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Efficiency of fluazifop-p-butyl and Oxyfluorfen herbicides separately and in combinations with selected spray tank additives on weeds in onion field

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Abstract

Two field experiments were carried out at Faculty of Agriculture Farm, Al-Azhar University, Assiut governorate in 2014-2015 and 2015-2016 seasons to evaluate the efficiency of two post-emergence herbicides, i.e. Fusilade forte (fluazifop-p-butyl) and Goal (oxyfluorfen) on onion weed control at 30 and 60 days after treatment. Both herbicides were applied at their recommended and ¾ recommended rates with and without spray tank additives, i.e. sodium lauryl ether sulphate and organosilicone adjuvants. The results showed that the tested adjuvants obviously increased the herbicidal efficiency of fusilade forte against grassy weeds and Goal against broad leave weeds. In most cases the maximum efficiency was achieved when both fusilade forte and Goal were applied at their recommended (187.5 and 180 g a.i/fed.) or ¾ recommended (140.625 and 135 g a.i/feddan) rates, + organosilicone adjuvant at 0.1% v/v concentration without significant adverse effects in onion crop.

Keywords: Onion, weeds, oxyfluorfen, fluazifop-p-butyl, additives.

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Introduction

Onion (*Allium cepa* L.) is belonging to the family Alliaceae, one of the important bulbous vegetable crops of economic importance and widely cultivated all over the world (Ramalingam et al., 2013). It is one of the most important field and vegetable crops for both local or export market in Egypt (Ghalwash et al., 2008). The first citation of these plants was found in the Codex Ebers (1550 bc), an Egyptian medical papyrus reporting several therapeutic formulas based on onions (Lanzotti, 2006). It is one of the oldest vegetable mentioned in the Bible as well as in the Holy Quran (Marwat et al., 2005). The critical period for weed control in onion is extended beyond the first few weeks after crop emergence (Ghosheh, 2004). Several herbicides that used as early post-emergence treatments for annual weed control in onions must be applied only at certain stages of growth to avoid injury to the crop (Ashton & Monaco, 1991). Several workers have found that, oxyflourfen and fluazifop-p-butyl was efficient in controlling weeds in onion (Elian et al., 2016; Sharma et al., 2009). Research on adjuvant technology for agrochemicals has made good progress in recent years in part due to increased efforts by agrochemical manufacturers to ensure that the best adjuvants are used with their products for maximum performances. The efficacy of herbicide formulation can be expressed as a function of deposition, retention, absorption, translocation and phytotoxicity. Although adjuvants are not able to directly affect inherent herbicide toxicity, they can significantly alter each of the preceding terms (Zabkiewicz, 2000). Adjuvants are the compounds that can be added to herbicide formulations to facilitate their mixing, application, or effectiveness. As such compounds are chemically and biologically active. They produce pronounced effects in plants and animals, and may have the potential to be mobile and pollute surface or ground water sources (Penner, 2000; Parr, 1982). Such activator adjuvants encompass wide varieties of surfactants and may be included in the product formulated by the manufacturer or tank-mixed by the herbicide applicator. The efficacy of these compounds is a function of not only the adjuvant but also the herbicide, the particular weed species and environmental conditions (Penner, 2000). The objective of this research was to evaluate the efficiency of Fusilade forte (fluazifop-p-butyl) and Goal (oxyfluorfen) herbicides without and with spray tank additives, i.e. organosilicone and the nonionic sodium lauryl ether sulphate surfactants for controlling onion weeds as well as their effect on onion productivity.

Materials and methods

Two field experiments were carried out during the two growing seasons 2014-2015 and 2015-2016 at the Farm of Faculty of Agriculture, Al Azhar University, Assiut, to evaluate the efficiency of both fluazifop-p-butyl and oxyflurofen herbicides separately and in combinations with selected spray tank additives in controlling the weeds associated with onion crop. The common, trade and IUPAC names of the tested herbicides as well as their structural formulas are shown in table (1), while those of the selected spray tank additives are in table (2). Onion, *A. cepa* (Giza 6-CV variety) transplants, were obtained from Shandaweel Research Station "ARC" and transplanted on double row ridges on

November, 15th in both growing seasons. Normal agricultural practices used for onion production in the region were followed.

Table 1: Common, trade and IUPAC names of the tested herbicides.

