

Evaluation some of herbicides for weed control of garlic (*Allium sativum*) in Iran

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Abstract: An experiment was conducted in the years 2011 and 2012 to investigate the effects of some herbicides on weed control in garlic. This experiment was conducted as a randomized complete block design with three replications at the Agricultural Research Center of Tehran province. In each replication, 8 treatments including weeding control, oxyfluorfen at doses of 2, 1.5 and 0.75 + 0.75 liters per hectare (in two leaves of garlic) and Pendimethalin in pre-emergence and post-emergence (3 liters per hectare) and oxadiazon (3 liters per hectare), and ioxynil + Haloxyfop-R methyl ester (0.75 ± 0.2 liters per hectare of garlic). In terms of yield, oxadiazon herbicides, oxyfluorfen 0.75 + 0.75 and pre-emergence Pendimethalin with the mean yield of 8487, 8401 and 7801 (kg ha⁻¹) were the most significant treatments, respectively. The highest plant injury for, oxyfluorfen 2 and 1.5 liters per hectare was 33% and 27%, respectively, and Pendimethalin had no adverse effects on garlic. Finally, Pendimethalin herbicides were pre-emergence and oxadiazon in post-emergence form of the best treatments.

Keywords: Ioxynil, Oxadiazon, Oxyfluorfen, Pendimethalin, Plant injury.

Date of Submission: 18-12-2017

Date of acceptance: 30-12-2017

I. Introduction

Garlic is the scientific name of the *Allium sativum* L. of the Alliaceae family. There are 450 species of alive in both ornamental and edible forms, the most famous feature of which is the smell of spicy. The most well-known are onions (*Allium cepa*), garlic, moss (*Allium cepa* var. *aggregatum*), leeks (*Allium ampeloprasum*), some onions (*Allium* spp) and wild garlic (*Allium canadense*) [1]. FAO cited Iran's production of garlic in 2010 at 66,000 tons, according to statistics, Hamadan province accounted for 35 percent of the country's total. Iran's export volume in 1995 was 1243.7 tons, of which the total exports of garlic was 66 percent to Europe, 0.24 percent to North America [2].

The root crops have a weak competitive power against weeds that grow on rows [3]. Due to its low height, low growth rate, shallow roots and weak canopy, garlic cannot shade the surface of the soil and suppress the weeds [4]. Therefore, the necessity of weed control in the early stages of growth is essential [5]. Weeds are one of the most important problems in the production of onion family plants because they are able to quickly germinate and grow and compete with crops for water and food [1]. Warren reported 89% loss of garlic yield against weeds [6].

Qassem studied that the effects of 18 herbicides on garlic weeds and reported that the post-emergence application of oxadiazon at a dose of 241/0 (active ingredient per hectare) had the best result in 3-4 leafy stage [7]. Mehmood et al by examining the effects of glyphosate (pre-emergence of garlic and post-emergence of weeds), pendimethalin, oxadiazon and metribuzin with pre-emergence application, concluded that the highest and lowest yields were related to pendimethalin and metribuzin, respectively, and the highest plant injury were reported in the metribuzin treatment [8]. The results of study of hand weeding, weedy and herbicide treatments was showed that pendimethalin use at a dose of 0.8 (liters of active ingredient per hectare) and Additional use of one time hand weeding had the highest economic efficiency [9]. Mahmood et al, compared the efficacy of pendimethalin (0.8 L of active ingredient per hectare) and oxadiazon (0.25 L of active ingredient per hectare) herbicide against hand weeding, indicating that one time use of the above mentioned herbicides to obtain a similar result with hand weeding treatment is not enough [8].

Most vegetables are considered weak in competition with weeds. However, plants such as cabbage, carrots and beets, after a short time after planting, have the effect of suppressing weeds because of a wider canopy, but a plants like garlic due to the lack of broad canopy and dense foliage and low height, Is in poor competition with weeds. Moreover, due to the lack of practical work on garlic herbicides, the need to evaluate herbicides to guide farmers was completely felt. Because many years are spent on weeding the weed of this product. In addition, the recommended herbicide makes it easy to work and thus encourage farmers to increase the level of culture. In general we can say that weed problems are a challenge in the field of garlic.

