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Study of the effects of delayed tribenuron-methyl treatment on Cleavers *(Galium aparine*) and winter wheat yield

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Abstract

Sometimes environmental variables make herbicide application in recommended times unfeasible. Therefore, the evaluation of the herbicide application in a framework out of recommended schedules seems necessary. To do this, an experiment based on field conditions was performed by applying different doses of tribenuron-methyl herbicide on weeds Cleavers (*Galium aparin*) in winter wheat farmat the middle of itsstem elongation stage in the growing season 2013-2014. The experiment was conducted in a completely randomized block design (RCBD) with 3 replications including3 doses of tribenuron-methyl herbicide 10g/ha, 15g/ha, 20g/ha, an unweeded level and a hand weeded one. Results indicated that increasing the dose of herbicide would lead to a decline in the weed's dry weight and its height -the highest level of decline was observed in 20g/ha dose. Maximum height of winter wheat was recorded for hand weeded level followed by 20g/halevel. Neither were grain yield nor yield components such as number of grains per spike, number of fertile spikelets per spike and thousand grain weight affected by these treatments. Based on this study, delay in applying this herbicide, despite reducing the weed biomass, left no impact on grain yield. Thus, the application of tribenuron-methyl herbicide at the middle of stem elongation stage of winter wheat is not recommended.

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Introduction

Weeds compete crops to absorb more nutrients, water and sunlight. This results ina reduction in the quantity and quality of crop yield such as those of wheat (Olesen *et al.,* 2004; Soufizadeh *et al.,* 2007; Grichar, 2006). Oztetik (2010) stated that the lack of control over weeds may end in a loss of 40-00% yields. Some researchers also reported a similar reduction in wheat yield by 25 to 30 percent due to the weeds' presence in Iran (Soufizadeh *et al*., 2007; Montazeri *et al*., 2005).

These all indicate how a vital and crucial role weed control can play. Today, different methods are used to control weeds such as cultural, biological, mechanical and chemical procedures. The chemical control of herbicides is the most popular method in Iran (Soufizadeh *et al*., 2007; Zand *et al*., 2006), which in turn has had a major role in increasing yield in non-weeding plants such as wheat (Oztetik, 2010; Zand *et al*., 2007).

With respect to this, researchers believe that herbicides can be held accountable for decreasing growth, biomass and density of weeds thus increasing wheat yield (Gar'kova *et al*., 2011; El-Kholy *et al*., 2013).

Tribenuron-methyl ({methyl 2-[4-methoxy-6-methyl-1,3, 5-triazin- 2-yl (methyl) carbamoylsulfamoyl] benzoate}, commercially available as Granstar) is one selective herbicide used to control broad-leaved weeds in wheat fields (Adamczewski *et al*., 2014; Kieloch *et al*., 2014). This herbicide belongs to the sulfonylurea herbicide group, which prohibits ace to lactate synthesis (ALS) activation (Cui *et al*, 2012; Han *et al*., 2012; Adamczewski *et al*., 2014).

This enzyme, catalyzes first step in the biosynthesis of branched-chain amino acids such asleucine, isoleucine and valinevia biosynthesis acetolactate (Kieloch *et al*., 2014). Branched-chain amino acids are essential for plant growth and stop or reduce the activity of acetolactate synthase enzymes by disturbing the process of cell division leading to plant death (Han *et al*., 2012; Cui*et al*., 2012).

Tribenuron-methylwas applied at wheat's tilling stage or 3- 4 leaf stage of weeds (Zadoks *et al*., 1974; Kieloch *et al*., 2014). But some environmental variables such as rainfall, undue frost along with being sure of the possibility of weeds growth all can delay the use of herbicides in wheat fields. Nice *et al*. (2003) reported if the delay in using herbicides coincides with reproductive stage, a decrease in wheat yield can be expected due to the sensitivity of wheat at this stage. Moseley and Hatzios, (1993) reported that the untimed application of herbicides in maize fields causes stress in the plant and decreases its tolerance against herbicides.

So the use of herbicides at an appropriate time not only controls weeds development but also ensures the safety of crops by preventing extra change and environmental pollution. Auskalins and Kadrys, (2006) concluded that applying Florasulam + 2,4-D ester in the stages 3- leaf, tilling and stem emerging would guarantee the maximum efficiency of herbicide at the two stages of 3-leaf and tilling. Hence it is obvious that applying dose-increased herbicide at the stage of stem elongation of this plant greatly reduces weed dry weight.

