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EVALUATION OF SOME POST EMERGENCE HERBICIDES IN ORCHARDS OF IRAN

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ABSTRACT

Experiments were conducted in 2006 at three apple orchards of Iran, to compare the efficacy of a factory-mixture of Amitrol + Ammonium thiocyanate + Glyphosate (ATG) marketed as or Illico SL 30.9% applied at 2.2, 2.9, 3.6 and 4.3 kg a.i. ha^{-1} and new glyphosate (NG) marketed as Weedmaster 360 SC 35% at 0.36 and 0.54 kg a.i. ha^{-1} as new herbicides with some currently applied herbicides including Old glyphosate (OG) marketed as Roundup SL 41% and paraquat (P) marketed as Gramaxone SL 20% and standard herbicides. Herbicides were applied post-emergence when weeds were 10 cm high. The results showed that 15 days after post emergence paraquat application, P completely controlled weeds, except in Jiroft where P 30 days after application showed its effects. ATG and NG after 30 days also controlled weeds. At the end of the season ATG at 2.9, 3.6 and 4.3 kg a.i. ha^{-1}, NG at 0.54 kg a.i. ha^{-1}, P and OG provided the best weed suppression.

Key word: Weed biomass, weed injury, new herbicides, orchards, perennial weeds.

INTRODUCTION

The most important agricultural products exported by Iran are fresh and dry fruits (Anonymous, 2002). Fruit production is limited by a number of factors, among which is severe weed infestation (Mousavi, 2001). Weed interference in orchards can affect tree growth, fruit bud set, flower initiation, yield, fruit quality and winter hardiness (Majek *et al.*, 1993). The critical weed-free period is the length of time that a crop must be maintained free of weeds to minimize quality reduction and/ or yield loss (Monks and Schultheis, 1998; Weaver *et al.*, 1992). MacRae *et al.*, (2007) reported that maintaining the orchard floor

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weed-free for 12 weeks after peach tree bloom, resulted in the greatest fruit size (individual fruit weight and diameter), total yield and fruit number.

Weeds are an increasing problem in many orchards in Iran. Shimi and Termeh (1994) ranked *Descurania sophia* (L.) Webb. (flixweed), *Galium* sp. (bedstraw), *Sinapis arvensis* L.(wild mustard), *Cirsium arvense* (L.) Scop. (canada thistle), *Convolvulus arvensis* L. (field bindweed), *Glycyrrhiza glabra* L. (licorice), *Cyperus rotundus* L.(purple nutsedge), and *Cynodon dactylon* (L.) Pers. (bermuda grass) among the ten most troublesome weeds of orchards in Iran.

Herbicides have been the main means of weed control for more than 30 years in Iran (Zand and Baghestani, 2002). Today, high-yielding orchards heavily depend on herbicides, as they constitute a vital and integral component of weed management practices (Mousavi, 2001). However, there are very few herbicide options available for orchards of Iran. Currently, herbicides used include post-emergence application of glyphosate and paraquat (Mousavi, 2001; Mosalanejad *et al.*, 2003). However, the continuous use of these herbicides might lead to the development and evolution of resistant biotypes. Evolution of herbicide resistance may be considered as an example of recurrent selection in which there is a progressive and sometimes rapid shift in average fitness of populations of weeds exposed to a herbicide (Shane-Friesen *et al*., 2000). Thus, there is a great need to identify new post-emergence herbicides for orchards. Also, we need to introduce and to use new herbicides with lower application rate and less negative environmental effects.

Amitrol+ Ammonium thiocyanate + glyphosate (hereafter referred to as ATG) (Illico) and new glyphosate (NG) (Weedmaster) are among the new registered herbicides. ATG contains active ingredients that are members of both the triazole and glycine groups of herbicides and exhibit the carotenoid and EPSP synthase mode of action. For weed resistance management this herbicide is both a group F and group M herbicide (Nufarm ILICO, 2005, Approval No: 55765/0703). This herbicide is designed specifically for use in vineyards and orchards (Nufarm ILICO, 2005, Approval No: 55765/0703). New glyphosate (NG) (Weedmaster 360) is a member of the glycine group of herbicides. This herbicide has the inhibitors of EPSP synthase mode of action (Nufarm Weedmaster 360, 2005, Approval No: 49909/0698).

The objective of this study was to evaluate the efficacy of some newly registered herbicides, since no information is available in the literature on these chemicals in Iran.

MATERIALS AND METHODS

Studies were conducted in 2006 in apple orchards of Iran. Site description and schedule of events is shown in Table-1. The experimental design at all locations was a randomized complete block with four replications. Naturally occurring weed populations were used in the experiments. Weed composition at each location is presented in Table-2.

Table-1. Schedule of events, herbicide application date and data collection date.

