between weed control treatments in both seasons on their effect on top yield (ton/fed.), Applying hand weeding thrice, hand weeding twice, Harness followed by Safari, Safari followed by Select Super and Tegro followed by Select super gave the best results of top yield (ton/fed.) in the first season. In the second season, the highest top yield resulted from hand hoeing thrice and hand hoeing twice, respectively.

10. Data clearly showed weed control treatments significantly increased root yield (ton/fed.) in both growing seasons. Plots received hand hoeing thrice and twice gave the highest root yield in both seasons as compared to unweeded plots. Data also revealed that spraying with Harness followed by Safari and spraying with Safari followed by Select super resulted in higher root yield than the other chemical weed control treatment.

11. Results revealed that the sugar yield (ton/fed.) increased significantly by weed control treatments in both seasons as compared with unweeded check.

12. Data indicated that there wasn't any significant difference between all weeds control treatments and the unweeded plots on total soluble solids (T.S.S %) in both seasons.

13. Results indicated clearly that sucrose % was increased significantly with weed control treatments compared with unweeded in the second season only.
14. Data revealed that purity % significantly affected by weed control treatments in both growing season. In the first season the highest value of purity percentage obtained from Safari followed by Select super, whereas, unweeded treatment gave the lowest value of this trait. In the second season Harness followed by Tegro gave the highest value of purity percentage. Meanwhile, unweeded plots gave the lowest value of this trait.
15. The relationship between dry weight of grassy, broad-leaved weeds and total annual weeds at 75 days after planting at 105 days after planting and root yield (ton/fed) was significant negative.
16. Data showed that all studied active ingredients were under acceptable daily intake (ADI).

CONCLUSION

From this study it could be concluded that the critical period of weed–sugar beet competition was 2-12 weeks after sugar beet emergence. The removal of weeds during the previous critical period by using the following treatments in descending order: hand hoeing thrice, hand hoeing twice, Harness followed by Safari and Safari followed by Select Super gave the highest values of sugar beet yields and its component in both seasons.

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الملخص العربي

أقيمت تجربتين حقليتين بمحطة البحوث الزراعية بملوي – مركز البحوث الزراعية –محافظة المنيا – مصر الوسطي خلال الموسمين الشتويين 2010/2009 و 2011/2010 بهدف:

1- تحديد الفترة الحرجة لمنافسة الحشائش لمحصول بنجر السكر.
2- معرفة تأثير بعض معاملات الحشائش علي الحشائش، المحصول ومكوناته والصفات الكيماوية لمحصول بنجر السكر.

التجربة الأولي: تحديد الفترة الحرجة لمنافسة الحشائش لمحصول بنجر السكر وكانت المعاملات كما يلي:

1- إزالة الحشائش طوال الموسم.
2- إزالة الحشائش حتى 2 أسبوع من الإنبات.
3- إزالة الحشائش حتى 4 أسبوع من الإنبات.
4- إزالة الحشائش حتى 6 أسبوع من الإنبات.
5- إزالة الحشائش حتى 8 أسبوع من الإنبات.
6- إزالة الحشائش حتى 10 أسبوع من الإنبات.
7- إزالة الحشائش حتى 12 أسبوع من الإنبات.
8- ترك الحشائش في المحصول لمدة 2 أسبوع من الإنبات ثم إزالة الحشائش.
9- ترك الحشائش في المحصول لمدة 4 أسبوع من الإنبات ثم إزالة الحشائش.
10- ترك الحشائش في المحصول لمدة 6 أسبوع من الإنبات ثم إزالة الحشائش.
11- ترك الحشائش في المحصول لمدة 8 أسبوع من الإنبات ثم إزالة الحشائش.
12- ترك الحشائش في المحصول لمدة 10 أسبوع من الإنبات ثم إزالة الحشائش.
13- ترك الحشائش في المحصول لمدة 12 أسبوع من الإنبات ثم إزالة الحشائش.
14- ترك الحشائش بالمحصول طوال الموسم.

وتم توزيع المعاملات في تصميم القطاعات كاملة العشوائية في أربع مكررات وكانت مساحة القطعة التجريبية 10.5 م^2 وتم إجراء كافة العمليات الزراعية المتبعة في محصول البنجر.

ويمكن تلخيص النتائج كما يلي:

1- إنخفض الوزن الجاف للحشائش الحولية النجيلية عريضة الأوراق الكلية (جم/م^2) في نهاية موسم النمو معنويا بزيادة فترة إزالة الحشائش من المحصول ولكن هذه الصفة لم تتأثر معنوياً بزيادة فترة ترك الحشائش خلال موسمي النمو.