The two factors–necessity to control weeds and the inevitability of untimed application of herbicides due to some restrictions in Khodafarin Region demanded the study to see what the effects of broad-leaf plant herbicides could be when they are used after the critical period. Therefore the study focused on applying the varied doses of the herbicide tribenuron-methyl at the middle of stem elongation stage of wheat on broad-leaf weeds, yield and yield components of winter wheat in the above mentioned area.

Martials and methods

Field studies

The study was carried out on a farm in Alajujeh, East Azerbaijan, Iran, during growing season 2013-2014.The given farm soilhada silty clay texture with 0/84% organic matter and pH 5.7.

In order to provide seedbed, the field undertook a moldboard plow followed by getting disked, and smoothed with a land leveler.

Then fertilizing practices came according to soil test. Based on the soil test, the soil bed was prepared by adding a mixture of nitrogen (75kg per ha) and phosphorus (50kg per ha) - the former from urea and the latter from triple super phosphate sources.

Plant growth

Before planting, the winter wheat seeds (*Triticum aestivum* L., cv. Azar 2), were sterilized using Carbendazim fungicide (7/0 to 1000, the weight-weight).

Then experimental plots were created each in an area of 3×3 m and planting took place with the density scale of 300 seeds per m^2 in the second half of November 2013 followed by immediate irrigation of plots. Other irrigations were based on plant needs five times. It is worth mentioning that later top dressing fertilizing with nitrogen was scheduled as 50 and 75kg per ha at the stages of tilling and heading respectively.

Herbicide treatments and application

The experimental design was a randomized complete block with three replications. Treatments with herbicide tribenuron-methyl (formulated as 75% active water dispersible granules Granstar 75WG) were planned as 10g/ha, 15g/ha, 20g/ha, hand weeding (simultaneous with herbicide application) and unweeded control (allowing weeds to grow with wheat plants until harvest).

The combat against weeds at the middle of stem elongation stage of wheat (code- Zadoks) became concurrent with the beginning of weeds' flowering. The combat was contributed by an electric knapsack sprayer called Elegance 18 equipped with a flooding nozzle and calibrated to deliver 300L/ha of spray solution at a pressure of 2.5 bar (Zand *et al*., 2007).

Unplanted weeds in experimental plots were indexed as 32 to 41 shrubs per square meter in density. Among the weeds, *Galium aparine* (Cleavers) which later became subject of the present study as broad leaf weeds had the highest distribution.

It is worth nothing that the density of thin-leaf weeds was too low, so they were removed by hand after spraying.

Data collection and analysis

Four weeks after getting sprayed the weeds, using a quadrant, were randomly picked and in a drying span of 48 hours in 75°C the dried weight was measured and the results were recorded.

It has to be reminded that the weeds heights were individually measured before the process of having them dried. Taking marginal effects of the field into consideration, we preferred to sample the wheat at the stage of harvest to measure some parameters called the number of fertile spikelet per spike, number of grains per spike, thousand grain weight and wheat grain yield.

For statistical analysis Gen State software v. 12.1 was hired and then Duncan's multiple range 5 percent test was used to compare the data. Excel 2013 was also employed for drawing the diagrams.

Results

The results of data analysis is illustrated in table 1.It indicates that the effects different levels of herbicide had on weed length and its dry weight, and on winter wheat length were noticeable.

They were measured as 1% and 5% respectively. However, applying these treatments didn't prove significant in components like the number of fertile spikelet per spike, number of grain per spike, thousand grain weight and wheat grain yield (kg/ha).

Table 1. Analysis of variance for weed control treatments effects on dry weight and height of weed.

	Mean squares		
S.V	df	weed height	dry weight
Treatment	3	2155/6**	3/56 **
Block	2	77/2	0/11
Error	6	148/8	0/02
CV (%)		24/3 %	6/6 %

Table 2. Analysis of variance for weed control treatments effects on yield of wheat.

		Mean squares				
S.V	df	Yield wheat	Grain yield	number of fertile spikelets spike^{-1}	number of grains spike^{-1}	thousand grain weight
Treatment	4	61/83**	1088490 ns	1/8 ns	79/23 ns	5/17 ns
Block	2	5/6	123092	2/07	40/9	15/08
Error	8	9/33	75990	1/08	55/8	14/19
CV (%)		3/2 %	13.6 %	5/8 %	15/8 %	7/5 %

The effects of treatments on weed

The comparison of the following Figs. (1, 2) confirms that an increase in the rate of herbicide dose leads to a lower height and a less dry weight of Cleavers than those of the control replications. A % 77 decrease in the dry weight was recorded for the dose 20g/ha, but other doses didn't have any significant effect on this variable. Also the height of Cleavers for doses 15 and 20g/ha decreased by % 58 and % 63 respectively, but for the dose 10g/ha no significant change in height was recorded.

