SPECIFIC ACTIVITY OF FOUR PRE-EMERGENCE HERBICIDES ON THE MOST POPULAR WEED SPECIES IN COTTON (*GOSSYPIUM BARBADENE* CV. GIZA 80) CULTIVATED IN MINIA UNIVERSITY FARM

Sanaa Abdel-Hamid Ibrahim
Mohamed Farouk Kamel
Plant Protection Department, Faculty of Agriculture
Minia University- Egypt
Ahmed Mostafa Ahmed
Weed Research Central Laboratory
Agriculture Research Center, Giza-Egypt

Abstract

Of twelve weed species surveyed in 2014 cotton growing season, only five species (*Euphorbia helioscopia*; *Corchorus olitorius*; *Brachiaria repans*; *Echinochloa colonum* and *Convolvulus arvensis* var. *arvensis*) were dominant. In 2015, 16 weed species were surveyed (ten from those surveyed in 2014 and six extra species); however, the sole dominant species was *Echinochloa colonum*. Four preemergence herbicides were applied at the recommended field rate just after sowing cotton and before the first irrigation. Those herbicides are: Amex, EC-48% (butralin) at 2.5 L (1.2 kg a. i.) per feddan (0.42hectar); Stomp extra, SC-45.5% (pendimethalin) at 1.7 L (0.7735 kg. a. i.); Lumax, SC-15% (mesotrione) at 1L. (0.15 kg. a. i.) /feddan; and Gardo, EC-96% (s-metolachlor) at 0.6L (0.576 kg. a. i.) /feddan. The specific performance of tested herbicides on five predominant weed species was compared when each was used as a single treatment or when followed by one hand hoeing at 60 days after herbicide treatment. Percentages of reduction, in either the population density or the green biomass from the two year pooled data, were used in the comparison among treatments. For ***Echinochloa colonum***; Amex and Stomp extra performed very well either when used as single treatments or when followed by one hand hoeing; Gardo as a single treatment, moderately controlled this species, however one hoeing significantly enhanced its performance; Lumax was ineffective in controlling *Echinochloa colonum*. For controlling ***Brachiaria repans***; Amex and Stomp extra were effective; Gardo was ineffective as a single treatment, however its performance moderately enhanced when followed by one hand hoeing. Lumax both single and combined treatments were ineffective in controlling this weed species. It seems that the reduction in the green biomass of the broad leaved weeds such as ***Corchorus olitorius*** was more accurate indicator for evaluating the herbicidal efficiency than that of population density and hoeing once is a complementary treatment. The efficiency of the four herbicides on *Corchorus olitorius* ranged from weak to moderate; however, their joint performance with one hand hoeing was excellent. Hand weeding twice (weeded control treatment) was better in controlling *Corchorus olitorius* than the four herbicides when used as single treatments. The four herbicides were ineffective on ***Euphorbia helioscopia***; however their integration with one hand hoeing enhanced their performance to great extent, almost to the same magnitude of weeded control treatment. Based on the reduction in the population density, none of the four herbicides offered good control against ***Convolvulus arvensis* var. *arvensis*** even when they followed by one hand hoeing. Weeded control treatment was ineffective (17.02%) in controlling *Convolvulus arvensis* var. *arvensis*. Based the comparison on the green biomass, similar trend was achieved except for Amex and Lumax with one hoeing that offered 20.65 and 60.16% reduction, respectively. Also, weeded control treatment that was ineffective in reducing the population density of *Convolvulus arvensis* var. *arvensis* offered 79.33% reduction in the green biomass of this perennial herb. For the specific activity of tested herbicides on two less abundant species, *Cynodon dactylon* and *Cyperus rotundus*, moderate enhancement of Lumax combined treatment in reducing the population density of both species (55.26%); however it was ineffective in reducing the green biomass (-32.10%). Single treatments of Amex, stomp extra and Gardo offered good control based on the reduction in either the population density or the green biomass; however one hand hoeing antagonized their performance. Weeded control treatment was ineffective in reducing the population density of perennial grasses; however, offered great performance in reducing the green biomass (90.15%)

Introduction

Cotton (*Gossypium* spp) is an economic crop in Egypt and worldwide. In cotton, weeds cause several direct and/or indirect negative impacts, such as (a) reducing fiber quality, (b) reducing crop yield, (c) increasing production costs, (d) reducing irrigation efficiency, (e) serving as hosts and habitats for insect pests, disease-causing pathogens, nematodes, and rodents; and (f) releasing allelopathic, or growth suppressing, chemicals. Therefore, weeds have been documented as serious plant pests **(Smith *et al.,* 2000 and Zimdahl, 2013).**

The damage by weeds varied according the growth habit of weeds and the time of infestation **(Knezevic and Datta; 2015)**. It is important to start control early to prevent the effect of weeds on cotton squares and bolls. In

India, **Ferrel *et al*. (2001)** found that the infestation of weed flora in cotton crop reduced the yield to 1.28 and 1.6 ton /ha compared to 2.41 and 2.33 ton/ha from weed free cotton field, and the severity of weed competition depending on weed densities and their compositions. Competition with (*Cyperus esculentus*) for 6 to 8 weeks reduced yield by 20% and full season competition cut it by 34%. *Xanthium pensylanicum* also is a very serious problem weed in cotton where at densities of 1 to 10 plants per 10 cotton plants reduced yield by more than 20% up to more than 80% **(Buchanan and Burns, 1971)**.

During recent times, herbicides and other modern means of weed control have been used. However, since the beginning of modern agriculture, hand weeding, mechanical weeding, and herbicide applications have been the most relied upon weed control methods **(Griepentrog and Dedousis, 2010; Bergin, 2011; Rueda-Ayala et al., 2011; and Chauvel et al., 2012).**

Recent approach in weed control is to integrate cultural and chemical treatments to increase the efficiency of herbicides and reduce the environmental contamination. One of the first steps in designing an IWM program is to identify the critical period for weed control (CPWC), which defined as a period in the crop growth cycle during which weeds must be controlled to prevent crop yield losses **(Zimdahl 1988 and Knezevic *et al.* 2002).** Timing of, weed control, is depending on the specific crop**.** It is defined in many crops including cotton (**Bukun 2004** and **Everman *et al.* 2008)**. This study aims to compare the specific activity of four preemergence herbicides on the predominant weed species and evaluate the joint impact of those herbicides when they integrated with hand hoeing once at 60 days after sowing.

Materials and Methods

In 2014, an area of about one fourth of feddan (1050m^2) was divided to 40 plots of ~ 26.0m^2 each. However, in 2015, similar area was divided in to 30 plots of ~ 35m2 each. Cotton **(***Gossypium barbadense*; cv. Giza 80) was sown in April 13, and April 6 in 2014 and 2015, respectively. In 2014, eight replicates were randomly chosen for each herbicide treatment; however they reduced to six plots in 2015. The plots for each herbicide received the recommended field rate just after sowing and before the first irrigation that was conducted within 24 hours after sowing. At sixty days after sowing, half of those plots were randomly chosen to conduct hand hoeing as an additional treatment and the other half were left for herbicide single treatment. Similarly, half of the control replicates were received hand hoeing twice at 30 and 60 days after sowing and named hand weeding or weeded control treatment. The other half did not receive any treatment and called unweeded control treatment or the untreated check.