2- تأثر طول الجذر معنوياً بمعاملات إزالة الحشائش في كلا الموسمين وأمكن الحصول علي أعلي طول للجذر من إزالة الحشائش من المحصول لمدة 8 و10 أسابيع بالمقارنة بترك الحشائش طوال الموسم في كلا الموسمين.

3- أعطت معاملة ترك الحشائش مع المحصول لمدة 2 أسبوع من الإنبات وكذلك نقاوة الحشائش من المحصول طوال الموسم أعلي القيم لقطر الجذر متبوعاً بترك الحشائش لمدة 4 أسبوع ثم إزالة الحشائش لمدة 12، 10،8 أسبوع من الانبات ومن ناحية أخري أدي ترك الحشائش طوال الموسم إلي الحصول علي أقل القيم لقطر الجذر خلال موسم النمو.

4- أشارت النتائج إلي أن عدد أوراق بنجر السكر /نبات إزدادت معنويا بكل معاملات إزالة الحشائش. وتم الحصول علي أعلي عدد للأوراق /نبات من معاملة ترك الحشائش لمدة 4 أسابيع ثم إزالة الحشائش حتى 2 أسبوع في الموسم الأول. وتم الحصول علي أعلي عدد الأوراق /نبات من إزالة الحشائش طوال الموسم في الموسم الثاني بالمقارنة بترك الحشائش طوال الموسم في كلا الموسمين.

5- أعطت معاملة ترك الحشائش مع محصول البنجر لمدة أسبوعين أعلي وزن لأوراق بنجر السكر في الموسم الأول، ومن معاملة إزالة الحشائش طوال الموسم في الموسم الثاني ، بينما أعطت معاملة ترك الحشائش طوال الموسم أقل القيم لهذه الصفة في كلا الموسمين.

6- أشارت النتائج إلي أن معاملات إزالة الحشائش أحدثت زيادة معنوية في وزن جذور بنجر السكر في كلا موسمي الدراسة. وتم الحصول علي أعلي وزن للجذور من إزالة الحشائش طوال الموسم متبوعاً بترك الحشائش لمدة 4،2 أسابيع من الانبات ثم إزالة الحشائش حتى 12، 10 أسابيع م الانبات بينما تم

الحصول علي أقل وزن للجذور من ترك الحشائش طوال الموسم في كلا الموسمين.

7- أشارت النتائج إلي أن معاملات إزالة الحشائش أحدثت زيادة معنوية في محصول العروش (طن/فدان) في الموسم الأول والثاني. وتم الحصول علي أعلي محصول للعروش من معاملة إزالة الحشائش طوال الموسم في كلا الموسمين. بينما أعطت معاملة ترك الحشائش مع المحصول أقل القيم لهذه الصفة.

8- أوضحت النتائج أن محصول الجذور(طن/فدان) تأثر معنوياً بمعاملات إزالة الحشائش في كلا الموسمين وأعطت معاملات ثم إزالة الحشائش طوال الموسم أعلي محصول للجذور متبوعة بترك الحشائش لمدة 2 أسبوع ثم ترك الحشائش لمدة 4 أسبوع ثم إزالة الحشائش حتي 12 أسبوع ثم إزالة الحشائش حتي 10 أسبوع بينما أعطت معاملة ترك الحشائش مع المحصول أقل محصول لجذور بنجر السكر في كلا الموسمين.

9- أظهرت النتائج أن محصول السكر (طن/فدان) تأثر معنوياً بمعاملات إزالة الحشائش في كلا الموسمين. وتم الحصول علي أعلي محصول سكر من إزالة الحشائش طوال الموسم بينما تم الحصول علي أقل محصول سكر من ترك الحشائش مع المحصول طوال الموسم في كلا الموسمين.

10- أشارت النتائج إلي أن معاملات إزالة الحشائش لم تظهر أي تأثير معنوي علي صفة المواد الصلبة الذائبة الكلية في الموسم الأول بينما أدت جميع معاملات إزالة الحشائش إلي زيادة هذه الصفة معنوياً في الموسم الثاني.

11- أوضحت النتائج أن جميع معاملات إزالة الحشائش أدت الي زيادة معنوية في صفة نسبة السكروز في الموسم الثاني فقط.

12- أشارت النتائج أن نسبة النقاوة في بنجر السكر لم تتأثر معنوياً بمعاملات إزالة الحشائش في كلا الموسمين.