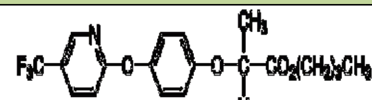
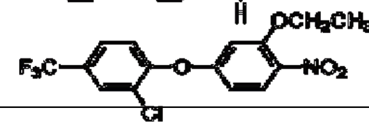
Common name	Trade name	IUPAC name	Structure
Fluazifop-p-butyl	Fusilade forte 15% EC	(R)-2-[4-[[5-(trifluoromethyl)-2-pyridinyl] oxy] phenoxy] propanoic acid propionate	
Oxyfluorfen	Goal 24% EC	2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl) benzene	

Table 2: Common, trade and IUPAC names of the tested spray tank additives.

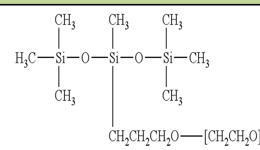
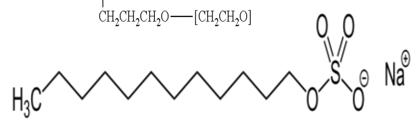
Common name	Trade name	IUPAC name	Structure
Siloxane Polyalkyleneoxide Copolymer	Silwet L-77	3-(2-methoxyethoxy)propyl-methyl-bis (trimethylsilyloxy)silane	
Sodium lauryl ether sulphate	Ricksy 25%	α-sulfo-ω-(dodecyloxy)-poly(oxyethane-1,2-diyl), sodium salt	

Table 3: The tested treatments and their application rates.

Treatments	Rate of application /fedddan	Treatments	Rate of application /feddan
Recommended rate			
FRR	187.5g a.i.	GRR	180g a.i.
FRR + Ricksy	187.5g a.i. + 0.4 %v/v	GRR + Ricksy	180g a.i. + 0.4 %v/v
FRR + Silwet-L77	187.5g a.i. + 0.1 %v/v	GRR + Silwet-L77	180g a.i. + 0.1 %v/v
¾ recommended rate			
¾ FRR	140.625g a.i.	¾ GRR	135g a.i.
¾ FRR + Ricksy	140.625g a.i. + 0.4 %v/v	Goal + Ricksy	135g a.i. + 0.4 %v/v
¾ FRR + Silwe-L77	140.625g a.i. + 0.1 %v/v	¾ GRR + Silwet-L77	135g a.i. + 0.1 %v/v
Hand weeding	20, 40 DAT	Hand weeding	20, 40 DAT
Unweeded Control		Unweeded Control	

FRR: Fusilade forte at its recommended rate; GRR: Goal at its recommended rate; DAT: Days after treatment.

Herbicidal treatments (at their recommended and ¾ recommended rates) with and without the selected spray tank additives, Ricksy at 0.4% (Sodium lauryl ether sulphate + Glue) and Silwet L-77 at 0.1% (Siloxane Polyalkyleneoxide Copolymer) beside the hand weeding (twice) and the unweeded control treatments were arranged in randomized complete block design with four replicates of 21 m^2 (3×7 m) for each as shown in Table (3). Herbicidal treatments with and without spray tank additives were applied 30 days after onion transplanting, while hand weeding treatments was performed 20 and 40 days after treatments. Thirty and sixty days after herbicidal application (with and without the spray tank additives), the grown weeds in area of 50×50 cm within each plot were randomly collected four times. The weeds were sorted, identified (by using the weed flora of Egypt), counted and oven dried at 70 °C for 48 h. Dry weight of each narrow and broad leaved weeds was estimated (g/m^2) at 30 and 60 DAT. The weed control efficiency (WCE) was calculated according to Mani et al., (1973). As follows:

WCE % = [(WDc – WDt/ WDc)] ×100

Where: WDc= Dry weight of weed biomass (g. m−2) in the unweeded control and WDt= Dry weight of weed biomass (g. m−2) in treated area. At the time of hand pulling (15th of April) onion fresh yield (ton/ feddan) was measured (feddan= 1.04 acre=0.42 hectare). Data recorded were subjected to analysis using SAS (SAS Inst. 2013) software for treatments.