At 90 days after sowing, individual weeds were carefully pulled from a square meter randomly chosen from each replicate. Weed collections from 40 plots in 2014 and from 30 plots in 2015 were taken to the laboratory and each collection was segregated into different species. Mean population density and fresh weight for each species were calculated and compared between treatments using one way analysis of variance followed by Duncan Multiple Comparison test at 5% level of probability **(Gomez and Gomez, 1984).** Combined data of the two seasons were used to calculate percentages of reduction in either population density or green biomass. Reduction percentage = ((Control – treatment)/ control))*10**0** was also used in comparison between treatments

Results

1. Weed survey and frequency profile:

Weed survey was conducted at 90 days post sowing in the unweeded plots. Weed species in a square meter of each replicate were identified, counted and weighed**.** In 2014, twelve weed species were surveyed (*Brachiaria repans*; *Convolvulus arvensis* var. *arvensis; Corchorus olitorius; Cynodon dactylon; Cyperus rotundus*; *Echinochloa colonum; Euphorbia helioscopia; Hibiscus trionum,* L.; *Medicago polymorpha; Portulaca oleracea; Sonchus oleraceus;* and *Xanthium pungens*).

In 2015, 16 weed species were surveyed. Ten weed species were shared in the two seasons and six additional weed species (*Datura quercifolia*; *Rumex dentatus; Solanum nigrum*; *Tribulus terrestris*; *Urtica ureas*; and *Vicia sativa.)* were added to the list of 2015. The survey in the two seasons revealed that the total number was 18 species, only one from perennial broad, two from perennial narrow, two from annual narrow and the rest (13 species) from annual broad.

Of twelve weed species surveyed in 2014 cotton growing season, five were dominant and considerable (**Table 1 and Figure 1)**. The frequency profile based on population density is graphed in **Figure (2, Set A).** *Brachiaria repans* represented 30.09%; followed by *Echinchloa colonum* (20.54%); *Corchorus olitorius* (20.38%);

Euphorbia helioscopia (13.85%) and *Convolvulus arvensis* var. *arvensis* represented 7.49% of the population density of all weed species. However, the rest of surveyed weed species represented altogether 7.64%. In 2015 only *Echinochloa colonum* was the greatest popular species with 98.82% representative; however, 15 weed species were negligible (1.18%) **(Figure 2, Set B).**

Per cent abundance was recalculated from the green biomass **(Figure 3)**. In 2014, *Euphorbia helioscopia* represented 26.3% followed by *Echinochloa colonum* (23.22%); *Corchorus olitorius* (22.66%); *Convolvulvus arvensus* var *arvensus* (11.88%); *Brachiaria repans* (10.57%). Seven weed species represented altogether 5.37% **(Figure 3, Set C)**. In 2015 **(Figure 3, Set D)**, only three species were more dominant; *Echinochloa colonum* represented 92.05; followed by *Corchorus olitorius* (4.63%) and *Convolvulus arvensus* var, *arvensus* (3.26%). However 13 weed species represented altogether 0.07%.

<u>2. Specific activity of tested herbicides on the five predominant weed species</u>

2.1. *Echinochloa colonu*m

In 2014 cotton growing season, *E colonum* represented 20.54 and 23.22% when the calculation was based on the population density and the green biomass, respectively. However, in 2015, its representative was 98.82 and 92.05%, respectively. It seems that the population density in the untreated plots at 90 days after sowing was very much greater (559.67individual weeds/m^2) in 2015 compared to 32.25individual weeds/m^2 in 2014. As seen in **Table (2)**, four treatments (Stomp extra with or without hoeing (91.48 and 100% reduction, respectively); Amex with one hand hoeing (90.26%) and Gardo with one hand hoeing (99.58%) were excellent and insignificantly different.

Green biomass of this species is reduced by 82.61 to 100% in the four treatments of Amex and Stomp Extra without significant differences between them in this respect. However, Gardo was significantly more effective when followed by hand hoeing once than when it used as a single treatment (99.08 versus 56.77%, respectively). Lumax was inferior either when used as a single treatment or when integrated with hand hoeing. Percent reduction in the population density was -1.61 and 38.18%, respectively and per cent reduction in the green biomass was 12.19 and 48.13%, respectively. Hand weeding twice was very much better than Lumax when integrated with one hand hoeing; percent reduction in the population density and green biomass was 66.21 and 64.87% compared to 38.18 and 48.13% in the case of Lumax when integrated with one hand hoeing.

2.2. *Brachiaria repans*

In contrast to *Echinochloa colonum*, population density of *Brachiaria repans* was very much greater in 2014 (47.25individuals/m$^{2)}$) than in 2015 (0.67 individuals/m^2). In 2014, *Brachiaria repans* represented 30.09 and 10.57% from the population density and green biomass of all weed species, respectively. However, it was negligible in 2015. Amex and Stomp extra when both were used either as single treatments or in combination with hand hoeing, were effective in reducing the population density of *Brachiaria repans* **(Table 3)** with no significant differences between the four treatments (85.89% to 99.46%). It seems that hand hoeing once was not needed when Amex and Stomp extra was used to control *Brachiaria repans*. In contrast, Gardo, when integrated with hand hoeing once was moderately effective (68.70%) against this weed species; however, was less effective as a single treatment (24.17%). As with *Echinochloa colonum,* Lumax was ineffective in reducing the population density of *Brachiaria repans,* neither when used as a single treatment (17.57%) nor when integrated with hand hoeing once (-59.14%). Hand weeding twice gave unsatisfactory reduction (40.53%) in the population density; however was ineffective in reducing the green biomass (-7.22%)... This means that hand hoeing is not valuable treatment in controlling the annual grasses.

2.3. *Corchorus olitorius*

As recorded in **Table (4**), the population of *Corchorus olitorius* was very much greater in the untreated plots during 2014 season than that during 2015 season (32.0 versus 2.0individual weeds/m^2). In 2014; population density in all weed control treatments was significantly less than those in the unweeded plots. However, in 2015, the population density of this weed species was significantly less in Lumax both treatments, Gardo when integrated with one hand hoeing as well as weeded control treatment. For the rest (Amex and Stomp extra both treatments and Gardo as a single treatment), they were insignificantly different with those in the unweeded control treatment.

