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COMPARATIVE EFFICIENCY OF CERTAIN FORMULATIONS OF GLYPHOSATE AND GLUFOSINATE FOR CONTROLLING ANNUAL WEEDS IN POMEGRANATE

Ibrahim Abd El-Wahab Mohamed[1]

ABSTRACT

Pomegranate (Punica granatum L.) is one of the most common and important fruit crops in Mediterranean countries including Egypt. Weeds are one of the most serious pests in pomegranate. A few studies were published on controlling weeds in pomegranate all over the world. Thus, two field experiments were conducted at the Experimental Farm of Pomology Department, Faculty of Agriculture, Assiut University, Egypt during 2014/2015 to evaluate the efficacy of certain formulations of glyphosate, glyphosate isopropyl amine salt (Glyweed 41% SL), glyphosate- isopropyl ammonium (Rophosate 48% SL), glyphosate diammonium (Ouragan 4-39.6% SL) and glufosinate-ammonium (Lifeline 28% SL) and hand hoeing twice, compared with unweeded control against annual weeds in pomegranate. The results indicated that all treatments achieved efficiency against Echinochloa colonum (L.) Link, Portulaca oleracea L. and Corchorus olitorius L. and significantly reduced fresh weight of grass, broadleaved weeds and total weeds in pomegranate at 30 and 60 days after herbicide treatments compared with control in the first and second experiments. Moreover, all herbicides were more effective than hand hoeing. Glyphosate isopropyl amine salt (Glyweed 41% SL) was the most effective one comparing to other treatments in both experiments and recorded the highest increment for fruit weight, fruit numbers and yield per tree compared with control. As far as I know, this is the first study on the effect of glyphosate formulations and glufosinate on weed control in pomegranate in Assiut Governorate, Egypt.

Key words: Glufosinate, glyphosate, orchards, *Punica granatum* L., and weed control.

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[1]Plant Protection Department, Faculty of Agriculture, Assiut University, 71526 Assiut, Egypt
*Corresponding author's email: ibrahimkorium@gmail.com

INTRODUCTION

Pomegranate (*Punica granatum* L.) is one of the oldest edible fruits cultivated extensively in Mediterranean countries as well as in a wide range of tropical and subtropical regions. In Egypt, pomegranate is one of the most common and important fruit crops which ranked 13th among other fruit crops (Abdel-Ghany, 2015). Recently, pomegranate plantation has been increased rapidly in the world for its importance in nutrition, industrial, pharmacological and medical values to human (Okatan *et al.,* 2015). Different major pests such as insects, acari, fungi and weeds affect pomegranate fruits all over the world. Weeds are one of the most troublesome pests in pomegranate and other orchard crops that compete with the trees for nutrition and water causing severe reduction in the growth, yield and fruit quality of these crops (Sharma and Bhutani, 1989; Foshee *et al.,* 2008). In addition, weeds are considered as a host or shelter for other pests like insects and plant pathogens that will attack other crops (Marwat *et al.,* 2005; *Khan et al.* 2009).

Chemical control using herbicides is the effective, practical and cheaper method for controlling weeds in many agricultural regions including orchards worldwide than other weed management tools such as hand or mechanical hoeing, tillage and mulching. Glyphosate [N-(phosphonomethyl) glycine] is the most dominant, popular and widely nonselective systemic post emergence herbicide used for controlling a broad spectrum of annual and perennial weed species in orchards, agronomic crops, gardens, forests as well as non-crop areas. Global registration of glyphosate was started in 1974 and in 2013 ranked to be the largest selling herbicide in the world (Stephen and Stephen, 2008). Many previous studies indicated that glyphosate exhibited excellent weed control in different orchard crops such as *Citrus* spp (Singh *et al.,* 2011); *Musa* spp (Hassan and Ahmed, 2007) and pecan (Foshee *et al.,* 2008).

In Egypt, glyphosate is the active ingredient of the most common herbicide formulations, which was registered and recommended by the Agriculture Pesticide Committee (APC) for controlling grass and broad-leaved weeds in orchard fields. This herbicide controls weeds through the inhibition of the essential enzyme, 5-enolpyruvyl-shikimate-3-phosphataes synthase (EPSPS), in the shikimic acid pathway causing a disruption in the synthesis of the essential aromatic amino acids that necessary for protein formation or precursors of other metabolic aromatic compounds such as plant growth regulators (Zhang *et al.,* 2015; Schonbrunn *et al.,* 2001). Glufosinate-ammonium is a contact and systemic post emergence herbicide registered for controlling different weed species in orchards and non-agriculture regions (Wibawa *et al.,* 2009).

