Short communication

Resistance of Winter Wild oat (*Avena ludoviciana* Durieu.) to Aryloxyphenoxy Propionate Herbicides in Wheat Fields of Khuzestan Province: First Screening Test

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ABSTRACT

To study resistance of winter wild oat (*Avena ludoviciana*) to clodinafop propargyl (Topik), diclofop methyl (Illoxan), and fenoxaprop p ethyl (Puma super) herbicides in wheat fields of Khuzestan province, seedlings of 46 wild oat population were collected from farmers' fields at seven sites of the province including Ahvaz, Andimeshk, Shush, Shushtar, Ramhormoz, Susangerd (Dashte Azadegan), and Dezful. The seed samples were screened in the greenhouse College of Agriculture, Ferdowsi University of Mashhad, in 2005. Clodinafop propargyl, diclofop methyl, and fenoxaprop p ethyl, were applied at recommended rates of 64, 900, and 75 g ai ha^{-1}, respectively. Each experiment was laid out in a completely randomized design with 3 replications. Visual phytotoxicity rating, the percentage of survived plants, and relative dry weight (percentage of control) were used to evaluate seed population response to herbicide treatment. Results showed that moderate but statistically significant variation in winter wild oat resistance existed among

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populations from different sites and among populations in wheat field of the same. Seed populations collected from Shushtar and Ramhormoz showed higher resistance to all three herbicides. It could be concluded that some winter wild oat seed populations collected from Khuzestan wheat fields are suspected to herbicide resistance.

Key words: Winter wild oat, clodinafop propargyl (Topik), diclofop methyl (Illoxan), fenoxaprop p ethyl (Puma super), screening, herbicide resistant

چکیده

به منظور شناسایی یولاف وحشی مقاوم به علفکشهای کلودینافوپ پروپارژیل (تاپیک)، دیکلوفوپ متیل (ایلوکسان) و فنوکساپروپ پی اتیل (پوماسوپر) در مزارع گندم استان خوزستان، گیاهچه های ۴۶ توده یولاف وحشی از مزارع کشاورزان در هفت شهر استان خوزستان شامل اهواز، اندیمشک، شوش، شوشتر، رامهرمز، سوسنگرد (دشت آزادگان) و دزفول جمع آوری شد. نمونه های جمع آوری شده در گلخانه دانشکده کشاورزی دانشگاه فردوسی مشهد در سال ۱۳۸۵ مورد آزمایش غربال قرار گرفتند. دز توصیه شده علفکش‌های کلودینافوپ پروپارژیل، دیکلوفوپ متیل و فنوکساپروپ پی اتیل به ترتیب به میزان ۶۴ ، ۹۰۰ و ۷۵ گرم ماده موثر در هکتار، مورد استفاده قرار گرفت. هر آزمایش در قالب طرح کاملا تصادفی با سه تکرار برای هر توده اجرا شد. به منظور ارزیابی پاسخ توده های مختلف به کاربرد علفکش از نمره دهی خسارت ظاهری ، درصد بقاء گیاهان و وزن خشک نسبی (درصد از شاهد) استفاده شد. نتایج آزمایش نشان داد که اختلاف متوسط ولی معنی داری بین میزان مقاومت توده‌های جمع‌آوری شده از شهرهای مختلف و نیز توده‌های مربوط به مزارع مختلف هر شهر وجود داشت. در بین توده‌های مختلف نیز توده‌های جمع آوری شده از شهرهای شوشتر و رامهرمز بیشترین سطح مقاومت را نسبت به هر سه علفکش نشان داده شد. به نظر می رسد برخی از توده‌های جمع آوری شده از مزارع گندم استان خوزستان مشکوک به مقاومت به علفکش می باشند.

واژه های کلیدی : یولاف وحشی، کلودینافوپ پروپارژیل، تاپیک، دیکلوفوپ متیل، ایلوکسان، فنوکساپروپ – پی – ایتل، پوماسوپر،غربال، مقاومت علف‌کش.