Based the comparisons on the two season combined data, population density was significantly reduced by 99.03% and 95.35% in the treatments of Lumax, and Gardo, respectively when they were combined with hand hoeing once. Also, population of this weed species was significantly reduced (84.56 to 95.82%) in Amex and Stomp extra all treatments. In comparison, hand weeding twice was excellent in reducing the population density of this weed species by 95.35%. Lumax and Gardo, each as a single treatment were less effective (58.09 and

73.29%, respectively). Similarly, green biomass was about three times greater in 2014 than in 2015 (224.40 versus 86.67gm/m^2). In 2014, means of green biomass in all weed control treatments were significantly less than those in control treatment. In 2015, those means were significantly less only in Amex, stomp extra and Gardo when each was followed by hand hoeing once as well as Lumax both treatments. The reduction in the green biomass revealed that, the four herbicides performed excellent, only when they were integrated with hand hoeing (87.7 to 98.5%) and were in the same magnitude of hand weeding twice (85.23% reduction).

2.4. *Euphorbia helioscopia*

This weed species was not observed in 2015 and data of 2014 season were used in the comparisons between treatments **(Table 5)**. Population density of *Euphorbia helioscopia* was insignificantly less in Lumax and Gardo combined treatments as well as weeded control treatment (85.06, 52.87 and 58.62% reduction in the population density, respectively). For the rest of chemical treatments, population density increased by 3.45% to 270.12% and this negative effect was very much reduced when the same treatments integrated with hand hoeing **(Table 5)**. Obtained data confirmed the importance of depending on green biomass for evaluating the performance of herbicides. For explanation, the four herbicidal treatments performed well when they were integrated with hand hoeing once (69.7 to 93.86%) compared to 85.38% in the weeded control treatment). In contrast, the four herbicides as single treatments were ineffective, moreover, green biomass of this weed species in herbicide single treatments increased by 98.81 to 365.78%.

2.5 *Cynodon dactylon* and *Cyperus rotundus*

Two perennial narrow leaved weed species were surveyed in 2014 season and were negligible in 2015 **(Table 5)**. Amex, Stomp extra and Gardo as single treatments were effective in reducing the population density and green biomass of perennial grasses. Mean number was significantly less in Amex single treatment; Stomp extra both treatments; Lumax single treatment; and Gardo single treatment (97.37, (100, 15.79), 55.26, 76.32%, respectively. However when they were integrated with one hand hoeing, their performance significantly decreased; moreover, number of both species increased by 7.9%, 139.47, 171.05% in Amex combined treatment; Gardo combined treatment, and Lumax single treatment, respectively. Interestingly, perennial grass populations in weeded control treatment increased by 113.16%, more than the unweeded control treatment. These data confirmed the antagonized impact of hand weeding on tested herbicides on perennial grasses. The reduction in the green biomass was great in Stomp extra single treatment (100%); followed by each of Amex, Gardo, both single treatments, weeded control treatment (~90.0%) followed by Stomp extra integrated with one hand hoeing (76.06%). Amex in integration with hand hoeing was ineffective (0.0), and Lumax both treatments increased the green biomass of both weed species by 32.10% more than the unweeded control treatment.

2.6. *Convolvulus arvensis* var. *arvensis*.

Convolvulus arvensis var. *arvensis* was the sole species from perennial herbs. Population density was insignificantly less in the treatments of Amex, Stomp extra and Lumax when each of the three treatments was integrated with hand hoeing once; also this trend was achieved in weeded control treatment **(Table 6)**. However, for other treatments, with the exception of Gardo single treatment, population density was insignificantly greater than that of unweeded control treatment. When the reduction in the two year combined data was compared, all treatments (except Lumax when integrated with hand hoeing as well as weeded control treatment) resulted in increasing the population more than the unweeded control treatment. Lumax with one hand hoeing resulted in 30.75% reduction in the green biomass compared to 17.02% in the weeded control treatment. Per cent reduction in green biomass was reduced in Amex with hoeing (20.65%); Lumax with hoeing (60.16%) and weeded treatment (79.33%). However, for the other treatments fresh weight of this species increased more than unweeded control treatment. These herbicides were ineffective against *Convolvulus arvensis* var. *arvensis* and are not recommended to be used when perennial weeds are expected to be dominant in cotton fields.

Discussion

In 2014, annual broad leaved weeds were the most popular species in cotton fields, particularly ***Euphorbia helioscopia*** and ***Corchorus olitorius*** followed by two species (***Brachiaria repans*** and ***Brachiaria repans***) from annual narrow. The only perennial broad achieved in cotton fields was ***Convolvulus arvensis*** var ***arvensis*** and its representative in 2014 ranged from 7.49 to 11.88% based on the population density and green biomass, respectively. *Convolvulus arvensis* hangs on cotton plants which difficulties the hand picking of cotton at harvest. Perennial narrow include ***Cynodon dactylon* and *Cyperus rotundus*** and both were negligible. Data in 2015 confirmed that the only dominant species was ***E. colonum*** and perennial grasses were not recorded in this season. In previous study, **Norsworthy *et al.* (2007)** In Arkanses, USA, mentioned that horseweed, Palmer amaranth, and morningglories were the three most problematic weeds in cotton**. Mahmoud and Sabra (2009)** conducted a field experiment in Egypt, in 2007 and 2008 on cotton (*Gossypium barbadense*) cv. Giza 86; the predominant weed species was common purslane (*Portulaca oleracea*) in the first *season and livid amaranth (Amaranthus ascendens lois) in the second season.* **Madhu *et al.* (2014**) in Bapatla surveyed in experimental plots *Cynodon dactylon, Dactyloctenium aegyptium, Digitaria* sanguinalis, *Echinochloa colona, Panicum repens*, (grasses) *Cyperus rotundus* (sedge) and broad leaved weeds *viz.*, *Acalypha indica*, *Acalypha ciliata, Achyranthes aspera, Aristolochia bracteata*, *Cleome viscosa*, *Commelina benghalensis*, *Corchorus trilocularis*, *Cynotis cucullata*, *Digera arvensis, Euphorbia hirta, Euphorbia geneculata, Merrimia emerginata*, *Physalis minima, Phyllanthus maderaspatensis, Trianthema portulacastrum*, and *Tridax procumben*to. In Turkey, **Özaslan *et al.* (2015)** found *Xanthium strumarium* L. (common coclebur), *Sorghum halepense* (L.) Pers. (johnsongrass), *Amaranthus retroflexus* L. (common amaranth), *Cynodon dactylon* (bermudagrass), *Physalis* spp. (ground cherry) [*Physalis philadelphica* Lam*.* (Mexican groundcherry) and *Physalis angulata* L. (cutleaf groundcherry)] , *Solanum nigrum* L. (black nightshade), *Portulaca oleracea* L. (purslane), *Cyperus rotundus* L. (nutgrass) to be the predominant weed species in Diyarbakır Province of Turkey.