II. Materials And Methods

An experiment was conducted to investigate the effect of different herbicide treatments on garlic weed control at Tehran agricultural research center in a randomized complete block design with three replications in the years of 2011 and 2012. Treatments included some pre-and post-emergence herbicide (Table 1). Dimensions of each experimental plot of 2 × 8 m consisted of 4 rows of 8 meters with lines spacing of 50 cm. Each plot was divided in length into two parts, the first part was not sprayed (weed control) and the bottom part was treated. The spacing of the plants was 10 cm in row and planted on both sides of the furrow. Between the experimental plots to avoid mixing plots, two unplanted row were used to create spacing. It was also considered as a 1.5 meter distance between replications. The seeds were sown during the month of October each year, along with that (according to soil test) fertilization. Garlic plant injury, 2 and 4 weeks after herbicide spraying, were evaluated by scaling from zero percent (non-plant injury in crops) to 100% (crop death). In each experimental plot, weed density were counted by placing 2 fixed boxes of 2 × 2 meters in two halves of the plot. At harvest stage, garlic yield, bulb diameter and clove count were measured. In the end, the data was analyzed using SAS software and the results were displayed using the Excel software.

Table 1. Treatments used in experiment

no	treatment	Trading name of herbicide	Dose (Liter per ha)	Time of application
1	Hand weeding	-	-	During the growing season
2	oxyfluorfen	Goal*	2	2 leaves of garlic
3	oxyfluorfen	Goal	1.5	2 leaves of garlic
4	oxyfluorfen	Goal	1.5	0.75 liter in 2 leaves of garlic + 0.75 liter 2 week later
5	pendimethalin	Stomp	3	Pre-emergence
6	pendimethalin	Stomp	3	Post- emergence
7	oxadiazon	Ronstar	3	2-3 leaves of garlic
8	ioxynil + methyl ester	Haloxypop-R Totril +Gallant Super	2+0.75	2-3 leaves of garlic

*Formulation of goal, stomp, ronstar, totрил and gallant super respectively were, 24% EC, 33EC, 12%SL, 10.8 EC and 22%EC

III. Results

3.1. YIELD

One of the most important traits that was considered in this experiment was garlic yield. The yield was affected by different herbicides and the difference between treatments was significant (P=0.01). Hand weeding treatment had the highest yield (9136 kg ha⁻¹) and the lowest yield (5426 kg ha⁻¹) related to post-emergence pendimethalin herbicide (Fig. 1). In total, oxadiazon, oxyfluorfen (0.75 + 0.75 liters per hectare) and pre-emergence pendimetalin (8487, 8051 and 7801 kg ha⁻¹), respectively, were in the next ranking.

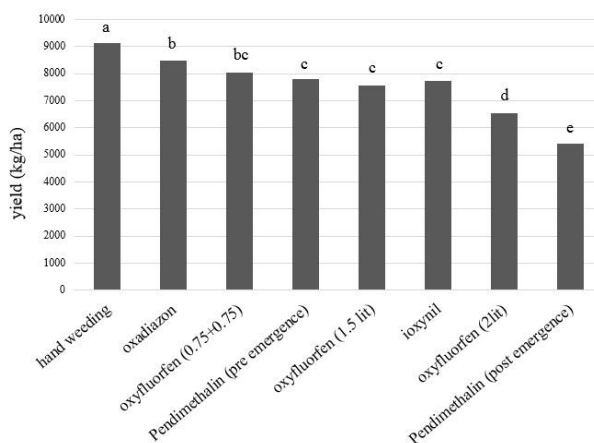


Fig 1. Means comparison of yield in treatments

3.2. PERCENTAGE OF INCREASE IN YIELD

In this experiment, due to weedy control in each experimental plot, the increase in yield of each treatment was compared with that of the control. The highest percentage of increase in yields were obtained from the hand weeding treatment (33%), oxadiazon (29%), oxyfluorfen (0.75 + 0.75 liters) (24%) and pre-emergence pendimethalin (20%). (Fig 2). Treatment of post-emergence pendimethalin had the least percentage of increase in yield among other treatments (Fig. 2).