INTRODUCTION

Winter wild oat (*Avena ludoviciana* Durieu.) is one of the most troublesome annual grass weeds of cereal farming systems in the Khuzestan province (Montazeri *et al.*, 2005). Chemical inhibitors of acetyl-CoA carboxylase (ACCase) are important post emergence herbicides used for selective control of grass weeds such as winter wild oat species (Maneechote et al., 2005). The aryloxyphenoxypropionate (AOPP) herbicides inhibit acetyl CoA carboxylase (ACCase), catalyzes the first committed step in fatty acid biosynthesis which leads to inhibition of acyl lipid biosynthesis, and eventually results in death of the plant (Burton *et al.*, 1991). Monocotyledons contain the eukaryotic form of ACCase in their plastids, which is sensitive to these herbicides (Konishi & Sasaki, 1994).

Since 1994, when resistance to ACCase-inhibiting herbicides was reviewed in detail (Devine & Shimabukuro, 1994), the number of grass weed species which their resistant plants have been reported, has increased from 9 to > 34, and resistance to ACCase-inhibiting herbicides has now been reported in 26 countries around the world (Heap, 2006). The results of several experiments have shown that in many wild oat populations, resistance to these herbicides has evolved (Bourgeois & Morrison, 1997; Beckie *et al.*, 1999). Also, resistance to ACC-inhibiting herbicides have been reported for winter wild oat (BenaKashani *et al.*, 2006; Zand *et al.*, 2006) and little seed canary grass (*Phalaris minor* Retz) (Elahi Fard *et al.*, 2006) in some regions of Iran such as Khuzestan province. Clodinafop propargyl, diclofop methyl, and fenoxaprop p ethyl are members of aryloxyphenoxypropionates herbicides family, which are recommended to control winter wild oat in wheat fields of Khuzestan province for several years. However, in recent years, unsatisfactory control of winter wild oat treated with these herbicides has been reported by local farmers. A review of the field histories, led us to the conclusion that the winter wild oat populations have evolved resistance to these herbicides.

The objective of this study was to screen winter wild oat populations suspected to resistance to clodinafop propargyl, diclofop methyl, and fenoxaprop p ethyl, which were collected from wheat fields of Khuzestan province.

MATERIALS AND METHODS

Three separate experiments were conducted in the greenhouse of the College of Agriculture, Ferdowsi University of Mashhad, in 2005. In spring 2005, seeds from winter wild oat suspected to resistance to clodinafop propargyl (Topik), diclofop methyl (Illoxan), and fenoxaprop p ethyl (Puma super) herbicides, were collected from 46 fields at seven sites of Khuzestan province (32° 25′ N, 48° 23′ E) including Ahvaz, Andimeshk, Shush, Shushtar, Ramhormoz, Susangerd (Dashte Azadegan), and Dezful . A coding system was used to classify the seed samples.

After breaking the seed dormancy (kept in Petri dishes containing moist filter paper for 96 h in refrigerator at 5 ^{0}C in the dark), ten germinated seeds were planted at a depth of 1 cm in 9 cm diameter plastic pots (volume 500 ml) filled with manure-loam-sand mixture (1:2:1 by volume), and the pots were watered as required until harvest. Shortly after emergence, plants were thinned to a final density of five seedlings per pot. A soluble fertilizer (2.4 g N L^{-1}) was applied twice during the growth period.

Four weeks after planting, at the three- to four-leaf stage, the plants were treated with a commercial formulation of Aryloxyphenoxypropionates herbicides using a laboratory sprayer (MATABI® Elegance plus) equipped with a flat-fan nozzle (8001) calibrated to deliver 153 L ha^{-1} of spray solution at 200 kPa. Clodinafop propargyl, diclofop methyl, and fenoxaprop p ethyl, were applied at recommended rates of 64, 900, and 75 g ai ha^{-1}, respectively. Plants were harvested 4 weeks after herbicide application and the dry weight of foliage was recorded following drying for 48 h at 75 ^{0}C, also the number of dead and surviving plants was scored. To examine the differences between seed populations, data were expressed as percentage of untreated control. One untreated control was harvested at the time of herbicide application for recording the initial weight, whereas the other two controls were harvested 4 weeks later with herbicide treated plants. Plants were clipped 1 cm above the soil level to measure shoot dry weights. Visual phytotoxicity rating according to EWRC method (Sandral *et al.*, 1997) was made every 7- day after herbicide application. Relative dry weight gain for each treatment was calculated, as described by Morrison and Maurice (1984) (Equation 1):