In the current study, Amex and Stomp extra (both from dinitroaniline group) as single treatments were effective on ***Echinochloa colonum*** and ***Brachiaria repans****.* Their efficiency was unsatisfactory on ***Corchorus olitorius*** and ***Euphorbia helioscopia***; however, their joint performance with one hoeing against the two broad leaved species was excellent. None of the two herbicides offered good control against ***Convolvulus arvensis* var. *arvensi****s* even when their treatments were followed by one hand hoeing. For both ***Cynodon dactylon*** and ***Cyperus rotundus***, **Amex, Stomp extra** offered good control; however one hand hoeing **antagonized** their performance. In this study, it was evident that pre emergent herbicides (Amex, Stomp extra and Gardo) are mostly effective on grasses and ineffective on broad leaved weeds; integrating hoeing may help in controlling annual broad leaves weeds that failed those chemicals to control them. The importance of integrating hand weeding for the control of the broad leaved weed species**, *Corchorus olitorius*** and ***Euphorbia helioscopia*** was confirmed in previous study by **Smart and Bradford (1998)**. In more recent study, **Singh and Rathore (2015)** reported that using pendimethalin in combination with cultural practices could be the practical solution for effective weed management. In the current study, pendimethalin performed well against annual grasses and this finding was confirmed in previous study by **Fayed *et al*. (1983; and Khan *et al*. (2001)**. More confirmation to the recent study was by **Al-Rahban *et al.* (2010) who** obtained 100% control of narrow-leaved weeds in pendimethalin treatment. In the current study, the two herbicides from dinitoaniline group were ineffective on annual broad leaved weeds. However in disagreement, **Dilbaugh *et al.* (2009)** obtained 82.5 % broad leaf and 84.1 % narrow leaf control.

Gardo (from chloroacetanilide group), EC-96% (s-metolachlor) at 0.6L (0.576 kg. a. i.) /feddan was used in the current study. **Gardo** as a single treatment moderately controlled ***Echinochloa colonum***, however one hoeing significantly enhanced its performance; it was ineffective in controlling ***Brachiaria repans***; however its performance moderately enhanced when followed by one hand hoeing. It was less efficient on ***Corchorus olitorius*** and ***Euphorbia helioscopia***; however its integration with one hand hoeing enhanced its performance to great extent, almost to the same magnitude of weeded control treatment. It was ineffective against ***Convolvulus arvensis* var. *arvensi****s* even when followed by one hand hoeing. Gardo offered good control of ***Cynodon dactylon*** and ***Cyperus rotundus***; however one hand hoeing **antagonized** its performance. In the current study, Gardo (s-metolachlor) was one of the most effective treatments against annual grasses, but was ineffective against annual broad leaved weeds; in agreement with our finding, **Webster *et al.* (2006)** confirmed that s-metolachlor at 1.60 kg a.i./ha were from the most effective (≥ 80% control) herbicides. It is clearly evident, that preemergence herbicides when integrated with hand hoeing gave the best results against annual weeds. In our study S-metolachlor was ineffective against annual broad leaved weeds; however its integration with hand hoeing enhanced its performance. For increasing the performance of preemergence herbicides against all annual weeds, they must be followed by hand hoeing once or a post-emergence herbicide. **Clewis *et al.* (2006)** combined S-metolachlor with glyphosate to control broadleaf signalgrass, goosegrass, large crabgrass, and yellow foxtail 14 to 43 percentage points compared with control by glyphosate alone. **Everman *et al*., (2007)** in the USA found that **t**he addition of S-metolachlor to glufosinate EPOST improved control of all weeds except sicklepod, ivyleaf morningglory, and entireleaf morningglory. Also, **Arantes *et al.* (2014)** recommend using S-metolachlor over the top, followed by one post-emergence mixture application of pyrithiobac-sodium + trifloxysulfuron-sodium. This treatment is the optimum to maximize cotton yield

Lumax (Benzoylcyclohexandione group) was ineffective in controlling ***Echinochloa colonum*** and ***Brachiaria repans***. Lumax moderately controlled ***Corchorus olitorius****;* however, its joint performance with one hoeing was excellent. With ***Corchorus olitorius***, it is clearly evident that the reduction in the green biomass was an accurate indicator for the herbicidal activity than that of population density. Herbicides may weakly affect the germination of weed seeds, but may be acted as strong inhibitors of seedling root or/and shoot growth. Green biomass is a function of growth inhibition is strongly involved in the competition of weeds with plant crop on different sources of growth.

It was ineffective on ***Euphorbia helioscopia***; however performed well with one hand hoeing, almost to the same magnitude of weeded control treatment. It was ineffective on ***Convolvulus arvensis*** **var.** ***arvensis*** even when was followed by one hand hoeing. Lumax without and with one hoeing offered 20.65 and 60.16% reduction in the green biomass of *Convolvulus arvensis* var. *arvensis*, respectively compared to 79.33% in weeded control treatment. Based on the population density, moderate enhancement of **Lumax** herbicidal activity on ***Cynodon dactylon*** and ***Cyperus rotundus*** was achieved with one hand hoeing however it was ineffective in the two treatments when the reduction of the green biomass was considered. From the current study it seems that Lumax acts only on annual broad leaved weeds and controlling this group it must be followed by one hoeing. It seems that the rate of field application of Lumax was lower (0.15kg a.i./feddan) and must be increased to offer acceptable control of annual herbs. In agreement, **Mahmoud and Sabra (2009)** obtained good results with Lumax only when combined with acetochlor. In agreement with our finding, **Kelton *et al,* 2013** confirmed the importance of hand hoeing for enhancing the performance of pre-emergent herbicides.

Acknowledgment

The fund for participating in 2016 Beltwide Cotton Conferences, Cotton Insect Research and Control Conference was partially offered by Minia University, Egypt. This research is a part of study conducted by a Master Degree Student, Mohamed Farouk Kamel Ali, a Demonstrator at Plant Protection Department, Faculty of Agriculture, Minia University.

References

Al-Rahban, B.; Mhemid, K.; and Mhemid, A. (2010). Effect of irrigation methods on herbicides activity for controlling cotton weeds and crop yield. Arab Journal of Plant Protection; **28** (2): 156-162.

Arantes, J. G. Z.; Constantin, J.; Oliveira, JR. R. S.; Braz, G. B. P.; Barbosa, C. A. S.; Brugenera, P.; Oliveira, Neto, A. M.; and Gemlli, A. (2014). Selectivity of chemical weed control systems in conventional cotton. Planta Daninha, Viçosa-MG; 32 (4): 827-841,

Bergin, D. (2011). Weed control options for coastal sand dunes: a Review. New Zealand Forest Research Institute LTD: 5-13.

Buchanan, G. A.; and Burns, E. R. (1971). Weed competitions in cotton. Weed Sci.; **19**: 580-582..

Bukun, B. (2004). Critical periods for weed control in cotton in Turkey. Weed Research; 44: 404-412.