Results

The results obtained revealed that the narrow-leaved weeds prevailed in the experimental field during both seasons 2014-2015 and 2015-2016 were: *Phalaris minor* Retz., *Cyndon dactylon* (L.), *Cyperus rotandus* L. and *Avena fatua* L., whereas the broad leaved weeds were: *Cichorium endivia* L., *Malva parviflora* L., *Convolvulus arvensis* L., *Sonchus oleraceus* L. and *Chenopodium murale* L. (Table 4).

Table 4: Weed species prevailed in onion experimental field during 2014-2015 and 2015-2016 seasons.

Scientific name	Family	Common name
Cichorium endivia	Asteraceae	Endive
Malva parviflora	Malvaceae	Cheeseweed mallow
Convolvulus arvensis	Convolvulaceae	Field bindweed
Sonchus oleraceus	Compositae	Sowthistle
Chenopodium murale	Chenopodiacea	Goosefoot
Phalaris minor	Poaceae	Little seed canary grass
Cyndon dactylon	Poaceae	Bermuda grass
Cyperus rotandus	Cyperaceae	Purple nut sedge
Avena fatua	Poaceae	Wild oat

Efficiency of Fusilade forte with and without spray tank additives against the narrow-leaved weeds prevailed in the experimental field during 2014-2015 and 2015-2016 seasons: Data in Table (5) show the effect of Fusilade forte at its two application rates with and without spray tank additives on narrow leave weeds population count (WPC), weed dry weight (WDW), weed control efficiency (WCE) and onion fresh yield (OFY) during the two growing seasons 2014-2015 and 2015-2016. Generally, the results obtained indicate that the herbicidal treatments with and without the spray tank additives as well as hand weeding treatment significantly reduced the WPCs and WDWs, meanwhile significantly increased the OFYs as compared with the unweeded control. Such results indicate that the hand weeding treatments resulted in the lowest WPC and WDW values 30 and 60 DAT in both seasons. The WPC values were 24.4 and 28.0 /m^2 in the 1st season and were 22.0 and 23.1 in the 2nd season, respectively. The corresponding values of WDW in the 1st season were 2.37 and 8.11 g/m^2 and in the 2nd season were 5.57 and 5.61 g/m^2 .Consequently, hand weeding treatment gave the highest WCE rates and OFY values. The WCE rates were 96.67 and 93.32 % in the 1st season and were 91.50 and 94.95 % in the 2nd season at 30 and 60 DAT, respectively, whereas the OFY values in the 1st and 2nd seasons were 11.90 And 12.01 ton/fed. Comparing with those of the unweeded control of 8.33 and 8.60 ton/feddan.

Fusilade forte at recommended rate (FRR): Data in Table (5) indicate that Fusilade forte at both rates + Silwet-L77 (at 0.1 v/v) gave the lowest WPC and WDW values and then gave the highest average WCE rate and OFY values at 30 and 60 DAT in both seasons. In this concept, Fusilade forte + Silwet-L77 recorded the lowest WPC were 37.7 and 50.5 /m^2 ,followed by Fusilade forte + Ricksy were 42.1 and 58.0 /m^2 with while the highest WPC values of 64.8 and 96.5 /m^2 were recorded with Fusilade forte without additives, all comparing with those of the unweeded control of 192.2 and 326.8 /m^2, in the 1st season at 30 and 60 DAT respectively, the same trend was observed during the 2nd season 2015-2016 as the lowest WPCs were recorded at 30 and 60 DAT were 22.4 and 24.5/m^2 with (Fusilade Forte + Silwet-L77) followed by Fusilade forte + Ricksy 30.6 and 38.5 /m^2 () and finally 45.6 and 54.5 /m^2 with (Fusilade forte without additives), all comparing with those of the unweeded control of 178 and 302/m2, respectively. For weed dry weights, the results obtained during the 1st season revealed that Fusilade forte + Silwet-L77 treatment resulted in the lowest values of 3.69 and 8.80 g/m^2 at 30 and 60 DAT, followed by Fusilade forte + ricksy treatment with WDWs of 4.61 and 14.7 g/m^2 and finally the treatment of Fusilade forte without additives with WDWs of 12.64 and 28.52 g/m^2 comparing with those of the unweeded control of 71.19 and 121.02 g/m^2 respectively. In the 2nd season and at 30 and 60 DAT, the results took the same trend, with 7.33 and 6.01 g/m^2 for (Fusilade forte + Silwet-L77), followed by Fusilade forte + ricksy 7.38 and 7.15 g/m^2 and finally for Fusilade forte without additives 15.62 And 22.04 g/m^2 compared with those of the unweeded control of 65.80 and 111.85 g/m^2, respectively. Consequently, (Fusilade forte + Silwet-L77) treatment gave the highest average WCE against the narrow-leaved weeds at 30 and 60 DAT in both growing seasons, followed by Fusilade forte + Ricksy and Fusilade without any additives treatments. The WCE rates at the two inspection dates for Fusilade forte + Silwet-L77 were 94.81 and 92.71 % in the 1st season and 88.85 and 94.63 in the 2nd season, respectively. The corresponding WCE rates of Fusilade forte + Ricksy were 93.53 and 87.81 % in the 1st season and 88.77 and 93.60 % in the 2nd season, whereas those of Fusilade forte without additives were 82.18 and 76.36 % in the 1st season, and 76.31 and 80.31 in the 2nd season.