Location	Herbicide application date	Data collection date
Tehran	19/4/2006	19/06/2006
Dezfol	08/04/2006	08/062006
Jiroft	07/03/2006	07/05/2006

Treatments consisted of full-season weed-infested plots, and post-emergence applications of Amitrol+ Ammonium thiocyanate+ glyphosate (ATG) SL30.9% at 2.2, 2.9 3.6 and 4.3 kg a.i. ha^{-1}, New glyphosate (NG) SC 35% at 0.36 and 0.54 kg a.e. ha^{-1} and Old glyphosate (OG) SL 41% and paraquat (P) SL 20% as standard herbicides. Herbicides were applied at blossoming time of trees, when weeds were 10 cm high, with an Elegance 18 electric knapsack sprayer equipped with flooding nozzle and calibrated to deliver 300 L ha^{-1} of spray solution at a pressure of 2.5 bar.

Table 2- Weed composition of the experimental field at each location.

Weed Species	Location		
	Tehran	Dezfol	Jiroft
Cirsium arvense (L.) Scop.	+	-	-
Convolvulus arvensis L.	+	+	-
Tragopogon gramininfolius DC.	+	-	-
Cyperus rotundus L.	-	+	-
Ammi majus L.	-	-	+
Anagallis arvensis L.	-	-	+
Cynodon dactylon (L.) Pers.	-	-	+
Melilotus indica L.	-	-	+
Plantago lanceolata L.	`	-	+

Visual percent weed control was rated 15 and 30 days after herbicide applications (DAHA) on a scale of 0–100. A rating of 0 was defined as no control and 100 as complete control. Weed biomass was measured using two 0.25 m^2 quadrates which were dropped in each plot. All weeds were cut at ground level, separated by species, and oven dried at 75°C for 48 h. All data were subjected to analysis of variance (ANOVA) using SAS statistical software (SAS Institute, 1996), and means were separated using Duncan's multiple range test (DMRT) set at 0.05 probability level. Data were analyzed separately by location because weather conditions, soil types and weed species were different at each location.

RESULTS AND DISCUSSION

Weed Biomass

At Tehran, based on biomass evaluation, results indicated that ATG at 2.2 and NG at 0.36 and 0.54 kg a.i. ha^{-1} had no significant effect in reducing the biomass of *Cirsium arvensis* (L.) Scop. (Table-3). However, P and ATG at 2.9, 3.6 and 4.3 kg a.i. ha^{-1} significantly reduced this weed biomass. All herbicides could satisfactorily control *Convolvulus arvensis* L. biomass (Table-3). This weed was mostly controlled by ATG at 3.6 and 4.3, NG at 0.54 kg ae ha^{-1}. *Tragopogon graminifolius* DC. biomass was satisfactorily controlled by all herbicide treatments except ATG at 2.2 kg a,i. ha^{-1} which failed to control this weed satisfactorily.

Barros, e*t al.* (2005) also reported that herbicide efficiency in controlling weeds differs according to weed species.

Table-3. Effect of different herbicide treatments on weed biomass (g m^{-2}) 60 days after herbicide application at Tehran.

Treatment (kg a.i./ae ha^{-1})	*Cirsium arvense*	*Convolvulus arvensis*	*Tragopogon graminifolius*
ATG 2.2†	41.4abcd*	7.4bc	27.6ab
ATG 2.9	11de	3.6cde	14.4bcd
ATG 3.6	21.4cde	1.88de	12.8bcd
ATG 4.3	13.4cde	1.34e	19.4bcd
Newglyphosate(NG) 0.36	40.8abcd	5.6bcd	22.1bc
New glyphosate (NG) 0.54	52.4abc	0.56e	11.6bcd
Old glyphosate (OG) 2.2	29.6bcd	10.6b	5.8cd
Paraquat (P) 0.53	2.2e	0.74e	4.2d
Control	71.8a	13.5a	49.4a

*Means within each column followed by same letter are not significantly different at 0.05 probability level to DMRT test.

†ATG=Amitrol+ Ammonium thiocyanate+ glyphosate

At Dezfol, like the trial at Tehran, all herbicides except ATG at 2.2 kg a.i. ha^{-1}, could satisfactorily control *Convolvulus arvensis* L. biomass (Table-4). Spraying with ATG and NG at the lowest dose

resulted in the highest *Cyperus rotundus* L. biomass compared with other herbicides. Based on different environmental conditions, Zhang, *et al.* (2000) found substantial variation in weed control efficiency using different herbicide doses.

Table-4. Effect of different herbicide treatments on weed biomass (g m^{-2}) 30 days after herbicide application at Dezfol.