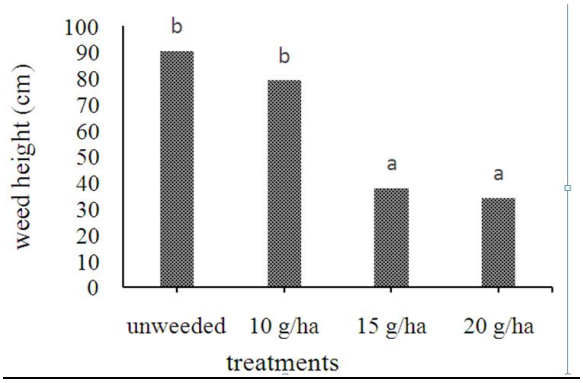


Fig. 1. Effect of weed control treatments on dry weight of weed.

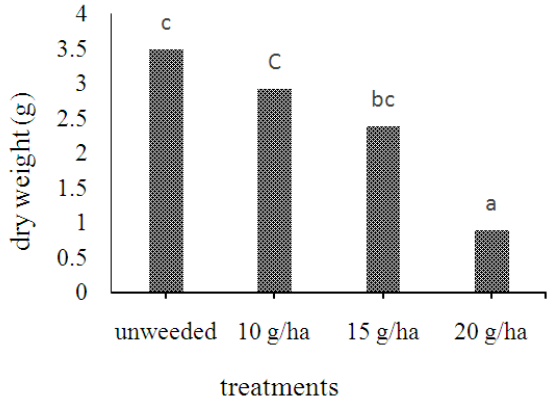


Fig. 2. Effect of weed control treatments on height of weed.

The effects of treatments on winter wheat

Comparing the averages of herbicide doses effects on the height of winter wheat (Fig. 3) demonstrates the longest wheat height belonged to the control (hand weeded) and the 20 g/ha replications. For doses 15g/ha and 20 g/ha no significant effect was observed on this variable. The higher the wheat length is in these two levels of hand weeding and herbicide treatments, the more successful the wheat will be in fighting against weeds. This also means the wheat's higher photosynthetic processing capability which will make it even more productive.

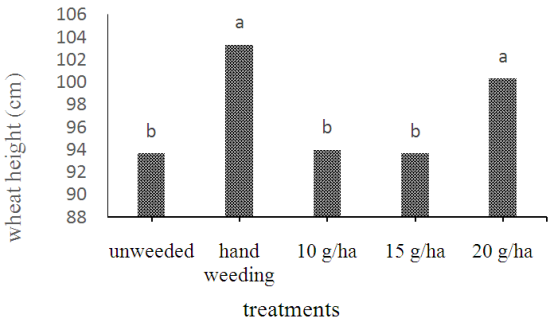
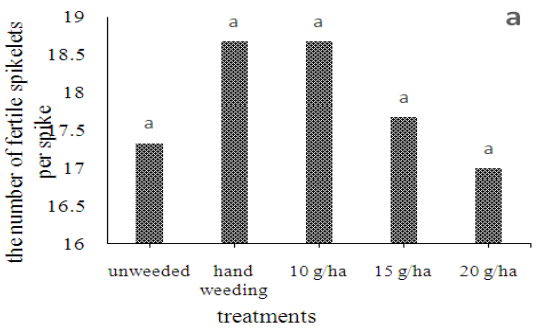


Fig. 3. Effect of weed control treatments on height of wheat.

Based on the data, applying the herbicide tribenuron-methyl didn't prove significant on grain yield, thousand grain weight, number of grain per spike, the number of fertile spikelet per spike (Fig.4).



