Original Research Article

Effect of Clodinafop-Propargyl and Mesosulfuron-methyl herbicides on wild oat (*Avena ludoviciana*) control under moisture stress condition

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ABSTRACT

In order to investigate the effects of drought stress on the effect of herbicides of Clodinafop-Propargyl (Topic) and Mesosulfuron-methyl (Chevalier) in greenhouse conditions, a split factorial experiment was conducted in 4 replications in a completely randomized design. The main plot consisted of three levels of irrigation (no stress, medium stress and severe stress) and subplots in a factorial arrangement including 6 doses (0, 25%, 50%, 75%, 100% and 125% of the recommended dose) herbicides Clodinafop-Propargyl (Topic) and Mesosulfuron-methyl (chevalier) in pot. The results of analysis of variance showed that the type of herbicide had no significant difference in the amount of wild oat dry matter and in fact both herbicides had the same effect. However, drought stress had a significant effect on dry weight of oat (P = .05). The means dry matter of wild oat in treatments without stress, medium stress and severe stress was 0.47, 0.46 and 0.41 g/plant, respectively. The highest amount of wild oat dry weight was related to control without herbicide treatment or zero dose with means of 0.17 g / plant, and the lowest was 125% with 0.02 grams per plant. Drought stress reduces the efficiency of herbicides and, by increasing the dose of herbicide from the recommended amount, this defect can be eliminated. In this experiment, with a 25% increase in dosage of herbicides, their efficacy was similar to that in the recommended dosage in non-stress conditions.

Keywords: Herbicide, Drought stress, Herbicide efficiency

1. INTRODUCTION

Drought is a multidimensional tension that occurs on different plant organs at different levels [1]. The process of dehydration of plants in drought causes fundamental changes in water relations, biochemical and physiological processes, the structure of the membrane and the inner and outer cells of the plant [2]. Drought does not only affect the water relationship, causing the plant to close the stomach, it reduces the rate of photosynthesis and grows. The closure of the stomach reduces the diffusion of carbon dioxide into the mesophilic cell of leaf, As a result, NADPH accumulates [3]. Soil drying and leaf water depletion, cause pressure on the photosynthesis process and disrupt carbon and nitrogen assimilation [1]. Reducing the amount of photosynthesis is the result of stomatal and non-stomatal Biochemical restrictions [2]. With drought, the plant closes its stomats to lose less water through transpiration. As a result, the diffusion of carbon dioxide into the leaf is limited and the rate of photosynthesis comes down. Although the dual-photosystem is highly resistant to drought, the electron transfer is limited under dry conditions [2]. In conditions of lack of moisture, increasing transpiration of the plant prevents the increase of leaf area. Therefore, it is clear that the higher the allotment of dry matter to the leaf surface has the advantages of growth, but it also causes more water loss from the leaves [4].

Despite the availability of different herbicides for wild oat control, this weed is still considered as one of the main challenges in the production of crops, especially cereals. The use of herbicides in the 1950s is one of the most important agricultural advances in controlling weeds. Only in North America, herbicides use 20-30% of the inputs [5]. Such reports indicate that the major part of the cost of weed management is related to the use of herbicides.
mushtagh et al., Compared the treatments with six herbicide treatments, including clodinafop, , isoprostane, isoprothron+carfentrazone, fenoxaprop, metribuzin and isoproturon + diflufenican on wheat weeds [6].
In Shahzad and colleagues field experiment, they examined the effectiveness of eight herbicides against the main weeds of wheat (P.minor, A.fatua and Emex spinosa) [7]. The results of their experiments showed that all herbicides significantly reduced the dry weight of weeds, and the highest reduction was related to clodinafop propargil (topic 15wp) with 89-87% [7]. In another experiment, weed control of iodosulfuron + mesosulfuron (Atlantis 3.6WG) with different doses (100, 75, 50 and 25% (recommended) was investigated in control of wheat weeds. Maximum dry matter reduction of weeds (99%) was observed at the recommended dose (100%). Reduced doses had a significant decrease in density (72-95%) and weed dry matter (83.94%) [8]. Many studies have been conducted on the effects of drought on wheat, but there is insufficient information on the interference of wheat and wild oats. Akey and Morrison, by arranging a simple experiment, examined the growth of wild oat at different levels of moisture [9]. In this study, the effects of water on oat growth (such as leaf area, dry weight, and tiller number) in both farm and greenhouse conditions were investigated. In both greenhouse and field conditions, they concluded that growth in low moisture conditions was lower than high humidity (10% and 20% moisture content). Also, the growth of wild oats when moisture is reduced from 20% to 10%, if the wild oat is at a pre-4-leaf stage, the biomass loss rate is much higher. In this experiment, although the soil conditions, light, temperature, and thermal regimes were different, the experimental results were consistent with each other [9]. Similar to the results of Akey and Morrison,Van Wychen, a greenhouse experiment on the effects of different levels of soil matrix potential on wild oat growth [10]. He examined the carbon allocation in wild oat and reproduction of wild oats at different levels of soil moisture without competition with wheat. The results of physiological studies in this experiment showed that in conditions of water stress, wild oat allocates 10% more carbon to roots than shoots [10].