Assiut Governorate is one of the largest producers of pomegranate fruits in Egypt which has about 25.7% of the total pomegranate acreage in Egypt (Abdel-Ghany, 2015). Although, weeds are the most serious factors encounter the pomegranate production in Assiut. A few research studies have been published in this topic worldwide and none in Assiut. In addition, many glyphosate herbicide formulations have been registered with different trade names and many of them are quite new. As far as I know, the effect of glyphosate formulations and glufosinate on weeds in pomegranate orchards in Assiut Governorate is not studied yet.

Thus, the study was investigated to evaluate the efficiency of certain glyphosate formulations and glufosinate-ammonium comparing to hand hoeing for controlling various annual weed species grown in pomegranate orchards in Assiut Governorate.

MATERIALS AND METHODS

Field trials were carried out on a uniform 12-year old Manfalouty pomegranate cultivar at the Experimental Farm of Pomology Department, Faculty of Agriculture, Assiut University, Assiut, Egypt in 2014-15. The trees were planted on spaced 5 × 5 m apart. The soil in this field is clay. The weed management treatments consisted of application of four post emergence formulation herbicides i.e., glyphosate isopropyl amine salt (Glyweed 41% SL) at 1 L/fed (Fed stands for Feddan and one Fed equals 0.42 hectare), glyphosate-isopropyl ammonium (Rophosate 48% SL) at 2.5 L/fed, glyphosate diammonium (Ouragan 4 - 39.6% SL) at 2.5 L/fed and glufosinate-ammonium (Lifeline 28% SL) at 1.5 L/fed; as well as hand hoeing (applied twice) and untreated control. All herbicides were sprayed using a Knapsack sprayer with one nozzle with water volume of 125 L / fed. The plot size was 75 m^2 (5 m x 15 m) and included three trees. The experiments were laid out in a randomized complete block design with three replications. Standard pomegranate agricultural practices such as fertilization, irrigation, and control of pests (insects and diseases) and others were applied as recommended to all tress in the experiments.

Weeds were cut from 1 m^{-2} area in each plot at 30 and 60 days after herbicides sprayed (DAS) in both experiments. Annual weeds were individually separated to grass, broad-leaved and total weeds then fresh weight of each individual weed species was recorded (g m^{-2}). The efficacy of weed treatments against grass, broad-leaved and total weed species compared to the control was estimated through the calculation of the percentage of fresh weight reduction according to Hamada *et al.* (2013).

Data were subject to root square transformation before performing the statistical analysis. Analysis of variance (ANOVA) was used for the data and the significant differences among means were separated by LSD test at 5% probability level (Gomez and Gomez, 1948).

RESULTS AND DISCUSSION

The results in Table-1 to Table-4 indicate that the field experiments were infested dominantly with two broadleaved weed species common purslane (*Portulaca oleracea* L.) and nalta jute (*Corchorus olitorius* L.) and only dominant grass weed, barnyard grass (*Echinochloa colonum* (L.) Link) at 30 and 60 days of herbicides sprayed (DAS).

Efficacy of weed control treatments at 30 DAS

Fresh weight (g m^{-2}) and the percent biomass reduction of grass, broadleaved weeds and total weeds in response to weed control treatments (herbicides and handhoeing) and compared to unweeded control after 30 DAS are shown in Table 1 and 2 for the first and the second experiments, respectively. The results showed that all herbicides and hand hoeing treatments showed a high efficiency against grass and broadleaved weeds in pomegranate field. They provided a significant difference in which the fresh weight was reduced in all weeds in both experiments after 30 DAS compared to control. Maximum fresh weight of grass and total broadleaved weeds in unweeded control were 596.03 and 475.43 g m^{-2}; and 1753.33 and 1526.00 g m^{-2} at 30 DAS in the first and second experiments, respectively. Glyphosate isopropyl amine salt (Glyweed 41% SL) showed the highest fresh weight reduction percentages of grass, total broadleaved weeds and total weeds with 96.59, 98.75 and 98.21%, respectively and a significant difference from other herbicides and hand hoeing in the first experiment at 30 DAS (Table-1).