Chauvel, B.; Guillemin, J.-P.; Gasquez, J.; and Gauvrit, C. (2012). History of chemical weeding from 1944 to 2011 in France: changes and evolution of herbicide molecules. Crop Prot.; **42**: 320-326.

Clewis, Scott B.; Wilcut, John W.; and Porterfield, Dunk (2006). Weed Management with S-Metolachlor and Glyphosate Mixtures in Glyphosate-Resistant Strip- and Conventional-Tillage Cotton (*Gossypium hirsutum* L.). Weed Technology; **20** (1): 232-241.

Dilbaugh, M.; Muhammad, N. A.; Raza, I.; and Mian, M. A. (2009). Growth and development of cotton (*Gossypium hirsutum* l.) as affected by different methods of pendimethalin application, Pak. J. Weed Sci. Res.; 15 (1): 11-17,

Everman, W. J.; Clewis, S. B.; Thomas, W. E.; Burke, I. C.; and Wilcut, J. W. (2008). Critical period of weed interference in peanut. Weed Technol.; **22**: 63–67

Fayed, M. T.; Mostafa, M. T.; and Hassanein, E. E. (1983). Increasing the efficiency of herbicides in controlling cotton weeds by one light hoeing. Proc. First Conf. of Agron. Egyptian Soc. of Crop Sci.; **2**: 679-688.

Ferrel, J. A.; Mac Donald, G. E.; and Brecke, B. J. (2001). Weed management in cotton. University of Florida IFSA Extension, pp, 1-32. (C.F. Asian j). plant sci.; **6** (2): 344-348,

Gomez, K. A. and Gomez, A. A. (1984): Statistical procedures for agricultural research (2nd edition). John Wiley & Sons, New York; 704p

Griepentrog, H. W.; and Dedousis, A. P. (2010). Mechanical Weed Control, Soil Engineering. Springer; pp. 171-179.

Kelton, Jessica A.; Price, Andrew J.; Patterson, Michael G.; Monks, Dale C.; and van Santen, Edzard (2013). Evaluation of Tillage and Herbicide Interaction for Amaranthus Control in Cotton. Weed Technology; **27** (2): 298-304.

Khan, N. U.; Khan, S. U.; Hassan, G.; Shah, I. H.; and Nawaz, Q. (2001). Studies on weed control in cotton (*Gossypium hirsutum L*). J. Bid. Sci.; 1 (3): 143-145.

Knezevic, S. Z.; Evans, S. P.; Blankenship, E. E.; Van Acker, R. C.; and Lindquist, J. L. (2002). Critical period of weed control: the concept and data analysis. Weed Sci ;50: 773–786.

Knezevic, Stevan, Z.; and Datta, Avishek (2015). The Critical Period for Weed Control: Revisiting Data Analysis. Weed Science; Special Issue: 188–202

Madhu, G.; Srinivasulu, K.; Prasuna Rani, P.; and Rao, A. S. (2014). Economics of rainfed Bt cotton as influenced by sequential application of herbicides. J. Cotton Res. Dev. **28** (2) 257-259.

Mahmoud, M. S. M.; and Sabra, F. S. (2009). Efficacy of certain herbicides and their mixtures on cotton weeds and their impact on yield and yield components. Alexandria Journal of Agricultural Research; **54** (3): 91-98.

Norsworthy, Jason K.; Smith, Kenneth L.; Scott, Robert C.; and Gbur, Edward E. (2007). Consultant Perspectives on Weed Management Needs in Arkansas Cotton. Weed Technology; **21** (3): 825-831.

Özaslan, Cumali; Akin, Songül; and Gürsoy, Songül (2015). Weed Control and Crop Production Practices in Cotton Production in Diyarbakır Province of Turkey. YYÜ TAR BİL DERG (YYU J AGR SCI); **25** (1): 41-47

Rueda-Ayala, V.; Rasmussen, J.; Gerhards, R.; and Fournaise, N. E. (2011). The influence of post-emergence weed harrowing on selectivity, crop recovery and crop yield in different growth stages of winter wheat. Weed Res.; **51**: 478-488.

Singh, Kulvir and Rathore, Pankaj (2015). Efficacy evaluation of selected herbicides on weed control and productivity evaluation of *Bt* cotton in Punjab. Journal of Environmental Biology; **36**: 993-998.

Smart, J. R.; and Bradford, J. M. (1998); edited by **Dugger, P.; and Richter, D.** No-tillage cotton weed management in corn and sorghum stubble. 1998 Proceedings Beltwide Cotton Conferences, San Diego, California, USA**; 1**: 866-868.

Smith, Dudley T.; Baker, Roy V.; and Steele, Gregory L. (2000). Palmer Amaranth (*Amaranthus palmeri*) Impacts on Yield, Harvesting, and Ginning in Dryland Cotton (*Gossypium hirsutum*). Weed Technology; **14** (1): 122-126.

Webster, T. M.; Burton, M. G.; Culpepper, A. S.; Flanders, J. T.; Grey, T. L.; and York, A. C. (2006). Tropical spiderwort (*Commelina benghalensis* L.) control and emergence patterns in preemergence herbicide systems. Journal of Cotton Science; **10** (1): 68-75.

Zimdahl, R. L. (1988). The concept and application of the critical weed-free period. Pages 145–155 in Altieri, M. A. and Liebmann, M. eds. Weed Management in Agroecosystems: Ecological Approaches. Boca Raton, FL: CRC Press.

Zimdahl, R. L. (2013). Fundamentals of Weed Science, fourth ed. Academic Press, San Diego, CA, USA.

Table (1): Arabic, common, Latin and family names of five popular weed species surveyed in the unweeded control plots at ninety days post sowing in 2014 and 2015 cotton growing seasons. Weed species arranged in genera alphabetic order.

Arabic name and season of survey	Common name	Scientific name	Family	Description
حشيشة الأرانب 2015/2014	Sweet signal grass, Signal grass	*Brachiaria repans,* L. Gardner et Hubb	Gramineae	Annual grass
العليق الافرنجي 2015/2014	Field bindweed	*Convolvulus arevensis* var. *arvensis,* L.	Convolvulaceae	Perennial herb
ملوخية شيطاني 2014/2015	Nalta jute, Jews mallow	*Corchorus olitorius,* L.	Tiliaceae	Annual summer herb
أبو ركبة 2015/2014	Deccan grass, Jungle rice, awnless, Barnyard grass	*Echinochloa colonum*	Gramineae	Annual summer grass
لبينة أو أم اللبن أو الشربة 2014	Mexican fir plant, Cat's milk, mad woman's milk, sun euphorbia, Sun spurge, Umbrella milk weed, Wart spurge, Wart weed	*Euphorbia helioscopia*	Euphorbiaceae	Annual summer herb