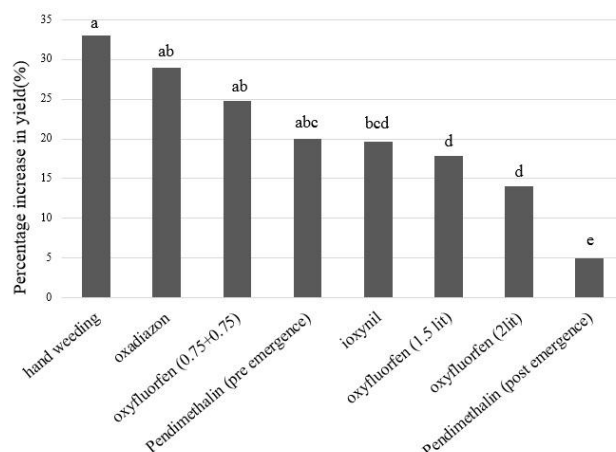


Fig 2. Means comparison of Percentage of increase in yield in treatments

3.3. BULB WEIGHT

Bulb weight is one of the important components of the yield that has been measured in this experiment. Bulb weight was not influenced by the experiment year and did not show any significant difference between the experimental years. In the first year, the average weight of onions was 32 g and in the second year 35 g (data not shown). Also, different weed treatments also had a significant effect ($P=0.01$) on bulb weight. The highest weight of onions was observed in, hand weeding, oxadiazon, oxyfluorfen (0.75 + 0.75 liters per hectare) treatments with weight of 40, 37 and 37 grams, respectively, and post-emergence pendimethalin treatment with a weight of 24 grams had the lowest bulb weight (Table 2).

3.4. BULB DIAMETER

One of the characteristics that is important for bulb products is the diameter of the onion. In this experiment, the studies showed that the treatments had a significant effect ($P=0.01$) on this trait and there was no significant difference between different years. Also, the interaction between year \times herbicide was not affected. The highest diameter of onions in weeding and oxadiazon treatments was observed at 5.47 and 5.42 cm, respectively, and the lowest amount was observed in post-emergence pendimethalin treatment with 3.62 cm. oxadiazon and oxyfluorfen (0.75 + 0.75 liters per hectare) treatments (0.75 ± 0.75) showed no significant difference with hand weeding treatment and were in a similar statistical group (Table 2).

Table 2. Comparison of mean of bulb diameter and bulb weight traits in different treatments

treatment	Bulb diameter (cm)	Bulb Weight (gr)
hand weeding	5.47 a	40 a
oxadiazon	5.42 a	37 ab
oxyfluorfen (0.75+0.75)	5.02 ab	37 abc
Pendimethalin (pre emergence)	4.72 b	36 bc
ioxynil	4.72 b	33 c
oxyfluorfen (1.5 lit)	4.65 b	28 d
oxyfluorfen (2lit)	3.95 c	35 bc
Pendimethalin (post emergence)	3.62 c	25 d

3.4. CLOVE COUNT

The number of clove was also evaluated in this experiment. The results showed that this trait was not affected by the experiment year and showed a no significant difference between herbicide treatments. The overall result was a slight decrease in clove and, consequently, weight loss bulb (data not shown).

3.5. WEED DENSITY

One of the important traits in weed experiment is density, or, in other words, number of plants per square meter. It should be noted that the weed density was recorded in two stages and the average was taken. The lowest density was observed for weed control treatment and the highest weed density was observed in Pendimethalin (post emergence) treatment. It should be noted that Oxyfluorfen (2lit) had the lowest density and showed no significant difference with weed control (Fig. 3).