13- العلاقة بين الوزن الجاف للحشائش الحولية الكلية في نهاية الموسم ومحصول الجذور لبنجر السكر تحت ظروف الإصابة بالحشائش في التجربة (10طن،

9.7 طن/ف) كانت معنوية سالبة في معاملات إزالة الحشائش وترك الحشائش وكان معامل التنبؤ 73.1، 82.3، 10.2، 48.3% في موسم 2010/2009، 2011/2010 علي الترتيب.

14- تحديد الفترة الحرجة لمنافسة الحشائش لبنجر السكر:

أ- <u>الأساس البيولوجى:</u>

كانت الفترة الحرجة لمنافسة الحشائش لمحصول بنجر السكر من 2-10 أسابيع من الإنبات حيث أمكن للبنجر تحمل منافسة الحشائش لمدة أسبوعين فقط من الإنبات ويحتاج إلي فترة أطول خالياً من الحشائش تصل إلي 10 أسابيع.

ب- <u>الأساس الإحصائى (النماذج الرياضية):</u>

بتطبيق المعادلات تبين انه للمحافظة علي 95% من محصول جذور بنجر السكر يلزم ازالة الحشائش ابتداءاً من 1-2 أسبوع من الإنبات، والمحافظة علي المحصول خالياً من الحشائش حتي 13-14 أسبوع من الإنبات.

جـ - <u>الأساس الاقتصادى:</u>

وجد أن الفترة الحرجة اقتصاديا لمنافسة الحشائش لمحصول البنجر تقع ما بين 4-10 أسابيع من إنبات البنجر.

التجربة الثانية: تأثير بعض معاملات مكافحة الحشائش ،المحصول ومكوناته وجودة بنجر السكر وعلى الحشائش المصاحبة له

وكانت المعاملات كما يلي:

1- سفارى 50% WG (ترايفلوسلفيورون- ميثايل) بمعدل 12جم/فدان عند 21 يوم من الزراعة ثم سلكت سوبر 12,5 % EC (كليثوديم) بمعدل 300 سم^3/فدان عند 24 يوم من الزراعة.

2- تجرو 27.4% EC (فينمديفام + ديسميدفام + ايثوفيوميسات) بمعدل 1 لتر/فدان عند 21 يوم من الزراعة ثم سلكت سوبر 12,5 % EC بمعدل 300 سم^3/فدان عند 24 يوم من الزراعة.

3- بيت أب 16% EC (فينمديفام) بمعدل 1 لتر/فدان عند 21 يوم من الزراعة ثم سلكت سوبر 12,5 % EC بمعدل 300 سم^3/فدان عند 24 يوم من الزراعة.

4- جولتكس 70% SC (ميتاميترون) بمعدل 2 لتر/فدان بعد الزراعة وقبل الري.

5- جولتكس 70% SC بمعدل 2 لتر/فدان بعد الزراعة وقبل الري ثم بيت أب 16% EC بمعدل 1 لتر/فدان عند 21 يوم من الزراعة.

6- جولتكس 70% SC بمعدل 2 لتر/فدان بعد الزراعة وقبل الري ثم سفارى 50% WG بمعدل 12جم/فدان عند 21 يوم من الزراعة.

7- جولتكس 70% SC بمعدل 2 لتر/فدان بعد الزراعة وقبل الري ثم تجرو 27.4% EC بمعدل 1 لتر/فدان عند 21 يوم من الزراعة.

8- هارنس 84% EC (أسيتوكلور) بمعدل 1 لتر/فدان بعد الزراعة وقبل الري.

9- هارنس 84% EC بمعدل 1 لتر/فدان بعد الزراعة وقبل الري ثم بيت أب 16% EC بمعدل 1 لتر/فدان عند 21 يوم من الزراعة.

10- هارنس 84% EC بمعدل 1 لتر/فدان بعد الزراعة وقبل الري ثم سفارى 50% WG بمعدل 12جم/فدان عند 21 يوم من الزراعة.

11- هارنس 84% EC بمعدل 1 لتر/فدان بعد الزراعة وقبل الري ثم تجرو 27.4% EC بمعدل 1 لتر/فدان عند 21 يوم من الزراعة.

12- عزيق مرتين (20، 40 يوم من الزراعة).

13- عزيق ثلاث مرات (20، 40، 60 يوم من الزراعة).

14- بدون معاملة.