Fusilade forte at ¾ recommended rate (3/4 FRR): Data presented in Table (5) show that, Fusilade forte at 3/4 FRR + Silwet-L77 gave the lowest average WPC at 30 and 60 DAT in both seasons which recorded 43.9 and 61.0 /m^2 in the 1st season and 39.2 and 53.0 in the 2nd season, respectively. However, ¾ FRR without any additives gave the highest WPCs at the same inspection dates which were 90.6 and 140.5 /m^2 in the 1st season and 60.6 and 89.5 /m^2 in the 2nd season, meanwhile ¾ FRR + Ricksey gave intermediate WPC values of 57.4 and 84.0 /m^2 in the 1st season and 39.8 and 54.0 /m^2 in the 2nd season, respectively.

Table 5: Effect of Fusilade forte with and without spray tank additives on average of narrow-leaved weeds population count (WPC), weed dry weight (WDW), weed control efficiency (WCE) and onion fresh yield (OFY) during 2014-2015 and 2015-2016 seasons.

Treatments	WPC/m^2		WDW (g/m^2)		WCE (%)		OFY
	30 DAT[(a)]	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT	(Ton/feddan)
Season 2014-2015							
FRR[(b)]	64.8^C	96.5^C	12.64^C	28.52^C	82.18^E	76.36^E	10.29^D
FRR+Ricksy	42.1E^F	58.0^{EF}	4.61^E	14.7^D	93.53^B	87.81^B	10.92^C
FRR+Silwet-L77	37.7^F	50.5^F	3.69^{EF}	8.80^E	94.81^B	92.71^A	11.43^B
¾ FRR	90.6^B	140.5^B	20.48^B	41.10^B	71.21^F	65.98^F	8.73^F
¾ FRR+Ricksy	57.4^D	84.0^D	6.92^D	16.15^D	90.27^C	86.65B^C	9.61^E
¾ FRR+Silwet-	43.9^E	61.0^E	4.68^E	15.00^D	93.39^B	87.57^B	10.78^C
Hand weeding[(c)]	24.4^G	28.0^G	2.37^F	8.11^E	96.67^A	93.32^A	11.90^A
Unweeded control	192.2^A	326.8^A	71.19^A	121.02^A			8.33^G
Season 2015-2016							
FRR	45.6^C	54.5^C	15.62^C	22.04^C	76.31^D	80.31^D	10.63^D
FRR+Ricksy	30.6^E	38.5^D	7.38^{EF}	7.15^F	88.77^{AB}	93.60^A	11.35C^B
FRR+Silwet-L77	22.4^F	24.5^E	7.33^{EF}	6.01^F	88.85^{AB}	94.63^A	11.67^{AB}
¾ FRR	60.6^B	89.5^B	25.74^B	39.98^B	60.91^E	64.23^E	8.87^F
¾ FRR+Ricksy	39.8^D	54.0^C	9.44^E	12.70^E	85.58^B	88.60^B	9.85^E
¾ FRR+Silwet-	39.2^D	53.0^C	7.61^{EF}	7.25^F	88.43A^B	93.51^A	11.03^C
Hand weeding	22.0^F	23.1^E	5.57^F	5.61^F	91.50^A	94.95^A	12.01^A
Unweeded control	178^A	302^A	65.80^A	111.85^A			8.60^F

Note: Means sharing the same letter in the same column do not differ significantly; [(a)] days after treatment; [(b)] Fusilade forte at its recommended rate; [(c)] hand weeding twice at 20 and 40 DAT.