$$\text{Relative dry wt} = 100(Fwt_t - Fwt_0) / (Fwt_c - Fwt_0) \qquad \text{(Eq. 1)}$$

where Fwt_0 is dry weight per plant at the time of spraying, Fwt is dry weight per treated plant at final harvest, and Fwt_c is dry weight per plant of control (mean of two controls) at final harvest.

The percentage of survived plants were also recorded 4 weeks after spraying. Each experiment was laid out in a completely randomized design with 3 replications. Data were subjected to analysis of variance (ANOVA), and means were separated using Duncan's New Multiple Range Test (DNMRT) at the 0.05 significance level (SAS, 1996).

RESULTS AND DISCUSSION

At recommended dosage, all three herbicides reduced shoot dry weight (% control) by 8 to 100% and plant number (Percentage of control) by 0 to 100% (Table 1). Moderate but statistically significant variation in resistance existed among the population from different sites and among population in wheat fields of each site (Table 1). According to the results, winter wild oat population showed the highest resistance to diclofop methyl and the least resistance to fenoxaprop p ethyl. The recommended field rates of each herbicide resulted in complete kill of the susceptible population and some other population (i.e. VR_2, VR_9, NR_1, DR_6, and DR_7 in clodinafop propargyl treatment) (Table 1). Response of seed population to herbicide application showed that some populations, such as STR_2 exhibited high resistance to all herbicides. However, in some populations (e.g. SOR_4) resistance varied among herbicides (Table 1). According to Table 1, seed populations collected from Shushtar and Ramhormoz sites had higher resistance to all three herbicides. Our results showed that some winter wild oat seed populations collected from Khuzestan province wheat fields are suspected to herbicide resistance. These findings are similar to BenaKashani *et al.* (2006) and Zand *et al.* (2005;2006).

Table1. Response of 46 winter wild oat population to clodinafop propargyl, diclofop methyl, and fenoxaprop p- ethyl.

Winter wild oat population	Clodinafop propargyl (Topik)			Diclofop methyl (Illoxan)			Fenoxaprop p ethyl (Puma super)		
	Density reduction (%)	Dry Wt. reduction (%)	EWRC Score	Density reduction (%)	Dry Wt. reduction (%)	EWRC Score	Density reduction (%)	Dry Wt. reduction (%)	EWRC Score
Ahvaz:									
VR1	100.0a	41.07cd	7	100.0a	69.59abc	8	100.0a	45.87abc	6
VR2	0.0c	0.00e	1	100.0a	26.69de	6	0.0c	0.00cd	1
VR4	44.4bc	23.26cde	5	100.0a	64.93abc	8	100.0a	67.52a	8
VR5	100.0a	75.77a	8	100.0a	45.12cd	7	100.0a	46.84abc	6
VR6	22.2c	38.55cd	5	16.7d	22.52e	5	0.0c	0.00cd	1
VR7	33.3bc	6.35de	2	44.4c	26.52de	6	0.0c	0.00cd	1
VR9	0.0c	0.00e	1	100.0a	41.07cd	6	66.7ab	19.43cd	5
Andimeshk:									
NR1	0.0c	0.00e	1	77.8ab	12.39e	4	0.0c	0.00cd	1
NR2	100.0a	46.28bc	7	100.0a	45.63cd	6	100.0a	34.35abcd	6
NR3	100.0a	62.89ab	8	100.0a	38.28cde	5	88.9ab	23.75cd	3
NR4	100.0a	13.07de	4	100.0a	35.53de	5	0.0c	0.00cd	1
NR5	100.0a	40.66cd	7	100.0a	60.02abc	8	100.0a	39.51abc	6
NR6	66.7ab	13.98de	4	100.0a	40.61cd	5	66.7ab	17.45cd	5
NR7	100.0a	73.59a	8	100.0a	42.33cd	5	88.9ab	15.06cd	4
NR8	100.0a	22.36cde	5	100.0a	44.59cd	5	88.9ab	37.01abc	6
NR9	100.0a	21.26de	5	100.0a	35.11de	4	66.7ab	28.96bcd	6
NR10	61.1ab	66.88ab	8	100.0a	39.37cde	5	88.9ab	42.34abc	6
NR11	100.0a	27.49cde	6	100.0a	67.56abc	8	88.9ab	60.29abc	8
NR12	88.9a	12.54de	4	100.0a	62.83abc	8	33.3bc	7.39cd	3
NR13	100.0a	62.27ab	8	100.0a	57.80abc	8	100.0a	50.60abc	7
NR14	83.3a	67.73ab	8	100.0a	78.77ab	8	66.7ab	43.92abc	6
Shush:									
SOR1	100.0a	68.08ab	8	100.0a	58.06abc	8	66.7ab	32.63abcd	6
SOR2	100.0a	40.23cd	7	100.0a	31.34de	5	0.0c	0.00cd	1
SOR3	77.8ab	21.03de	5	100.0a	39.47cde	6	33.3bc	6.24cd	2