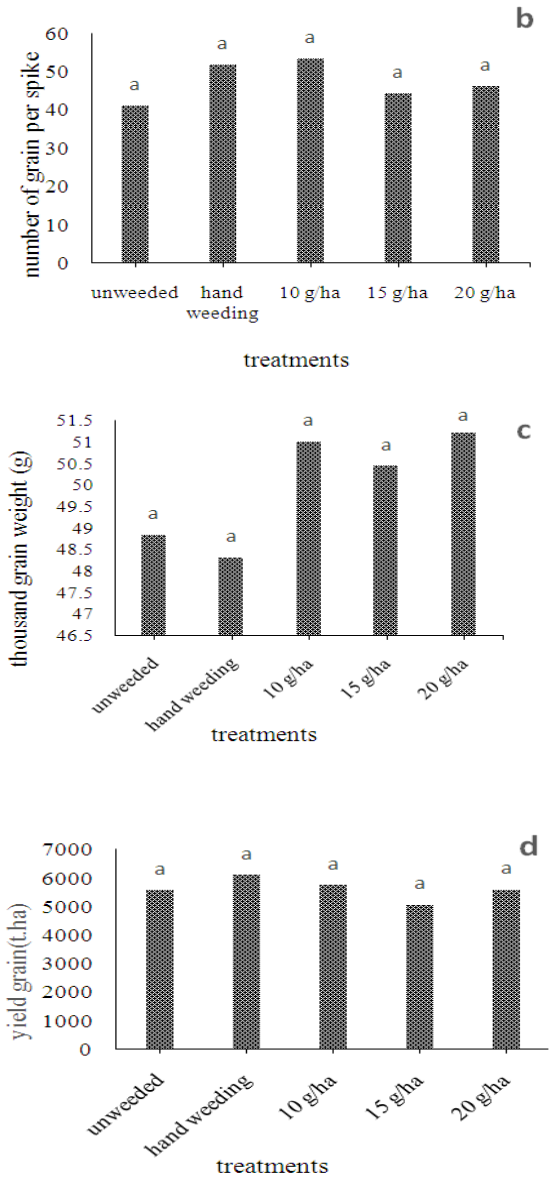


Fig. 4. Effect of weed control treatments on the number of fertile spikelet per spike (a), number of grain per spike (b), thousand grain weight (c), yield grain (d).

Discussion

Tribenuron-methyl is one of the most important herbicides for controlling broadleaf weeds in the wheat and barley in Iran (Zand *et al.,* 2007) that is applied at doses of 10g/ha to 20g/ha in wheat tilling or in the 3-4 leaf stages of weeds (Zadoks *et al.,* 1974; Kieloch *et al.,* 2014). Previous studies showed that tribenuron-methyl reduced weed growth (Adamczewski *et al.,* 2014; Kieloch *et al.,* 2014). In the present study, like other studies, tribenuron-methyl herbicide reduced the height and dry weight of the weed compared to those in the unweeded plots, but a lower dose of the herbicide (10g/ha) had no significant effect on weed growth. Growth indicators such as dry weight and height are important parameters to assess the effects of herbicides on weed's physiological processes. Since an increase in the height and dry weight of weed depends on cell division and its growth as a result of photosynthesis, the emergence of carbohydrates and other metabolites such as protein synthesis; the use of herbicide tribenuron-methyl prevents the synthesis of branched amino acids and disorders the cell metabolism, and this in turn reduces the number of cell divisions and leads to a lowered height and dry weight in weeds (Adamczewski *et al.,* 2014; Kieloch *et al.,* 2014). The findings of the present study confirm the above. Adamczewski *et al.* (2014) and El-Rokiek *et al.* (2013) also reported respectively their similar findings on the weeds Chamomile and Common Poppy in a wheat field and dry weight of weed Common Purslane all treated with tribenuron-methyl. The failure to reduce Cleavers growth with a lower dose of herbicide (10 g/ha) can be attributed to the delay in applying herbicide which ends in its inefficiency in fighting against the growth of the weed due to its having become resistant.

Lowered height and dry weight in weeds in higher doses of herbicide results in their inability to win over wheat in fight for space, water, food and light. This leaves stronger competitive effect for wheat and increases wheat's yield (Dadari and Mani, 2005). According to the findings of this study the application of herbicide at the stage of stem elongation didn't have any significant effect on grain yield and yield components of wheat such as number of grains per spike, number of fertile spikelet per spike and a thousand grain weight except for an increase in the stem length of wheat. Therefore, it can be explained that as the wheat components start to emerge and herbicides are applied in its stem elongation, weeds also feed on the same nutrients; so crop yield will inevitably have to suffer from those negative effects. Auskalins and Kadrys (2006) have reported delayed herbicide application disqualifies its efficiency so it is a waste of money.

Conclusion

The results of this experiment showed that the delayed application of herbicide tribenuron-methyl, reduces weed dry weight and height only on higher doses, and lower doses have no positive impact on controlling weeds. Increasing the dose results in a decrease in weed biomass and its competitive pressure on wheat; therefore, an increase in wheat height is evident. Despite the increase in wheat height and its higher photosynthetic level, grain yield showed no significant improvement. This can be attributed to the competition between weeds and wheat in taking up nutrients from the environment at the stage of vegetative growth. Hence it can said that applying tribenuron-methyl herbicide at the mid-stem stage of wheat isn't effective on weed control and the improvement of wheat yield in Khodafarin Region.

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