وتم توزيع المعاملات في تصميم القطاعات كاملة العشوائية في أربع مكررات وكانت مساحة القطعة التجريبية 10.5 م^2 وتم إجراء كافة العمليات الزراعية المتبعة في محصول البنجر. ويمكن تلخيص النتائج كما يلي:

1- أشارت النتائج أن جميع معاملات مكافحة الحشائش أعطت تأثير معنوي في خفض الوزن الجاف للحشائش الحولية النجيلية (جم/م^2) بعد 75 و 105 يوم من الزراعة في كلا الموسمين. كما سجل العزيق مرتين و ثلاث مرات اقل قيمة في الوزن الجاف للحشائش الحولية النجيلية فى الحصران بعد 75 و 105 يوم من الزراعة في كلا الموسمين. متبوعا بالمبيدات التالية تجرو ثم سلكت سوبر ، بيت أب ثم سلكت سوبر، سفارى ثم سلكت سوبر ، هارنس ثم سفارى ، هارنس ثم بيت أب ، هارنس ثم تجرو و هارنس مقارنةً بمعاملة الكنترول (بدون معاملة) .

2- أوضحت النتائج المتحصل عليها أن معاملات مكافحة الحشائش أعطت تأثير معنوي علي الوزن الجاف للحشائش الحولية عريضة الأوراق (جم/م^2) بعد 75 و 105 يوم من الزراعة في كلا الموسمين. وأعطت معاملة العزيق ثلاث مرات و العزيق مرتان أعلي نسبة مكافحة بالمقارنة بمعاملة الكنترول . فى كلا الحصرين في موسم 2011/2010.

3- أوضحت النتائج أن معاملات مكافحة الحشائش أعطت تأثير معنوي للوزن الجاف للحشائش الحولية الكلية (جم/م^2) عند 75 و 105 يوم من الزراعة في كلا الموسمين. وقد سجل العزيق ثلاث مرات والعزيق مرتان اقل قيمة للوزن الجاف للحشائش الحولية الكلية في الحصران (بعد 75 و 105 يوم من الزراعة) في كلا الموسمين متبوعا بالمبيدات التالية هارنس ثم سفارى ،

سفارى ثم سلكت سوبر ، تجرو ثم سلكت سوبر ، هارنس ثم تجرو ، جولتكس ثم سفارى ، هارنس ثم بيت أب ، جولتكس ثم تجرو ، بيت أب ثم سلكت سوبر ، هارنس ، جولتكس ثم بيت أب وجولتكس بالمقارنة بمعاملة الكنترول.

4- أثرت معاملات مكافحة الحشائش الكيماوية والميكانيكية معنويا على طول الجذر (سم) في كلا الموسمين بالمقارنة بمعاملة الكنترول.وأعطت معاملات العزيق ثلاث مرات ، هارنس ثم سفارى ، والعزيق مرتان ، سفارى ثم سلكت سوبر ، هارنس ثم تجرو ، تجرو ثم سلكت سوبر ، جولتكس ثم سفارى ، جولتكس ثم تجرو و جولتكس ثم بيت أب أعلى قيمة لهذه الصفة بدون اى فروق معنوية بين هذه المعاملات في كلا الموسمين .

5- أظهرت النتائج أن قطر الجذر تأثر معنويا بمعاملات مكافحة الحشائش في كلا الموسمين. و أدت معاملتي العزيق ثلاث مرات ومرتان أعلى قيمة في هذه الصفة بالمقارنة بمعاملة الكنترول .

6- أشارت النتائج أن عدد أوراق بنجر السكر/نبات تأثر معنويا بجميع معاملات مكافحة الحشائش. وأعطت معاملات العزيق مرتان و العزيق ثلاث مرات و جولتكس ثم تجرو ، تجرو ثم سلكت سوبر ، سفارى ثم سلكت سوبر و هارنس ثم سفارى أعلى عدد للأوراق /نبات في الموسم الأول. في الموسم الثاني أعطى العزيق ثلاث مرات ، سفارى ثم سلكت سوبر و العزيق مرتان أعلى قيمة في هذه الصفة وبينما أعطت معاملة الكنترول اقل قيمة لعدد الأوراق /نبات في الموسم الأول ومعاملة جولتكس و الكنترول في الموسم الثاني.

7- تأثر الوزن الأخضر للأوراق (جم/نبات) معنويا بمعاملات مكافحة الحشائش في كلا الموسمين. وأعطت معاملتي العزيق ثلاث مرات و العزيق مرتان أعلي زيادة في الوزن الأخضر للأوراق (جم/نبات) بالمقارنة بمعاملة الكنترول في كلا الموسمين .