Treatment (kg a.i./ae ha^{-1})	*Convolvulus arvensis*	*Cyperus rotundus*
ATG 2.2†	65a*	10.1ab
ATG 2.9	28.4bc	5.2bc
ATG 3.6	15.6c	3.5c
ATG 4.3	13.3c	0d
New glyphosate (NG) 0.36	28.1bc	10.7ab
New glyphosate (NG) 0.54	22bc	4c
Old glyphosate (OG) 2.2	0d	0d
Paraquat (P) 0.53	0d	0d
Control	65a	10.1a

*Means within each column followed by same letter are not significantly different at 0.05 probability level to DMRT test.
†ATG=Amitrol+ Ammonium thiocyanate+ glyphosate

At Jiroft (Table-5), with the exception of P, all other treatments reduced *Ammi majus* L. biomass. ATG at 2.9, 3.6 and 4.3 kg a.i. ha^{-1} and NG at 0.54 kg a.i. ha^{-1} reduced the biomass of *Anagallis arvensis* L., but P failed to control this weed. A comparison among different experimental locations showed that herbicide efficacy may vary based on differences in the environment. Baghestani *et al.* (2007) also found that herbicide efficacy varies based on differences in location and environment. *Cynodon dactylon* (L.) Pres. biomass was controlled by OG and P and by ATG at 3.6 and 4.3 kg a.i, ha^{-1} (Table-5). ATG at 2.9, 3.6 and 4.3 kg a.i. ha^{-1}, NG at 0.54 kg a,i.ha^{-1} and P controlled *Mellilotus indica* L. ATG at 3.6 and 4.3 kg a.i. ha^{-1}, NG at 0.54 kg a.i. ha^{-1} and OG controlled *Plantago lanceolato* L. biomass.

Visual weed control (%)

At Tehran, 15 days after herbicide application (DAHA), P provided the highest visual weed injury (100%) (Table-6). However, 30 DAHA, ATG at 4.3 kg a.i ha^{-1} provided 100% visual weed injury ATG at 2.2, 2.9 and 3.6 kg a.i ha^{-1}. NG at 0.36 and 0.54 kg a.i ha^{-1} provided 90% visual weed injury, and OG provided 80% visual weed injury.

At Dezfol 15 DAHA, P and OG provided the highest visual weed injury (100%) (Table-6), but 30 DAHA, ATG at 3.6 and 4.3 and NG at 0.54 kg a.i ha^{-1} provided 100% visual weed injury. At this time ATG at 2.2 and 2.9 and NG at 0.36 kg a.i ha^{-1} provided 90% visual weed injury.

Table-5. Effect of different herbicide treatments on weed biomass g m^{-2}, 30 days after herbicide application at Jiroft.

Treatment (kg a.i./ae $ha^{-1)}$)	*Ammi majus*	*Anagallis arvensis*	*Cynodon dactylon*	*Mellilotus indica*	*Plantago lanceolato*
ATG 2.2†	37.6dc*	53abc	47.6bcd	79ab	47.8abc
ATG 2.9	44bcd	41.2bc	49.4bcd	70.2b	48.6abc
ATG 3.6	34.4d	34.6c	54.4abc	64.6b	37bc
ATG 4.3	36.2dc	45.2bc	41.8dc	57.4b	33.4c
New glyph. (NG) 0.36	38.2cd	54.6abc	49abc	88ab	45.4abc
New glyph. (NG) 0.54	39.6cd	42.4bc	50.6abc	61.2b	40.6abc
Old glyph.(OG) 2.2	36dc	55.6abc	35.4d	83.6ab	34.4c
Paraquat (P) 0.53	54ab	55.6abc	46.8cd	47.6b	58.2ab
Control	59.4a	71.8a	68a	113.2a	61.4a

*Means within each column followed by same letter are not significantly different at 0.05 probability level by DMRT.
†ATG=Amitrol+ Ammonium thiocyanate+ glyphosate

Table-6. Visual weed control (%) 15 and 30 days at various locations, after herbicide application on a scale of 1-100.

Treatment (kg a.i./ae $ha^{-1)}$)	Tehran		Dezfol		Jiroft	
	15*	30	15	30	15	30
ATG 2.2†	40	90	50	90	50	50
ATG 2.9	40	90	70	90	50	60
ATG 3.6	40	90	80	100	60	90
ATG 4.3	40	100	90	100	60	90
New glyphosate (NG) 0.36	40	90	70	90	40	50
New glyphosate (NG) 0.54	40	90	70	100	60	80
Old glyphosate (OG) 2.2	40	80	100	100	50	70
Paraquat (P) 0.53	100	100	100	100	70	80

* 15 or 30 days after herbicides application
†ATG=Amitrol+ Ammonium thiocyanate+ glyphosate

An Jiroft 30 DAHA, ATG at 3.6 and 4.3 kg a.i ha^{-1} provided the highest visual weed injury (90%), and NG at 0.54 and P provided 80% visual weed injury.

Results indicate that ATG and NG are very slow acting and take 30 days for their effect. The effect of P herbicide in Tehran and Dezfol, and OG in Dezfol was observed 15 DAHA. But, the effect of OG in Tehran and P, and OG in Jiroft was observed 30 DAHA. Therefore, results showed that herbicide efficacy may vary based on differences in environment.

In conclusion, this study reveals that ATG at 2.9, 3.6 and 4.3 kg a.i ha^{-1} and NG at 0.54 kg a.i ha^{-1} could be suggested as suitable option for post-emergence control of broadleaved and grass weeds in

orchards of Iran. In other words, the standard herbicides used in these experiments could be replaced by NG at above dose, which not only helps to reduce herbicide consumption rate but also moves towards a healthier environment and for the combating weed resistance, the standard herbicides could be replaced by ATG.

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