Brachiaria repans

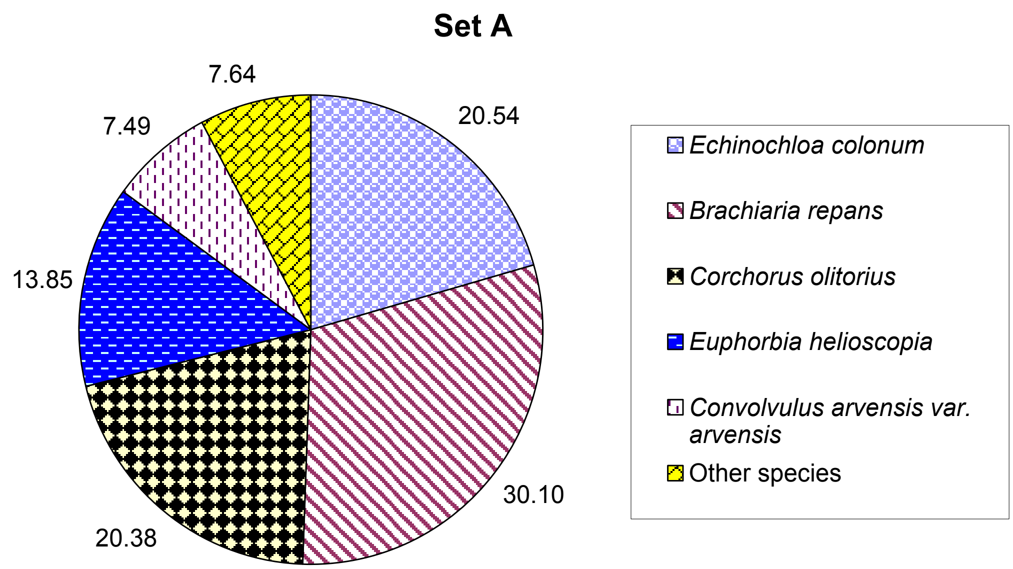
Convolvulus arevensis

Corchorus olitorius

Echinochloa colonum

***Euphorbia helioscopi*a**

Figure (1). Photos of the most popular weed species surveyed in the unweeded control plots at 90 days after sowing. Those photos arranged in genera aliphatic order.



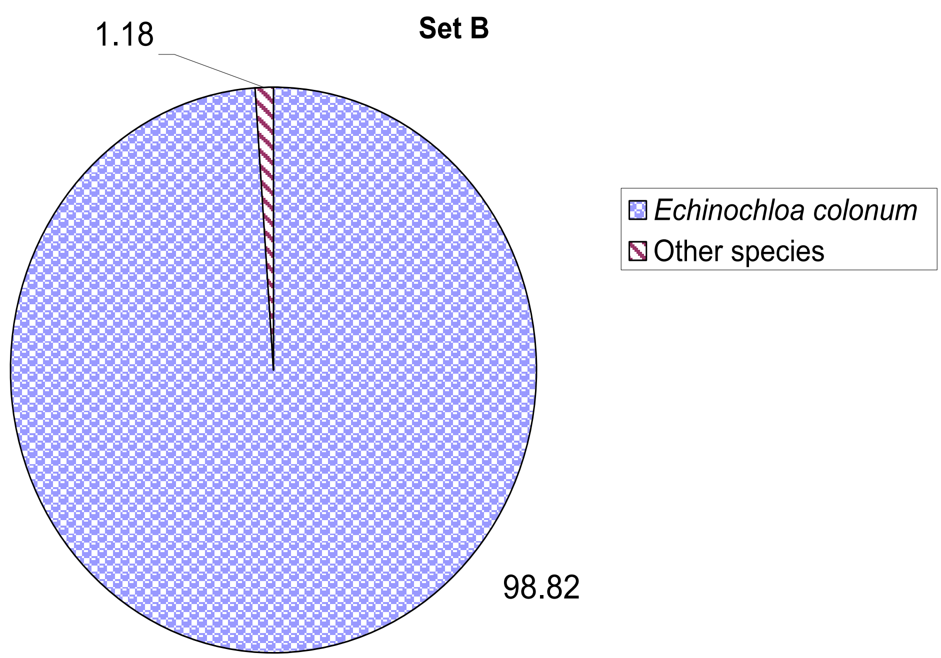


Figure (2). Per cent incidence (based on the population density) of the most plentiful weed species measured in the untreated plots at 90 day post sowing (in 2014 (Set A) and 2015 (Set B) cotton growing seasons.