Same trend with slight change was recorded in the second experiment (Table-2) where the application of glyphosate isopropyl amine salt (Glyweed 41% SL) achieved 95.59, 97.89 and 97.34%, respectively reduction percentages with no significant difference from other herbicides. However, a significant difference was observed in the percent of hand hoeing treatment. Whereas glyphosate-isopropyl ammonium (Rophosate 48% SL), glyphosate diammonium (Ouragan 4 - 39.6% SL) and glufosinate-ammonium (Lifeline 28% SL) treatments caused a reduction in fresh weight ranged from 87.04 to 92.22% and 88.67 to 91.16% for grass; 96.86 to 98.11% and 96.72 to 98.25% for total broadleaved weeds and 95.05 to 96.62% and 95.40 to 95.72% for total weeds, respectively in the first and second experiments (Table 1 and 2). Hand hoeing treatment exhibited the lowest fresh weight

reduction percent of 89.01, 94.52 and 93.12% for grass, total broadleaved weeds and total weeds respectively in the first experiment and 80.82, 91.45 and 88.93%, respectively in the second experiments.

Efficacy of weed control treatments at 60 DAS

All weed treatments exhibited a significant potency against grass, broadleaved weeds and total weeds in both experiments at 60 DAS compared with unweeded control which had the maximum fresh weight of grass (231.00 and 365.00 g m^{-2}) and total broadleaved weeds (1177.33 and 1337.33 g m^{-2}), respectively in the first and second experiments (Table-3 and 4). The percentages of fresh weight reduction of all weeds caused by all herbicides and hand hoeing treatments were less than that percent recorded at 30 DAS. Similarly with the above data at 30 DAS, glyphosate isopropyl amine salt (Glyweed 41% SL) was also the most potent herbicide against all target weeds compared with other weed treatments and it reduced the fresh weight of grass, total broadleaved weeds and total weeds by 82.25, 90.32 and 89.00% in the first experiment and by 76.93, 95.11 and 90.01% in the second experiment, respectively. No significant difference were obtained among the fresh weight reduction percentages of all weeds caused by all tested herbicides and hand hoeing in the first experiment and only among all herbicides in the second experiment after 60 DAS. The fresh weight percent reduction, caused by glyphosate-isopropyl ammonium (Rophosate 48% SL), glyphosate diammonium (Ouragan 4 - 39.6% SL) and glufosinate-ammonium (Lifeline 28% SL) against grass, total broadleaved weeds and total weeds were averaged 49.84 to 69.22%; 89.08 to 94.79% and 85.83 to 87.41%, respectively in the first experiment (Table 3) and 63.67 to 85.83%; 87.34 to 94.38% and 84.70 to 87.79%, respectively in the second experiment (Table 4). Hand hoeing resulted in the lowest fresh weight reduction of grass, total broadleaved weeds and total weeds which were 30.41, 86.65 and 77.43%, respectively in the first experiment compared with the herbicides treatments. Meanwhile, in the second experiment, hand hoeing showed 58.02, 93.22 and 85.67% reduction percentages, respectively.

Effect of weed control treatments on yield of pomegranate trees

Application of glyphosate isopropyl amine salt (Glyweed 41% SL) showed highest significant increment percentages of the pomegranate numbers of fruit per tree, fruit weight and tree yield by 26.84, 36.74 and 73.43%, respectively in the first experiment (Table 5) and 27.91, 33.48 and 70.74% in the second experiments (Table-6) compared with other treatments. However, the lowest pomegranate fruit weight, numbers of fruit per tree and tree yield values were

recorded in unweed control treatment compared with other weed control treatments in both the first and second experiments. The weed control treatments increased the pomegranate numbers of fruit tree^{-1} (2.39 to 12.32%), fruit weight (22.23 to 30.38%) and tree yield (25.13 to 46.43%) compared with unweeded control treatment in the first experiment (Table-5). In the second experiment, other weed control treatments increased the pomegranate fruit weight (21.66 to 32.58%) and tree yield (24.92 to 46.54%) while the increment percentages of fruit numbers per tree were 4.26 and 11.63% for glyphosate diammonium (Ouragan 4 - 39.6% SL) and hand hoeing as compared with control (Table-6).