8- أوضحت النتائج أن وزن الجذور (جم/نبات) تأثر معنويا بمعاملات مكافحة الحشائش في كلا الموسمين. ولقد تفوقت جميع معاملات مكافحة الحشائش

على معاملة الكنترول. وأعطت معاملتي العزيق ثلاث مرات و مرتان أعلى وزن للجذور بدون أي فروق معنوية بين هذه المعاملات في كلا الموسمين .

9- أظهرت النتائج وجود اختلاف معنوي بين معاملات مكافحة الحشائش في كلا الموسمين من حيث تأثيرها على محصول العروش (طن/فدان) ، وأدت معاملة العزيق ثلاث مرات ، العزيق مرتان ، هارنس ثم سفارى ، سفارى ثم سلكت سوبر و تجرو ثم سلكت سوبر إلى الحصول على أفضل نتائج لمحصول العروش (طن/فدان) في الموسم الأول . وكل من معاملتي العزيق ثلاث مرات والعزيق مرتان على التوالي في الموسم الثاني.

10- أوضحت النتائج عدم وجود اى اختلاف معنوي بين جميع معاملات مكافحة الحشائش و معاملة الكنترول على المواد الصلبة الذائبة الكلية في كلا الموسمين .

11- أوضحت النتائج أن نسبة السكروز ازدادت معنوياً مع معاملات مكافحة الحشائش بالمقارنة مع الكنترول في الموسم الثاني فقط .

12- أشارت النتائج أن نسبة النقاوة تأثرت معنويا بمعاملات مكافحة الحشائش في كلا الموسمين. حيث أعطت معاملة سفارى ثم سلكت سوبر أعلى نسبة نقاوة في الموسم الأول معاملة هارنس ثم تجرو في الموسم الثاني بينما أعطت معاملة الكنترول أقل قيمة لهذه الصفة في كلا الموسمين.

13- أوضحت النتائج أن معاملات مكافحة الحشائش أدت إلي زيادة معنوية في محصول الجذور (طن/فدان) في كلا الموسمين . وأعطت معاملات العزيق ثلاث مرات والعزيق مرتان أعلى محصول جذور في كلا الموسمين بالمقارنة بمعاملة الكنترول . كما أن الرش بمبيد هارنس ثم سفارى و سفارى ثم سلكت سوبر أعطت أعلى محصول جذور مقارنة بالمعاملات الكيماوية الأخرى لمكافحة الحشائش.

14- أظهرت النتائج أن معاملات مكافحة الحشائش أدت إلى زيادة معنوية في محصول السكر (طن/فدان) مقارنة بمعاملة الكنترول في كلا الموسمين .

15- العلاقة بين الوزن الجاف للحشائش الحولية النجيلية و عريضة الأوراق و الكلية عند 75 و 105 يوم من الإنبات و محصول الجذور (طن/فدان) كانت معنوية سالبة.

16- أظهر تحليل متبقيات المبيدات في جذور بنجر السكر أن الأثر المتبقي لجميع المبيدات المستخدمة كان تحت الحد المسموح به.

الخلاصة:

نستخلص من هذه الدراسة أن الفترة الحرجة لمنافسة الحشائش لمحصول بنجر السكر كانت من 2-12 أسبوع من إنبات بنجر السكر.

وإزلة الحشائش خلال هذه الفترة الحرجة بإستخدام المعاملات التالية مرتبة تنازلياً: العزيق ثلاث مرات، العزيق مرتين ، الهارنس ثم السفارى والسفارى ثم سلكت سوبر أدي إلي الحصول علي أعلي محصول لبنجر السكر ومكوناته في كلا الموسمين.

صفحة الموافقة علي الرسالة

تحديد الفترة الحرجة لمنافسة الحشائش مع محصول بنجر السكر وطرق مكافحتها

رسالة مقدمه من

أسامة ماهر محمود عبداللاه مبارك

بكالوريوس العلوم الزراعية - جامعة جنوب الوادي- سوهاج ٢٠٠٣
ماجستير العلوم الزراعية - محاصيل- جامعة المنيا ٢٠٠٨

للحصول على درجة دكتوراة الفلسفة فى العلوم الزراعية
(محاصيل)

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تحديد الفترة الحرجة لمنافسة الحشائش مع محصول بنجر السكر وطرق مكافحتها

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ماجستير العلوم الزراعية (محاصيل)- كلية الزراعة- جامعة المنيا 2008

للإستيفاء الجزئى لمتطلبات الحصول على درجة

دكتوراة الفلسفة فى العلوم الزراعية

(محـاصيـل)

من

قسم المحاصيل

كلية الزراعة - جامعة أسيوط

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