Data listed in Table (5) indicate that the average WDW values were recorded with ¾ FRR + Silwet-L77 treatment at 30 and 60 DAT which were 4.68 and 15.00 g/m^2 in the 1st season, and 7.61 and 7.25 /m^2 in the 2nd season comparing with those of the unweeded control of 71.19 and 121.02 g/m^2 in the 1st season and 65.80 and 111.85 /m^2 in the 2nd season, respectively. Therefore such treatments resulted high WCE rates of 93.39 and 87.57 % in the 1st season and 88.43 and 93.51 % in the second season, respectively. On the contrary, the 3/4 FRR without any additives gave the highest WDW values at the same inspection times of 20.48 and 41.10 g/m^2 in the 1st season and 25.74 and 39.98 g/m^2 in the 2nd season, respectively. Consequently, it resulted in lowest WCE rates of 71.21 and 65.98 % in the 1st season and 60.91 and 64.23 % in the 2nd season. On the other side, the treatment combined of 3/4 FRR + Ricksy gave intermediate WDW values and consequently the WCE rates.

Effect of Fusilade forte at its two application rates with and without the spray tank additives on the onion fresh yield (OFY) during the two growing seasons: Data represented in Table (5) show that addition of the spray tank additives Rickey or Silwet-L77 to Fusilade forte at its recommended and ¾ recommended rates significantly increased the OFY comparing with the unweeded control and Fusilade forte without additives treatments. Among the herbicidal treatments, however, FRR +Silwet-L77 gave the highest OFY values in both growing seasons (11.43 and 11.67 ton/fed.), followed by FRR + Ricksy treatment (10.92 and 11.35 ton/fed.) then FRR without any additives (10.29 and 10.63 ton/fed.). On the other side, 3/4 FRR + Silwet-L77 resulted in the highest OFY values in both seasons (10.78 and 11.03 ton/fed.), followed by ¾ FRR + Ricksy treatment (9.61 and 9.85 ton/fed.) then ¾ FRR without any additives (8.73 and 8.87 ton/fed.).

Efficiency of Goal with and without spray tank additives against the broad-leaved weeds prevailed in the experimental field during 2014-2015 and 2015-2016 seasons: Data in Table (6) indicate that Goal at its two application rates with and without spray tank additives affected on broad leave WPC, WDW, WCE and OFY during the two growing seasons 2014-2015 and 2015-2016. The addition of selected spray tank additives to Goal herbicide (at its two application rates) significantly decreased both WPCs and WDWs, and significantly increased the OFY comparing to the unweeded control. Moreover, the results take the same trend recorded with Fusilade forte again the narrow-leave weeds, i.e., GRR or ¾ GRR + Silwet-L77 treatments were more efficient than GRR or ¾ GRR without additives treatments against the broad-leaved weeds. However, hand weeding treatment, gave in most cases, the lowest WPC and WDW values at 30 and 60 DAT during the two growing seasons. The WPC recorded in the 1st season were 17.08 and 34.17 /m^2 and in the 2nd season were 24.5 and 48.6 g/m^2 in average respectively. The corresponding averages of WDWs were 5.99 and 9.36 g/m^2 in the 1st season and 6.39 and 8.96 g/m^2 in the 2nd season.

Goal at recommended rate (GRR): Data represented in Table (6) revealed that (GRR+ Silwet-L77) treatment resulted in the lowest average of WPCs (10.8 and 43.5/m^2 at 30 and 60 DAT in the 1st season and of 31.5 and 67.0 /m^2 in the 2nd season) comparing with those of the unweeded control of 194.88 and 675.00/m^2 in the 1st season and of 178.75 and 342.5/m^2 in the 2nd season, respectively, followed by (GRR + Ricksy) treatment (15.3and 56.7 /m^2 in the 1st season and 35.8 and 71.2 in the 2nd season). Whereas those of the (GRR without additives) treatment were 35.00 and 96.00/m^2 in the 1st season and 66.75 and 103.50 /m^2 in the 2nd season, respectively. For WDW values and WCE rates at 30 and 60 DAT, the results in (table, 6) indicate that GRR + Silwet-L77 treatment gave the lowest WDW rates of 7.02 and 12.6 g/m^2 in the 1st season and 3.62 and 4.01 g/m^2 in the 2nd season comparing with those of the unweeded control of 68.65 and 141.05 g/m^2 in the 1st season, and 65.71 and 129.47 g/m^2 in the 2nd season, respectively., therefore resulted in the highest WCE rates of