Therefore, overall results in the tow experiments clarified that the unweeded control plots were contained maximum fresh weight of *P. oleracea*, *C. olitorius* and *E. colonum* compared with the other weed treatments. Similar results were recorded in citrus orchards by Omaima and El-Metwally (2007) and Abouziena *et al.* (2008). Weeds are serious pests in pomegranate and other fruit crops that caused a great loss in yield and quality of fruits through their competition with fruit plants for the essential elements of growth such as nutrition, water and light (Gupta 2004).Treatment of all herbicides, glyphosate isopropyl amine salt (Glyweed 41% SL), glyphosate-isopropyl ammonium (Rophosate 48% SL), glyphosate diammonium (Ouragan 4 - 39.6% SL) and glufosinate-ammonium (Lifeline 28% SL) and hand hoeing were high efficient and exhibited a significant reduction in fresh weight of the grass, broadleaved weeds and total weeds in pomegranate field compared to unweeded control at 30 DAS and then the percentages were declined after 60 DAS in the first and second experiments. These finding are in agreement with those of Omaima and El-Metwally (2007) who found that glyphosate, glyfosinate then two hand hoeing treatments exhibited the greatest efficiency in decreasing biomass of weeds such as *P. oleracea* L., *E. colonum* L. and other weeds in orchard of Washington Navel Orange, *Citrus sinensis* L. Osbeck. Also, Wibawa *et al*. (2009) stated that application of glyphosate and glufosinate-ammonium provided an excellent efficiency in controlling grass and broad leaved weeds and they reduced the weed biomass at 28 and 56 days after treatment in oil palm regions and glyphosate was more effective than glufosinate-ammonium.

In this study, glyphosate isopropyl amine salt (Glyweed 41% SL) exhibited to be the most potent herbicidal effect against the target weeds followed by other herbicides then hand weeding in both experiments. In this regard, glyphosate was the most popular and efficient herbicide against various annual and perennial grass and broadleaved weeds in different fruit production regions in the world such as citrus (Barbora *et al.*, 2002; Singh and Singh, 2004), Banana

(Hassan and Ahmed, 2007) and Pecan trees (Foshee *et al.*, 2008). In Egypt, Abouziena *et al.* (2008) revealed that glyphosate was the most effective herbicide than hand hoeing and plant mulch treatments in controlling different broadleaf and grass weeds up to 90 days after treatments in Mandarin grave and the herbicide was more effective on broadleaf than grass weeds.

Here too, variable susceptibility of weed species to different formulations of glyphosate or glufosinate-ammonium herbicide was recorded. It may be attributed to 1) the variations in the morphological, anatomical and physiological characteristics of these weeds; 2) the chemically dissimilar between the formulations (in particular with glyphosate) and the active ingredients of both herbicides that resulted in various mode of actions, and 3) environmental factors such as soil types and properties, microbial organisms and weather factors.

In agreement with our results, variable glyphosate efficiency against different grass and broadleaved weed species had been recorded (Singh *et al.*, 2011). Moreover, Wibawa *et al.* (2009) reported that variable in response of weed species to glyphosate or glufosinate-ammonium may attributed to the growth and dominance characteristics of weed group such as density, frequency and productivity of weed community or it might contribute to the difference in the target site actions. The mode of action of glyphosate is inhibition of the EPSPS, a key enzyme in shikimate pathway which blocks the synthesis of the essential amino aromatic acids such as tryptophan causing accumulations of shikimate in the plant tissues then plant death. In addition, glyphosate can disrupt the chlorophyll synthesis in plant causing yellowish leave through increment in chlorophyll content in plants (Cole, 1985; Gravena *et al.*, 2012). Glufosinate-ammonium is a glutamine synthase inhibitor herbicide (Jalaludin *et al.*, 2010).

Moreover, differences on the efficacy of glyphosate formulations on weeds in this study may also relate to the herbicide forms and formulations whereas, the glyphosate formulations contain additives like surfactants that may improve the performance of foliar spray application and increase the active ingredient penetration. This suggestion is spurted with the studies of Sharma and Singh (2001), Stevens *et al.* (1991) and Sharma *et al.* (1993). However, decreasing the effect of glyphosate and glufosinate-ammonium on target weeds after 60 days of treatments may due to affect of both herbicides by biotic factor (i.e., soil microbial; weeds characteristics) and/or a biotic factors (soil type and properties) as well as herbicides chemical structure and formulations. Similar finding were reported by Caseley and Coupland (1985) and Zhang *et al.* (2015) which they found the herbicidal activity of either glyphosate or glufosinate-ammonium is

affected by many soil microbes and other different environmental factors. For example, various soil microorganisms, in particular some bacteria, have been founded to be able to decrease the effectiveness of glyphosate (Zhang *et al.*, 2015); glufosinate-ammonium (Smith, 1988; Tharp and Kells, 2001) on the target weeds which depends on the soil type and properties; some weather factors, herbicide formulations as well as the duration after treatments.