2. MATERIAL AND METHODS

In order to investigate the effects of drought stress on the effect of herbicides of Clodinafop-Propargyl (Topic) and Mesosulfuron-methyl (Chevalier) in greenhouse conditions, a split factorial experiment was conducted in 4 replications in a completely randomized design. The main plot consisted of three levels of irrigation (no stress, medium stress and severe stress) and subplots in a factorial arrangement including 6 doses (0, 25%, 50%, 75%, 100% and 125% of the recommended dose) herbicides Clodinafop-Propargyl (Topic) and Mesosulfuron-methyl (chevalier) in 20 × 20 × 25 pots (with 15 plants of wild oat per pot). The soil used was a combination of clay, sand and cow manure at a ratio of 2: 3: 2. Before the experiment, soil fertility was measured and the pots were irrigated twice a week. Drought treatments were used to weigh the pots which had the same weight at the beginning of the experiment. At each irrigation time, depending on the type of stress treatment, the required water content (60%, 45% and 30% of the soil capacity, respectively) Calculated and given to each pot. There were 36 pots in each replicate. In the greenhouse, the temperature was controlled with a range of 24 ± 3, 15± 3 ° C day and night. At the end of the experiment, the dry weights of wild oat plants weighed and herbicide performance was evaluated. All statistical calculations were performed using SAS statistical software and Excel and Word software were used to draw charts and tables. For fitting the equations, Sigma plot software was used.

3. RESULTS AND DISCUSSION

The results of analysis of variance showed that the type of herbicide had no significant difference in the amount of wild oat dry matter and in fact both herbicides had the same effect. However, drought stress had a significant effect on dry weight of oat (P = .05). In fact, the amount of dry matter of wild oat has a different response between herbicide treatments under stress conditions. Herbicide dosage also had a significant effect (P = .01) on dry weight of wild oat. The interaction between herbicides and doses was not significant. In fact, the doses were independent of the type of herbicide use. The interaction between drought stress and herbicide doses was also significant (P = .01). In fact, herbicide doses have a different effect on different levels of stress (table 1).

Table 1. Analysis of variance of wild oat dry matter under the influence of drought stress and herbicide and herbicide doses

Source of variation	df	Means of square	F	Pr>F
Herbicide	1	0.005	0.88	0.351
Replication	3	0.008	1.40	0.247
Herbicide× replication	3	0.014	0.24	0.865
Drought stress	2	0.019	3.33	0.039
Herbicide× Drought stress	2	0.004	0.72	0.49
Herbicide dose	5	3.51	589.08	0.001
Herbicide × dose	5	0.010	1.80	0.119
Drought stress × dose	10	0.133	22.44	0.001
Herbicide× Drought stress × dose	10	0.002	0.35	0.965
Error	102	0.0059	-	-
Total	143	-	-	-

The comparison of the means dry weight of wild oat in different levels of stress is presented in Fig 1. The means dry matter of wild oat in treatments without stress, medium stress and severe stress was 0.47, 0.46 and 0.41 g/plant, respectively. There were no significant differences between two levels without stress and medium stress, and severe stress did not show significant difference with medium stress, but there was a significant difference between treatments without stress.