Table 1: continued									
SOR4	100.0a	88.11a	9	100.0a	30.53de	5	0.0c	0.00cd	1
SOR5	100.0a	75.25a	8	100.0a	83.67ab	8	66.7ab	11.65cd	4
SOR6	66.7ab	40.40cd	7	100.0a	50.83bcd	7	66.7ab	2.35cd	2
SOR7	100.0a	25.05cde	5	100.0a	78.86ab	8	100.0a	44.74abc	6
SOR8	100.0a	50.30bc	7	100.0a	47.39bcd	7	33.3bc	9.60cd	3
Ramhormoz:									
ZR1	100.0a	72.41a	8	100.0a	41.03cd	6	66.7ab	17.83cd	5
ZR2	100.0a	90.06a	9	100.0a	48.24bcd	7	100.0a	25.32cd	6
ZR3	100.0a	81.24a	9	100.0a	45.19cd	7	66.7ab	15.95cd	4
ZR4	100.0a	64.76ab	8	100.0a	77.57ab	8	33.3bc	6.71cd	2
ZR5	100.0a	65.32ab	8	100.0a	67.58abc	8	100.0a	23.06cd	5
Susangerd (Dashte Azadegan):									
AR4	11.1c	37.90cd	5	0.0d	0.00e	1	11.1c	39.28abc	5
Dezful:									
DR1	77.8ab	58.69bc	7	100.0a	59.32abc	8	50.0abc	36.73abc	5
DR2	100.0a	39.85cd	5	100.0a	70.14abc	8	100.0a	63.47abc	8
DR3	100.0a	27.75cde	6	100.0a	78.69ab	8	100.0a	45.08abc	7
DR4	100.0a	81.28a	9	100.0a	92.26a	9	100.0a	30.19bcd	6
DR5	100.0a	49.07bc	7	100.0a	55.82bcd	7	88.9ab	30.31bcd	6
DR6	0.0c	0.00e	1	77.8ab	67.77abc	7	88.9ab	33.90abcd	6
DR7	0.0c	0.00e	1	66.7b	34.56de	6	0.0c	0.00cd	1
DR8	33.3bc	5.57de	2	100.0a	44.51cd	6	44.4bc	14.39cd	4
Shushtar:									
STR1	100.0a	78.01a	8	100.0a	74.69abc	8	66.7ab	8.58cd	3
STR2	100.0a	64.65ab	8	100.0a	79.03ab	8	88.9ab	44.69abc	6
STS	0.0c	0.00e	1	0.0d	0.00e	1	0.0c	0.00cd	1
C.V.	15.3	17.15	-	13.1	16.51	-	18.3	17.14	-

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