For hand hoeing treatment in this study, it exhibited an effective control for weed species but it had the lower effect compared with the efficacy of herbicide treatments. Similar results were reported by Wibawa *et al.* (2009) and Abouziena *et al.* (2008). On other side, Tucker *et al*. (1979) stated that mechanical control such as hand hoeing is labor, expensive and it can cause damage to the fruit tree parts like shoot branches and the shallow root system.

The current study, the increment in the fruit weight, number of fruit per tree and tree yield of pomegranate may couple with the effectiveness of all weed control treatments including hand hoeing and all herbicides especially glyphosate isopropyl amine salt (Glyweed 41% SL) for controlling weed species and decrease their competition with the pomegranate trees for the nutrition and water. By this act, the trees can get a high quantity of essential elements needed for vegetative growth and flowering. These results are in agreement with many previous research which indicated that using of herbicides (i.e., glyphosate and glufosinate-ammonium) and other weed management control treatments (i.e. hand hoe and mulching) revealed a significant decrease in weed biomass and improvement in the vegetative growth parameter of trees and increase in fruit yield and quality of various fruit crops (Kalita and Bhattacharyya, 1995; Wibawa *et al.*, 2009; Abouziena *et al.*, 2008; Hassan and Ahmed, 2007; Omaima and El-Metwally, 2007). In addition, the suggestion of these researchers may clear why unweeded control has the lowest values of the fruit weight, number of fruit per tree and tree yield of pomegranate. In this regard, MacRae *et al.* (2007) found that the competition of weeds with the trees of peach (*Prunus persica*) on water and nutrition due to decrease in the amount of cell division thus affecting the size and weight of fruit.

Table-1. Effect of selected formulations of glyphosate and glufosinate-ammonium herbicides, hand hoeing and unweeded control on fresh weight of grass, broadleaved annual weeds (g m^{-2}) and their reduction percentages in pomegranate orchards after 30 days of herbicide sprayed in the first experiment.

Weed types	Grass weed		Broadleaf weeds						Total all weeds	
	E. colonum L.		P. oleracea L.		C. olitorius L		Total broadleaf weeds			
Traits / Treatments	Fresh weight (g m^{-2})	Reduction %	Fresh weight (g m^{-2})	Reduction %	Fresh weight (g m^{-2})	Reduction %	Fresh weight (g m^{-2})	Reduction %	Fresh weight (g m^{-2})	Reduction %
Rophosate 48% SL	46.40	92.22	2.73	99.68	30.37	96.61	33.10	98.11	79.50	96.62
Ouragan 4 - 39.6% SL	77.24	87.04	5.46	99.36	33.53	96.26	38.99	97.78	116.23	95.05
Glyweed 41% SL	20.30	96.59	4.87	99.43	16.98	98.11	21.85	98.75	42.15	98.21
Lifeline 28% SL	57.00	90.44	18.15	97.88	36.96	95.88	55.11	96.86	112.11	95.23
Hand hoeing	65.53	89.01	95.01	88.92	1.04	99.88	96.05	94.52	161.57	93.12
Unweeded control	596.03	0.00	857.33	0.00	896.00	0.00	1753.33	0.00	2349.37	0.00
L.S.D. 5%*	2.55	-	2.16	-	1.39	-	2.64	-	2.18	-

* L.S.D was performed without control

Table-2. Effect of selected formulations of glyphosate and glufosinate-ammonium herbicides, hand hoeing and unweeded control on fresh weight of grass, broadleaved annual weeds (g m^{-2}) and their reduction percentages in pomegranate orchards after 30 days of herbicide sprayed in the second experiment.

Weed types	Grass weed		Broadleaf weeds						Total all weeds	
	E. colonum L.		P. oleracea L.		C. olitorius L		Total broadleaf weeds			
Traits / Treatments	Fresh weight (g m^{-2})	Reduction %	Fresh weight (g m^{-2})	Reduction %	Fresh weight (g m^{-2})	Reduction %	Fresh weight (g m^{-2})	Reduction %	Fresh weight (g m^{-2})	Reduction %
Rophosate 48% SL	47.82	89.94	5.78	98.99	32.13	96.63	37.91	97.52	85.73	95.72
Ouragan 4 - 39.6% SL	53.85	88.67	6.07	98.94	20.65	97.83	26.72	98.25	80.57	95.97
Glyweed 41% SL	20.94	95.59	13.02	97.73	19.23	97.98	32.26	97.89	53.20	97.34
Lifeline 28% SL	42.04	91.16	11.40	98.01	38.67	95.94	50.07	96.72	92.11	95.40
Hand hoeing	91.20	80.82	130.42	77.25	0.00	100.00	130.42	91.45	221.62	88.93
Unweeded control	475.43	0.00	573.33	0.00	952.67	0.00	1526.00	0.00	2001.43	0.00
L.S.D. 5%*	3.12	-	2.57	-	0.72	-	2.70	-	4.13	-

* L.S.D was performed without control

Table-3. Effect of selected formulations of glyphosate and glufosinate-ammonium herbicides, hand hoeing and unweeded control on fresh weight of grass, broadleaved annual weeds (g m^{-2}) and their reduction percentages in pomegranate orchards after 60 days of herbicide sprayed in the first experiment.