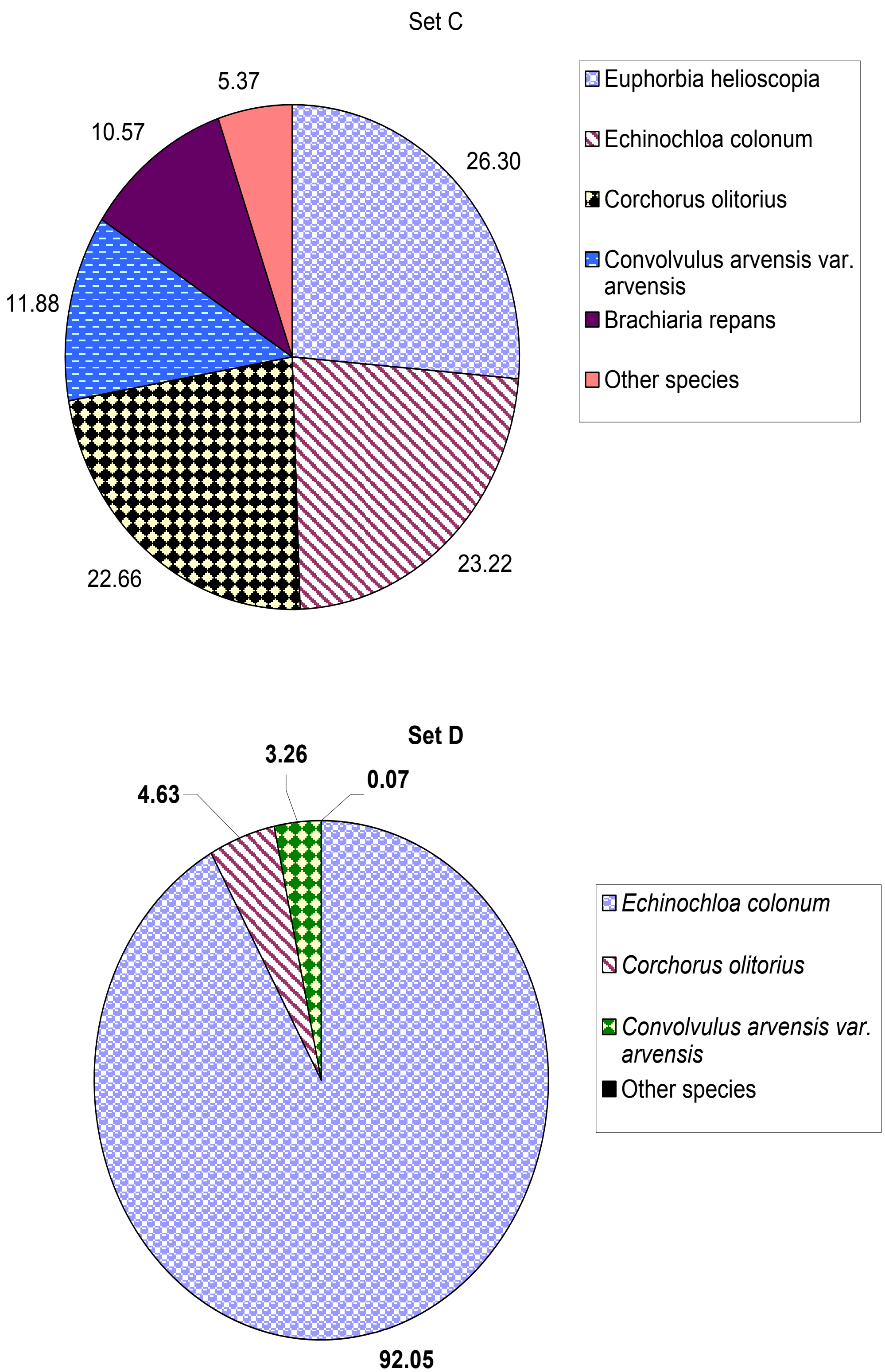


Figure (3). **Per cent incidence (based on the green biomass) of the most plentiful weed species measured in the untreated plots at 90 day post sowing (in 2014 (Set C) and 2015 (Set D) cotton growing seasons.**

Table (2): Mean population density and fresh weight of *Echinochloa colonum* measured at 90 days post planting and expressed per square meter.

Treatments	Rate (F.M. /fed.)	Population density (individual weed/m²) 2014	2015	Mean	%Red.	Mean fresh weight (gm./m²) 2014	2015	Mean	%Red.
Amex, EC-48%	2.5L	0.25 ± 0.13d	136.60 ± 75.89c	68.425	76.88	3.25 ± 1.63c	336.72 ± 191.59de	169.99	82.61
	2.5L + 1HO	1.0 ± 0.36d	56.67 ± 16.58cd	28.835	90.26	6.34 ± 2.98c	205.83 ± 42.27ef	106.09	89.15
Stomp extra, SC- 45.5%	1.7L	0.0d	0.0d	0	100	0.0c	0.0f	0	100
	1.7L + 1HO	0.75 ± 0.38d	49.67 ± 28.45cd	25.21	91.48	10.96 ± 5.48c	222.30 ± 121.61ef	116.63	88.07
Lumax, SC-15%	1L	1.75 ± 0.88d	599.67 ± 31.18a	300.71	-1.61	10.61 ± 5.31c	1705.98 ± 170.74a	858.30	12.19
	1L + 1HO	8.25 ± 1.99b	357.67 ±83.89b	182.96	38.18	50.33 ± 12.17c	963.78 ± 182.39b	507.06	48.13
Gardo, EC-96%	600ml	2.25 ± 0.97d	173.67 ± 88.25c	87.96	70.28	8.38 ± 3.23c	836.82 ± 88.25bc	422.60	56.77
	600ml + 1HO	0.50 ± 0.25d	2.0 ± 1.16d	1.25	99.58	6.16 ± 3.08c	11.87 ± 6.86ef	9.02	99.08
Weeded control	2HO	7.0 ± 0.41b	193.0 + 43.05c	100	66.21	113.40 ± 38.65b	573.41 ± 72.39cd	343.41	64.87
Un-weeded control	---	32.25 ± 4.24a	559.67 ± 100.09a	295.96	0	229.90 ± 37.08a	1725.06 ± 213.42a	977.48	0
$LSR_{0.05}$		4.489845	145.6957	---	---	51.01649	324.4848	---	---

For each column, means share at least one letter are not significantly different based on one way analysis of variance followed by Duncan Multiple Comparison test.

Table (3): Mean population density and fresh weight of *Brachiaria repans* measured at 90 days post planting and expressed per square meter.

Treatments	Rate (F.M. /fed.)	Population density (individual weed/m^2)				Mean fresh weight (gm./m^2)			
		2014	2015	Mean	%Red.	2014	2015	Mean	%Red.
Amex, EC-48%	2.5L	0.25 ± 0.13d	0	0.13	99.46	0.28 ± 0.14d	0.0b	0.14	99.74
	2.5L + 1HO	5.0 ± 0.74d	0	2.50	89.57	23.15 ± 3.17cd	0.0b	11.58	78.13
Stomp extra, SC- 45.5%	1.7L	6.75 ± 5.22d	0	3.38	85.89	47.53 ± 19.73bcd	0.0b	23.77	55.10
	1.7L + 1HO	1.50 ± 0.44d	0	0.75	96.87	3.06 ± 0.71d	0.0b	1.53	97.11
Lumax, SC-15%	1L	39.50 ± 11.01bc	0	19.75	17.57	255.61 ± 69.10a	0.0b	127.81	-141.44
	1L + 1HO	76.25 ± 22.29a	0	38.13	-59.14	278.78 ± 45.56a	0.0b	139.39	-163.33
Gardo, EC-96%	600ml	36.0 ± 12.67bc	0.33 ± 0.19	18.17	24.17	120.86 ± 35.49b	1.88 ± 0.19b	61.37	-15.94
	600ml + 1HO	14.0 ± 3.17cd	1.0 ± 0.57	7.50	68.70	47.44 ± 8.06bcd	5.02 ± 2.90a	26.23	50.45
Weeded control	2HO	28.50 ± 3.23cd	0	14.25	40.53	113.51 ± 13.82bc	0.0b	56.76	-7.22
Un-weeded control	---	47.25 ± 12.46b	0.667 ± 0.39	23.96	0	104.65 ± 31.16bc	1.22 ± 0.71b	52.93	0
$LSR_{0.05}$		28.49747	F is NS	---	---	90.55443	2.237478		

For each column, means share at least one letter are not significantly different based on one way analysis of variance followed by Duncan Multiple Comparison test.

2016 Beltwide Cotton Conferences, New Orleans, LA, January 5-7, 2016

Table (4): Mean population density and fresh weight of *Corchorus olitorius* measured at 90 days post planting and expressed per square meter.