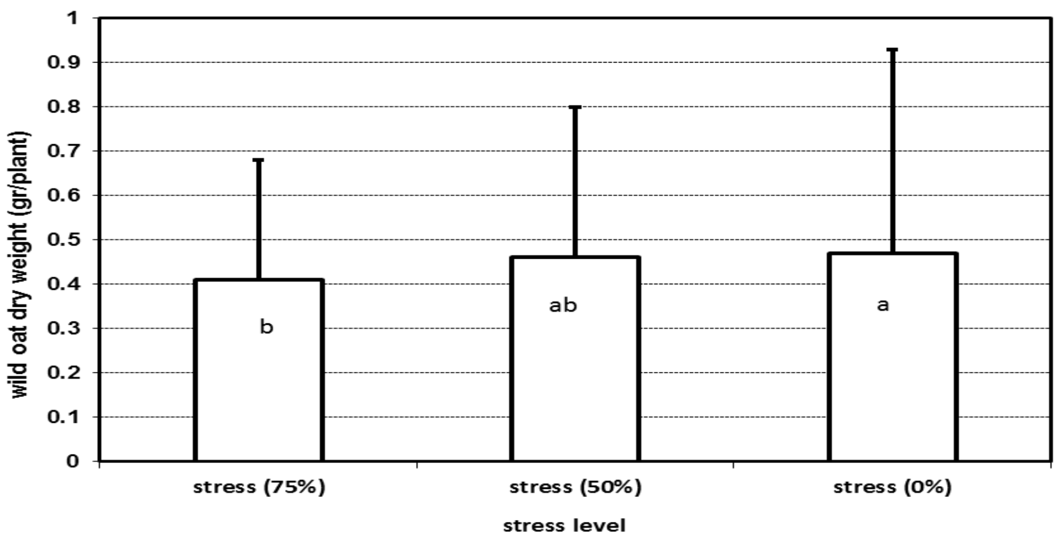

Fig. 1. Effect of drought stress on means dry weight of wild oat in different herbicide doses (The similarities and non-similarities of the words indicate a significant and non-significant difference between the two groups).

The average dry weights of wild oat in different herbicide doses were also significantly different. The highest amount of wild oat dry weight was related to control without herbicide treatment or zero dose with means of 0.17 g / plant, and the lowest was 125% with 0.02 grams per plant. All different levels of herbicide doses were placed in separate groups (Fig 2).