89.76 and 91.06 % in the 1st season and of 94.48 and 96.90 % in the 2nd season, respectively. On the other side GRR without additive treatment gave the highest WDW values of 21.08 and 41.15 g/m^2 in the 1st season and 12.97 and 23.27 g/m^2 in the 2nd season, and therefore it resulted in the lowest WCE rates of 69.23 and 70.78 % in the 1st season, and of 80.30 and 82.04 % in the 2nd season, respectively. The (GRR + Ricksy) treatment gave an intermediate WDW values and WCE rates in both growing seasons.

Table 6: Effect of Goal with and without spray tank additives on average of narrow-leaved WPC, WDW, WCE and OFY during the two seasons 2014-2015 and 2015-2016.

Treatments	WPC/m^2		WDW (g/m^2)		WCE (%)		OFY
	30 DAT[a]	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT	(Ton/feddan)
Season 2014-2015							
GRR[b]	35.00^{C}	96.00^{C}	21.08^{C}	41.15^{C}	69.23^{E}	70.78^{E}	9.7^{F}
GRR+Ricksy	15.3^{EF}	56.7^{EFD}	9.92^{F}	18.77^{E}	85.51^{B}	86.67^{C}	11.01^{C}
GRR+Silwet-L77	10.8^{F}	43.50^{E}	7.02^{G}	12.60^{F}	89.76^{A}	91.06^{A}	11.51^{B}
¾ GRR	74.50^{B}	175.00^{B}	30.59^{B}	61.15^{B}	55.40^{F}	56.61^{F}	8.81^{G}
¾ GRR+Ricksy	25.75^{D}	77.50^{CD}	17.17^{D}	27.64^{D}	74.92^{D}	80.35^{D}	10.95^{C}
¾ GRR+Silwet-	23.63^{D}	73.25EC	10.50^{F}	20.55^{E}	84.68^{B}	85.40^{C}	10.87^{CD}
Hand weeding[c]	17.08^{E}	34.17^{F}	5.99^{G}	9.36^{F}	91.26^{A}	93.35^{A}	11.89^{A}
Unweeded control	194.88^{A}	675.00^{A}	68.65^{A}	141.05^{A}			8.33^{H}
Season 2015-2016							
GRR	66.75^{C}	103.50^{C}	12.97^{D}	23.27^{D}	80.30^{E}	82.04^{E}	10.41^{E}
GRR+Ricksy	35.8^{EF}	71.2^{F}	5.105^{GH}	6.47^{H}	92.2A^{B}	95.0^{B}	11.06^{C}
GRR+Silwet-L77	31.5^{F}	67.0^{F}	3.62^{H}	4.01^{I}	94.48^{A}	96.90^{A}	11.60^{B}
¾ GRR	115.88^{B}	182.50^{B}	25.16^{B}	47.53^{B}	61.70^{G}	63.28^{G}	8.87^{F}
¾ GRR+Ricksy	47.7^{D}	97.0^{D}	10.41^{E}	14.7^{F}	84.14^{D}	88.6^{E}	10.73^{D}
¾ GRR+Silwet-	41.0^{E}	83.0^{E}	8.47^{F}	11.73^{G}	87.08^{C}	90.9^{D}	10.97^{CD}
Hand weeding	24.5^{G}	48.6^{G}	6.39^{G}	8.96^{G}	90.25^{B}	93.07^{B}	12.01^{A}
Unweeded control	178.75^{A}	342.50^{A}	65.71^{A}	129.47^{A}			8.59^{F}

Note: Means sharing the same letter in the same column do not differ significantly; [a] days after treatment; [b] Fusilade forte at its recommended rate; [c] hand weeding twice at 20 and 40 DAT.