Treatments	Rate (F.M. /fed.)	Population density (individual weed/m^2)				Mean fresh weight (gm./m^2)			
		2014	2015	Mean	%Red.	2014	2015	Mean	%Red.
Amex, EC-48%	2.5L	3.25 ± 0.63c	2.0 ± 0.0ab	2.63	84.56	102.90 ± 27.45b	175.33 ± 56.17a	139.12	10.56
	2.5L + 1HO	1.25 ± 0.24c	1.50 ± 0.71abc	1.38	91.91	3.59 ± 0.61d	34.77 ± 16.27de	19.18	87.67
Stomp extra, SC- 45.5%	1.7L	2.75 ± 0.63c	1.33 ± 0.19abc	2.04	88.0	46.24 ± 11.62cd	97.91 ± 17.19bc	72.08	53.66
	1.7L + 1HO	0.75 ± 0.38c	0.67 ± 0.39bc	0.71	95.82	6.45 ± 3.23d	8.78 ± 5.08e	7.62	95.10
Lumax, SC-15%	1L	14.25 ± 4.14b	0.0c	7.125	58.09	146.0 ± 26.87b	0.0e	73.0	53.07
	1L + 1HO	0.0c	0.33 ± 0.19c	0.165	99.03	0.0d	13.50 ± 7.81e	6.75	95.66
Gardo, EC-96%	600ml	6.75 ± 0.69bc	2.33 ± 0.78a	4.54	73.29	92.59 ± 11.87bc	98.0 ± 24.28b	95.30	38.73
	600ml + 1HO	1.25 ± 0.13c	0.33 ± 1.53c	0.79	95.35	2.20 ± 0.42d	2.63 ± 0.19e	2.42	98.45
Weeded control	2HO	1.25 ± 0.32c	0.33 ± 0.19c	0.79	95.35	16.15 ± 5.42d	29.80 ± 17.24de	22.98	85.23
Un-weeded control	---	32.0 ± 6.65a	2.0 ± 0.67ab	17.0	0.0	224.40 ± 43.90a	86.67 ± 25.573cd	155.535	0
$LSR_{0.05}$		7.171992	1.61617	---	---	56.03622	57.97034	---	---

For each column, means share at least one letter are not significantly different based on one way analysis of variance followed by Duncan Multiple Comparison test.

Table (5): Mean population density and fresh weight of *Euphorbia helioscopia* and two perennial narrow leaved weeds measured at 90 days post planting and expressed per square meter.

Treatments	Rate (F.M. /fed.)	*Euphorbia helioscopia* measured in 2014				Sum of *Cynodon dactylon* and *Cyperus rotundus* in 2014			
		Population density	%Red.	Fresh weigh	%Red.	Population density	%Red.	Fresh weigh	%Red.
Amex, EC-48%	2.5L	60.75 ± 6.27b	-179.31	1213.11 ± 224.13a	-365.78	0.25 ± 0.13c	97.37	4.19 ± 2.09ab	90.15
	2.5L + 1HO	22.50 ± 4.57cd	-3.45	64.21 ± 7.67d	75.35	10.25 ± 2.49bc	-7.90	42.52 ± 14.69ab	0.0
Stomp extra, SC- 45.5%	1.7L	80.50 ± 12.46a	-270.12	1098.86 ± 115.47a	-321.91	0.0c	100	0.0b	100.0
	1.7L + 1HO	22.25 ± 5.62cde	-2.30	78.91 ± 21.67d	69.70	8.0 ± 2.44c	15.79	10.18 ± 3.58ab	76.06
Lumax, SC-15%	1L	32.0 ± 4.37c	-47.13	517.80 ± 106.04bc	-98.81	25.75 ± 6.21a	-171.05	56.17 ± 45.48a	-32.10
	1L + 1HO	3.25 ± 0.75e	85.06	15.99 ± 4.09d	93.86	4.25 ± 1.05c	55.26	56.17 ± 24.53a	-32.10
Gardo, EC-96%	600ml	52.50 ± 7.98b	-141.38	764.09 ± 76.29b	-193.37	2.25 ± 0.83c	76.32	4.05 ± 1.56ab	90.48
	600ml + 1HO	10.25 ± 2.96de	52.87	36.53 ± 13.88d	85.97	22.75 ± 6.96a	-139.47	28.8 ± 13.30ab	32.27
Weeded control	2HO	9.0 ± 1.69de	58.62	38.08 ± 4.53d	85.38	20.25 ± 6.78ab	-113.16	4.19 ± 2.09ab	90.15
Un-weeded control	---	21.75 ± 1.79cde	0.0	260.45 ± 31.83cd	0.0	9.50 ± 3.15bc	0.0	42.52 ± 14.69ab	0.0
$LSR_{0.05}$		16.6927	---	263.673	---	13.47884	---	52.79399	

For each column, means share at least one letter are not significantly different based on one way analysis of variance followed by Duncan Multiple Comparison test.

2016 Beltwide Cotton Conferences, New Orleans, LA, January 5-7, 2016

Table (6): Mean population density and fresh weight of *Convolvulus arvensis* var. *arvensis* measured at 90 days post planting and expressed per square meter.

Treatments	Rate (F.M. /fed.)	Mean number of weeds (individual weed/m^2)				Mean fresh weight (gm./m^2)			
		2014	2015	Mean	%Red.	2014	2015	Mean	%Red.
Amex, EC-48%	2.5L	12.25 ± 5.81bcd	3.33 ± 1.67cde	7.79	-22.20	168.20 ± 26.96bcd	192.30 ± 48.53c	180.25	-101.80
	2.5L + 1HO	7.25 ± 1.70d	7.67 ± 2.41bc	7.46	-17.02	41.73 ± 10.09ef	100.02 ± 28.94c	70.88	20.65
Stomp extra, SC- 45.5%	1.7L	9.50 ± 4.56cd	12.67 ± 4.09a	11.09	-73.88	216.10 ± 36.89b	830.25 ± 219.59a	523.18	-485.80
	1.7L + 1HO	11.25 ± 3.95bcd	4.0 ± 3.0cd	7.63	-19.61	40.79 ± 7.61ef	182.10 ± 51.13c	111.45	-24.78
Lumax, SC-15%	1L	15.50 ± 8.87bc	1.0 ± 0.58d	8.25	-29.41	184.50 ± 70.50bc	60.32 ± 22.382c	122.41	-37.05
	1L + 1HO	5.50 ± 3.93d	3.33 ± 3.34cde	4.42	30.75	14.36 ± 3.93f	56.80 ± 32.86c	35.58	60.16
Gardo, EC-96%	600ml	25.0 ± 3.39a	10.33 ± 4.09ab	17.67	-177.10	314.40 ± 49.08a	519.78 ± 149.37b	417.09	-367.0
	600ml + 1HO	17.50 ± 8.66b	5.0 ± 1.0c	11.25	-76.47	80.80 ± 20.23def	107.40 ± 14.450c	94.10	-5.357
Weeded control	2HO	10.25 ± 3.49cd	0.33 ± 0.33e	5.29	17.02	33.53 ± 5.84ef	3.40 ± 1.97c	18.47	79.326
Un-weeded control	---	11.75 ± 0.95bcd	1.0 ± 1.0d	6.38	0.0	117.60 ± 24.96cde	61.03 ± 35.31c	89.32	0.0
$LSR_{0.05}$		7.1436	3.5803	---	---	93.88231	223.9311	---	---