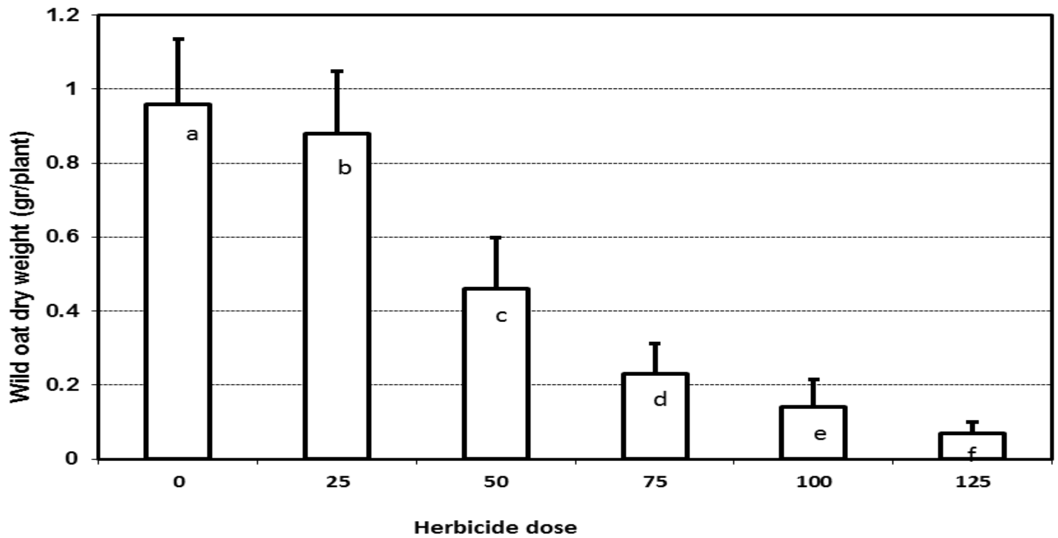

Fig. 2. Effect of herbicide dose on means dry weight of wild oat in different drought stress (The similarities and non-similarities of the words indicate a significant and non-significant difference between the two groups).

As mentioned earlier, the effect of drought stress and herbicide doses on wild oat dry matter was also significant. As seen in Fig. 3. Drought stress reduces the effectiveness of herbicides in wild oat control, and its dry matter content varies in different levels at each stress level. Only in dose of 125% we see no significant difference between the three levels of stress. As the dose of herbicide decreases, the difference between the three levels of stress also increases. Because stress even without presence of herbicide, reduces the amount of dry matter of wild oats. Therefore, in two doses of 0 and 25% , we can see the reduction in the means of dry mater after applying the stress, while in the doses of 50%, this trend is reversed and the stress increases the dry matter Because the effectiveness of herbicide has decreased in stress and in better conditions, irrigation has been better for herbicide.

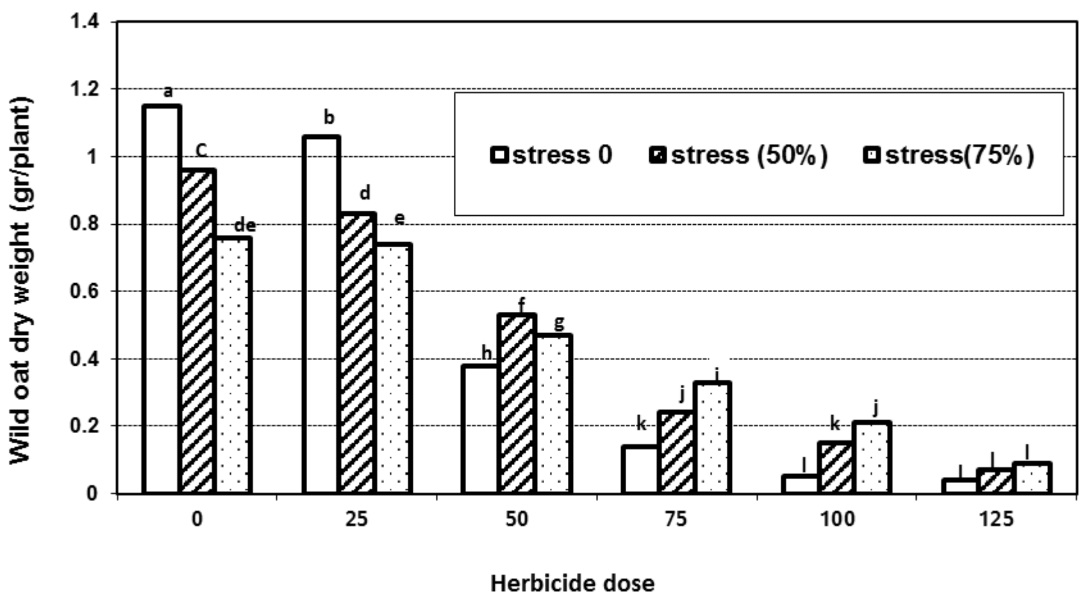

Fig. 3. Interaction between different doses of herbicide and drought stress on dry weight of wild oat (The similarities and non-similarities of the words indicate a significant and non-significant difference between the two groups).