Weed types	Grass weed		Broadleaf weeds						Total all weeds	
	E. colonum L.		P. oleracea L.		C. olitorius L		Total broadleaf weeds			
Traits / Treatments	Fresh weight (g m^{-2})	Reduction %	Fresh weight (g m^{-2})	Reduction %	Fresh weight (g m^{-2})	Reduction %	Fresh weight (g m^{-2})	Reduction %	Fresh weight (g m^{-2})	Reduction %
Rophosate 48% SL	71.10	69.22	108.72	81.74	19.79	96.60	128.51	89.08	199.61	85.83
Ouragan 4 - 39.6% SL	100.60	56.45	72.70	87.79	20.21	96.53	92.91	92.11	193.51	86.26
Glyweed 41% SL	41.00	82.25	81.04	86.39	32.90	94.35	113.94	90.32	154.94	89.00
Lifeline 28% SL	115.88	49.84	48.94	91.78	12.45	97.86	61.39	94.79	177.27	87.41
Hand hoeing	160.76	30.41	61.17	89.73	95.95	83.51	157.12	86.65	317.88	77.43
Unweeded control	231.00	0.00	595.33	0.00	582.00	0.00	1177.33	0.00	1408.33	0.00
L.S.D. 5%*	4.25	-	1.82	-	2.75	-	2.39	-	3.09	-

* L.S.D was performed without control

Table 4. Effect of selected formulations of glyphosate and glufosinate-ammonium herbicides, hand hoeing and unweeded control on fresh weight of grass, broadleaved annual weeds (g m^{-2}) and their reduction percentages in pomegranate orchards after 60 days of herbicide sprayed in the second experiment.

Weed types	Grass weed		Broadleaf weeds						Total all weeds	
	E. colonum L.		P. oleracea L.		C. olitorius L		Total broadleaf weeds			
Traits / Treatments	Fresh weight (g m^{-2})	Reduction %	Fresh weight (g m^{-2})	Reduction %	Fresh weight (g m^{-2})	Reduction %	Fresh weight (g m^{-2})	Reduction %	Fresh weight (g m^{-2})	Reduction %
Rophosate 48% SL	51.73	85.83	141.24	83.84	28.00	93.96	169.24	87.34	220.97	87.02
Ouragan 4 - 39.6% SL	124.93	65.77	119.57	86.32	15.89	96.57	135.46	89.87	260.39	84.70
Glyweed 41% SL	84.21	76.93	63.25	92.76	22.64	95.11	85.89	93.58	170.10	90.01
Lifeline 28% SL	132.61	63.67	60.78	93.05	14.44	96.88	75.22	94.38	207.83	87.79
Hand hoeing	153.22	58.02	60.97	93.02	29.70	93.59	90.67	93.22	243.89	85.67
Unweeded control	365	0.00	874.00	0.00	463.33	0.00	1337.33	0.00	1702.33	0.00
L.S.D. 5%*	3.44	-	3.29	-	1.54	-	3.79	-	5.97	-

* L.S.D was performed without control

Table-5. Effect of selected formulations of glyphosate and glufosinate-ammonium herbicides, hand hoeing on fruit weight (g), number of fruit and average yield per tree (Kg) and their increment percentage in pomegranate orchards in the first experiment.

Traits / Treatments	No. of fruit tree^{-1}	%	Fruit wt (g)	%	Yield (kg tree^{-1})	%
Rophosate 48% SL	98.00	12.32	532.83	30.38	52.22	46.43
Ouragan 4 - 39.6% SL	94.00	7.74	512.50	25.41	48.18	35.10
Glyweed 41% SL	110.67	26.84	558.83	36.74	61.84	73.43
Lifeline 28% SL	89.33	2.39	499.50	22.23	44.62	25.13
Hand hoeing	95.00	8.88	510.83	25.00	48.53	36.09
Unweeded control	87.25	0.00	408.67	0.00	35.66	0.00
L.S.D. 5%*	13.46	-	110.08	-	16.14	-

* L.S.D was performed with control

Table-6. Effect of selected formulations of glyphosate and glufosinate-ammonium herbicides, hand hoeing on fruit weight (g), number of fruit and average yield per tree (Kg) and their increment percentage in pomegranate orchards in the second experiment.