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Goal applied at ¾ recommended rate (3/4 GRR): Data listed in Table (6) show that the (¾ GRR separately or in combination with the spray tank additives behave the same trend previously observed with the GRR treatment. In this respect, (3/4 GRR+ Silwet-L77) gave the lowest WPC and WDW values at 30 and 60 DAT followed by 3/4 GRR + Ricksy and 3/4 GRR without additives treatments during the both growing seasons. For example, the WPCs of these treatments in the 1st season were 23.63 and 73.25 /m^2, 25.75 and 77.50 /m^2 and 74.5 and 175.00 /m^2, respectively. The corresponding WDWs of these treatments in the 2nd season were 8.97 and 11.73 g/m^2, 10.41 and 14.70 g/m^2 and 25.16 and 47.53 g/m^2, respectively.

Effect of Goal at its two application rates with and without the spray tank additives on the onion fresh yield (OFY) during the two growing seasons: Data in Table (6) indicate that addition of the spray tank additives Silwet-L77 and Ricksy to the tested application rates of Goal herbicide significantly increased the OFY comparing with either the unweeded control or Goal treatments without the spray tank additives. The maximum values of OFY in the 1st season were 11.51, 11.01, 10.95 and 10.87 ton/fed., which achieved by GRR+Silwet-L77, GRR+Ricksy, 3/4 GRR+Ricksy and 3/4 GRR + Silwet-L77 respectively, whereas the minimum values of 8.81 and 9.7 ton/fed., were recorded with 3/4 GRR and GRR treatments, respectively, meanwhile that of the unweeded control was 8.33 ton/fed. in the 2nd reason, results took the same trend as GRR + Silwet-L77, GRR + Ricksy, 3/4 GRR + Silwet-L77 and 3/4 GRR + Ricksy treatments gave the highest OFY values of 11.60, 11.06, 10.97, and 10.73 ton/fed., respectively meanwhile (GRR) and (3/4 GRR) gave the lowest OFY values of 8.87 and 10.41 ton/fed., respectively, whereas that of the unweeded control was 8.59 ton/fed.

Discussion

The results previously cited in table (4) show that the narrow and broad-leaved weeds recorded in the experimental field are matchable with those surveyed in onion fields by (Uygur et al., 2010). The aforementioned results (Tables 5 and 6) clearly indicate that the addition of organosilicone (Silwet-L77) and nonionic (Ricksy 25 %) surfactants to the decreased rates of Fusilad forte or Goal herbicides (their ¾ recommended rates) improved and prolonged their herbicidal efficiency. Also, it is clear that the organosilicone surfactant proved to be more effective than the nonionic surfactant with both of the tested herbicides. Therefore their WPCS and WDWs were significantly decreased and consequently their WCE rates or OFY values were significantly increased comparing with those produced when both herbicides were applied at their full (recommended) rates without additives. In this concept, (Robert et al., 1998) evaluated the herbicidal efficiency of reduced rates for the three post-emergence herbicides (fluazifop-P, imazethapyr, and sethoxydim) tank mixtures with the adjuvant (SAN 582H). They reported that the tested adjuvant synergistically increased broadleaf singalgrass control with reduced rates of all three herbicides from 50% to 83%.Moreover (Gaskin et al., 2000) tested the two novel organosilicone adjuvant blends, Du-Wett and Bond Xtra, to halve convention spray volumes in row crops including onion. They found that the two novel organosilicone adjuvants have the potential to reduce spray volumes in such crops and improved its deposition retention. Also (Zenon & Robert, 2010) stated that herbicide-tank-mixtures applied sequentially at reduced rates with adjuvants greatly increased weeds control rates that ranged between 92-99%. They found that Atpolan Bio 80 EC was the most effective adjuvants followed by trend 90 EC. They added that the application of herbicide mixtures with adjuvants provided high increase maize grain yield which ranged between 9.36 – 10.38 ton/ha while that achieved by the standard herbicide treatments applied at recommended rate without adjuvants ranged between 0.49 – 2.60 ton/ ha, all comparing with the unweeded control. It is stated that the use of adjuvants at optimum rates sufficiently improve the physical properties of the herbicide spray solutions including leaf coverage, retention, foliar penetration and phytotoxicity (Gaskin et al., 2000). Also, (Singh et al., 2002) studied the relationship between surface activity and weed control efficacy of diuron spray solution (75 g a.i/ha) with 12 adjuvants (0.1 % v/v) under laboratory and green house conditions. They reported that organosilicone adjuvants reduce surface tension and contact angel of the spray solution to a great extent than did nonsilicone adjuvants. They added that three organosilicone adjuvants significantly reduced the fresh weight of barnyard grass and consequently increased its control rate.

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