The response curve for herbicide doses in three levels of drought stress was fitted to data from two herbicides. The results of the coefficients are presented in Table 2. The numerical value of the Max and Min coefficients decreased from non-stressed to medium stress and severe stress. As it is seen, mortality of 50% of oat plants occurred in non-stress, moderate stress and severe stress in doses, 42.63%, 48.85% and 24.25% of the recommended amount. In fact, drought has reduced the mortality of wild oats in herbicide doses, and two moderate and severe stress treatments require higher doses of herbicide to eliminate the same amount in non-stress conditions.

As seen in Fig. 3, in a non-stressed treatment, at a dose of about 42, there is a very high loss in wild oat dry matter and in two levels of drought stress (severe and moderate), the slope of dry matter loss is much lower and the loss dry matter also occurred a later, and with increasing stress strength, the slope has become more less (Fig 4). In this regard, Parker et al. stated that the effectiveness of many herbicides varies under drought conditions [11]. Absorption and especially the transfer of herbicides depend on the vegetative growth status of the plant, thus having a direct effect on the transfer and arrival of the herbicide to the target.

Table 2. The coefficients obtained from fit equation * dose response curve in three levels of drought stress

Treatment	**Parameter***	**value**	**Standard error (±)**	**R2**
Stress (0%)	Min	0.0724	0.0213	
	Max	1.1730	0.0386	0.96
	Log Ec50	42.630	0.6940	
	b	-0.052	0.0082	
Stress (75%)	Min	0.0863	0.0230	
	Max	1.0155	0.0298	0.96
	Log Ec50	48.85	0.2766	
	b	-0.0524	0.0033	
Stress (50%)	Min	0.0613	0.0537	
	Max	0.8652	0.0681	0.93
	Log Ec50	57.240	0.8394	
	b	-0.0174	0.0042	

y=min + (max-min)/(1+10^((logEC50-x)×b)) *

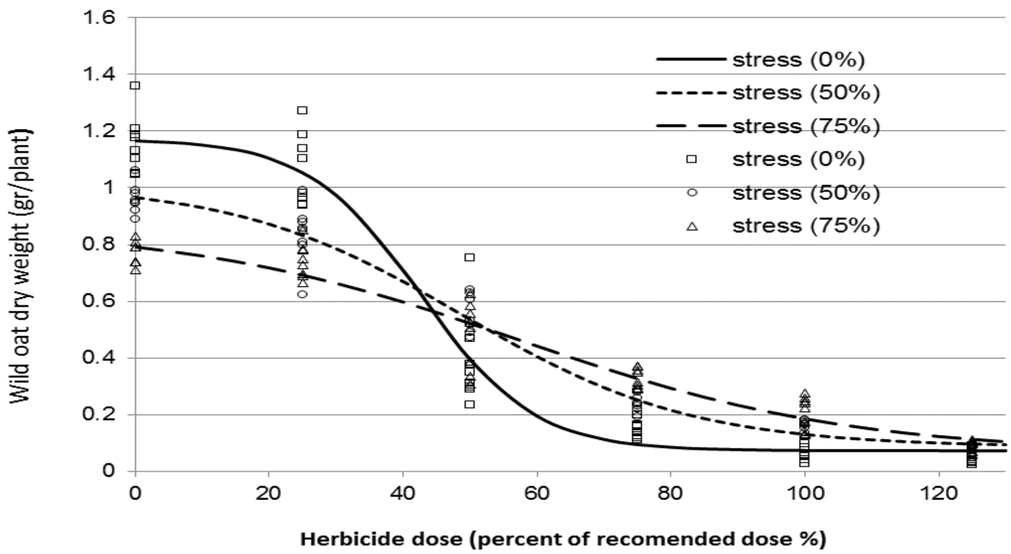

FIG 4. The response curve of wild oat herbicide in three levels of moisture stress

4. CONCLUSION

Drought stress reduces the efficiency of herbicides and, by increasing the dose of herbicide from the recommended amount, this defect can be eliminated. In this experiment, with a 25% increase in dosage of herbicides, their efficacy was similar to that in the recommended dosage in non-stress conditions.
In order to investigate more precisely, it is recommended that experiments be carried out in the presence of drought stress treatments and, in field conditions, also be repeated to provide better results to farmers.

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