Traits / Treatments	No. of fruit tree^{-1}	%	Fruit wt (g)	%	Yield (kg tree^{-1})	%
Rophosate 48% SL	86.00	0.00	516.17	32.58	44.39	32.59
Ouragan 4 - 39.6% SL	96.00	11.63	510.75	31.19	49.03	46.45
Glyweed 41% SL	110.00	27.91	519.67	33.48	57.16	70.74
Lifeline 28% SL	86.00	0.00	486.33	24.92	41.82	24.92
Hand hoeing	89.67	4.26	473.67	21.66	42.47	26.86
Unweeded control	86.00	0.00	389.33	0.00	33.48	0.00
L.S.D. 5%*	22.44	-	134.89	-	13.90	-

* L.S.D was performed with control

CONCLUSION

The efficacy of glyphosate isopropyl amine salt (Glyweed 41% SL), glyphosate-isopropyl ammonium (Rophosate 48% SL), glyphosate diammonium (Ouragan 4 - 39.6% SL) and glufosinate-ammonium (Lifeline 28% SL) and hand hoeing twice for controlling the annual weed species in pomegranate field were evaluated for the first time in Assiut, Egypt. To sum up, the results showed that all weed control treatments are effective and successful tools for controlling the target weeds and led to increase the pomegranate fruit weight, number of fruit per tree and tree yield compared with the unweeded control. Moreover, glyphosate isopropyl amine salt (Glyweed 41% SL) was the most effective one. However, further field experiments are required to test the efficiency of these herbicides against a wide spectrum of annul and perennial weed species in pomegranate and other fruit crops.

REFERENCES CITED

Abdel-Ghany, A.M.M. 2015. Physico-chemical and antioxidant properties in pomegrnates. MSc. Thesis, Assiut University, Egypt.

Abouziena, H.F., O.M. Hafez, I.M. El-Metwally, S.D. Sharma and M. Singh. 2008. Comparison of weed suppression and mandarin fruit yield and quality obtained with organic mulches, synthetic mulches, cultivation, and glyphosate. Hort. Sci. 43(3): 795–799.

Barbora, A.C., S.C. Borah and D. Bhattacharya. 2002. Effect of weed management on yield and quality of Khasi Mandarin (*Citrus reticulate* Blanco). Indian J. Citricult. 1(1): 62–65.

Caseley, J.C. and D. Coupland. 1985. Environmental and plant factors affecting glyphosate uptake, movement and activity. In The Herbicide Glyphosate. E. Grossbard and D. Atkinson (eds). Butterworths, London 92–123.

Cole, D.J. 1985. Mode of action of glyphosate – a literature analysis. In The Herbicide Glyphosate. E. Grossbard and D. Atkinson (eds). Butterworths, London 48–74.

Foshee, W.G. III, E.K. Blythe, W.D. Goff, W.H. Faircloth and M.G. Patterson. 2008. Response of young Pecan trees to trunk and foliar applications of glyphosate. Hort. Sci. 43(2): 399–402.

Gravena, R., R.V. Filho, P.L.C.A. Alves, P. Mazzafera and A.R. Gravena. 2012. Glyphosate has low toxicity to citrus plants growing in the field. Can. J. Plant Sci. 92: 119–127.

Gomez, K.A., and A.A. Gomez. 1984. Statistics for Agricultural Ressearch. 2nd edition. John Willey and Sons, New York.

Gupta, O.P. 2004. Modern weed management. 2nd edition. Agrobios Jodhpur, India. pp. 18-23.

Hamada, S.H.E, M.F. Abdel-Lateef, A. E. Abdelmonem, R.M.A. El-kholy and A.A.R. Helalia. 2013. Efficiency of certain clodinafop-propargyl formulations in controlling annual grassy weeds in wheat. Ann. of Agric. Sci. 58(1): 13–18.

Hassan, A.A.A. and M.A. Ahmed. 2007. Influence of different weed control methods on growth, yield, fruit quality and minerals content of Maghrabi banana cultivar. J. of Appl. Sci. Res. 3(7): 574–580.

Jalaludin. A., J. Ngim, B.B. Baki and A. Zazali. 2010. Preliminary findings of potentially resistant goosegrass (*Eleusine indica*) to glufosinate-ammonium in Malaysia. Weed Biol. and Manage. 10(4): 256–260.