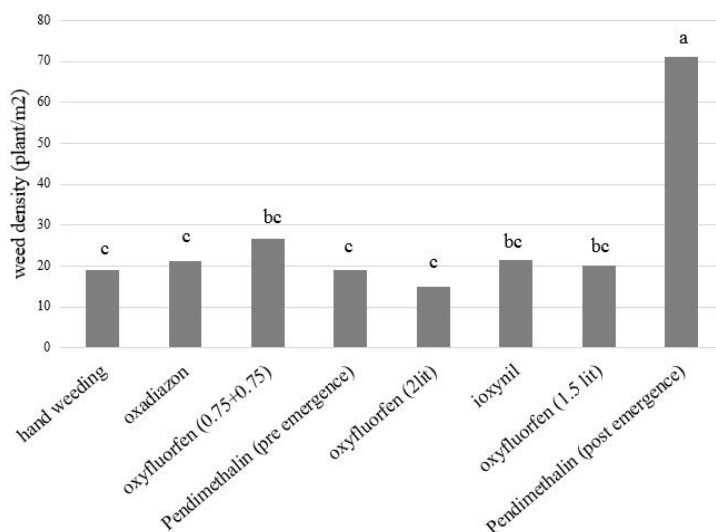


Fig 3. Means comparison of weed density in treatments

3.6. PLANT INJURY

One of the important issues that investigated in this experiment was the amount of plant injury due to the use of different herbicides. In this experiment, plant injury was recorded 2 weeks and 4 weeks after spraying. Results of 2 weeks after spraying indicated that different herbicides had a significant effect ($P=0.01$) on plant injury. The highest plant injury was related to Oxyfluorfen (2lit) and Oxyfluorfen (2lit) Oxyfluorfen (1.5lit) respectively with 33% and 27%, and the lowest was for ioxynil, pre-emergence pendimethalin and post-emergence pendimethalin respectively with 4%, zero and zero percentage (Table 3). In another sampling, 4 weeks after spraying, the order of treatments was as follows: oxadiazon with 36%, Oxyfluorfen (2lit) with 35% and oxyfluorfen (1.5 lit) with 26% had the highest amount of plant injury, the lowest of which was the same as 2 weeks after spraying (Table 3). In general, in the form of analysis with two observations, this trait was evaluated. The results showed that there is no significant difference between the two observations (2 and 4 week) and the order of the treatments in means of the amount of plant injury in two observed, is same to separated sample (data not shown).

Table 3. Comparison of mean of Plant injury trait in different treatments

treatment	Plant injury (%)	
	2 week after treat	4 week after treat
hand weeding	31.2 a	37.0 a
oxadiazon	21.0 b	35.1 a
oxyfluorfen (0.75+0.75)	12.2 c	11.5 b
Pendimethalin (pre emergence)	7.0 bc	8.0 b
ioxynil	4.5 d	2.0 c
oxyfluorfen (1.5 lit)	0.7 e	0.7 c
oxyfluorfen (2lit)	0.7 e	0.7 c
Pendimethalin (post emergence)	0.7 e	0.7 c

3.7. PERCENTAGE OF WEED CONTROL

Weed control percentage was obtained for each treatment as compared to weedy control. The results showed that there was no significant difference between the years of experiment and in treatments of herbicide, the difference was significant ($P=0.01$). The highest weed control percentage for oxyfluorfen (2lit), oxyfluorfen (1.5 lit) and oxadiazon were 86%, 85% and 80%, respectively, which did not have a significant difference with hand weeding and the lowest percentage was post-emergence pendimethalin with 31% (Fig. 4).

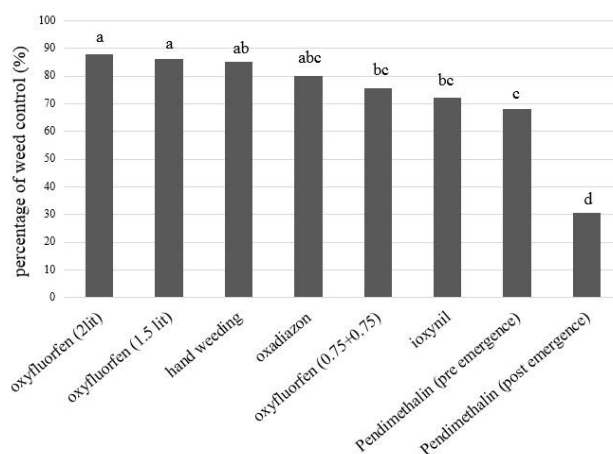


Fig 4. Means comparison of percentage of weed control

IV. Discussion

The control levels of weed control in oxadiazon and oxyfluorfen are competitive with hand weeding treatment. The results of other studies on the performance of these two herbicides have also been reported by other researchers [10]. ioxynil and Pendimethalin (pre emergence) also exhibited a moderate level of weed control. However, the effectiveness of herbicides such as Pendimethalin (pre emergence) and oxadiazon is reduced in cases where the length of the growing season is long. Plant injury was a necrosis or burn that occurred on garlic leaves. The highest plant injury is due to oxyfluorfen herbicide, which is mentioned in other research results [10]. This herbicide caused a decrease in crop height as compared to other treatments, but after several weeks they were similar in height to other treatments. The yield in hand weeding treatment was higher than other treatments. Research results from others also confirm this [10]. Pendimethalin (pre emergence) treatment also has acceptable results, while the results of some researchers on the onion are opposite to it [10] and others confirm these results [11]. This difference in outcome may be due to two causes. First, the use of soil treatments herbicide such as pendimethalin has no plant injury effects, and Garlic, due to the long period of growth, has two types of weeds, one in autumn, and the other in spring, threatens it, so the density or frequency of spring type can reduce its effects.

Acknowledgements

Special thanks to Mr. Parviz Shimi, for their guidance at all stages of this research.

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Mahdi Aghabeigi "Evaluation some of herbicides for weed control of garlic (*Allium sativum*) in Iran." IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT) 11.12 (2017): 36-40.