Kalita, H. and R.K. Bhattacharyya. 1995. Integrated weed management in Assam lemon in lemon (*Citrus limon* Burm.f.) orchards. Hort. J. 8:95–100.

Khan, M.A., R.E. Blackshaw and K.B. Marwat. 2009. Biology of Milk thistle and management options for growers in northwest Pakistan. *Weed Biol. Manag.*9(2): 99-105.

MacRae, A.W., W.E. Mitchem, D.W. Monks, M.L. Parker and R.K. Galloway. 2007. Tree growth, fruit size, and yield response of mature peach to weed-free intervals. Weed Technol. 21(1):102–105.

Marwat, K.B., Z. Hussain, M. Saeed, B. Gul and S. Noor. 2005. Chemical weed management in wheat at higher altitudes. Pak. J. Weed Sci. Res. 11(3-4): 102–107.

Okatan, V., Y. Akca, S. Ercisli and S. Gozlekci. 2015. Genotype selection for physico-chemical fruit traits in pomegranate (*Punica granatum* L.) in Turkey. Acta Sci. Pol. Hort. Cultus. 14 (2):123–132.

Omaima, M.H. and I. M. El-Metwally. 2007. Efficiency of zinc and potassium sprays alone or in combination with some weed control treatments on weeds growth, yield and fruit quality of Washington Navel Orange orchards. J. of Appl. Sci. Res. 3(7): 613–621.

Schönbrunn, E., S. Eschenburg, W.A. Shuttleworth, J.V. Schloss, N. Amrhein, J.N. Evans and W. Kabsch. 2001. Interaction of the herbicide glyphosate with its target enzyme 5-enolpyruvylshikimate 3-phosphate synthase in atomic detail. Proc. Natl. Acad. Sci. USA. 98(4): 1376–1380.

Sharma, S.D. and M. Singh. 2001. Surfactants increase toxicity of glyphosate and 2,4-D to Brazil pusley. Hort. Sci. 36(4): 726–728.

Sharma, S.D., R.C. Kirkwood and T.L. Whateley. 1993. The effect of surfactant polarity on cuticle penetration of selected hydrophilic and lipophilic herbicides. Pesticide Sci. 38 (2-3): 267–268.

Sharma, Y.P. and V.P. Bhutani. 1989. Effect of nitrogen levels and weed control treatments on nutrient status of peach. Hort. Sci. Abstr. 61:7745.

Singh, M., M. Malik, H.M.R. Analiza, H.M. Ramirez and A.J. Jhala. 2011. Tank mix of saflufenacil with glyphosate and pendimethalin for broad-spectrum weed control in Florida citrus. HortTechnol. 21(5): 606–615.

Singh, S. and M. Singh. 2004. Effect of growth stage on trifloxysulfuron and glyphosate efficacy in twelve weed species of citrus groves. Weed Technol. 18(4): 1031–1036.

Smith, A.E. 1988. Persistence and transformation of the herbicide (14C)glufosinate-ammonium in prairie soils under laboratory conditions. J. Agric. Food Chem. 36(2): 393–397.

Stephen, O.D. and B.P. Stephen. 2008. Glyphosate: A once- in-a-century herbicide: Mini-review. Pest Manage. Sci. 64(4): 319–325.

Stevens, P.J. G., R.E. Gaskin, S.O. Hong and J.A. Zabkiewicz. 1991. Pathways and mechanisms of foliar uptake as influenced by surfactants. Pesticide Sci. 33: 371–382.

Tharp, B.E. and J.J. Kells. 2001. Effect of glufosinate-resistant corn (*Zea mays*) population and row spacing on light interception, corn yield, and common lambsquarters (*Chenopodium album*) growth. Weed Technol. 15(3): 413–418.

Tucker, D.P.H., R. Muraro and B. Abbitt. 1979. Two weed control systems for Florida citrus. Proc. Fla. State Hort. Soc. 93: 30–33.

Wibawa, W., R. Mohamad, A. S. Juraimi, D. Omar, M. G. Mohayidin and M. Begum. 2009. Weed control efficacy and short term weed dynamic impact of three non-selective herbicides in immature oil palm plantation. Int. J. Agric. Biol. 11: 145–150.

Zhang, C., X. Hu, J. Luo, Z. Wu, L. Wang, B. Li, Y. Wang and G. Sun. 2015. Degradation dynamics of glyphosate in different types of citrus orchard soils in China. Molecules. 20(1): 1161–1175.