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Research Article

Comparison of sesame and lentil susceptibility to soil residual effects of total, apirus, and atlantis

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ABSTRACT - This research was conducted in order to study the sensitivity of sesame (*Sesamum indicum* L.) and lentil (*Lens culinaris* L.) to soil residue of three herbicides, including total, apirus, and atlantis under greenhouse conditions. The experimental design was a completely randomized design in a factorial arrangement with three replications. The stem and root length as well as stem and root dry weights were measured regarding both crop species. It was observed that the highest level of atlantis residue reduced the sesame stem length up to 91.61% compared to control. This herbicide decreased the sesame stem dry weight up to 89.93% compared to control plots, which was significantly higher than reduction caused by total and apirus. The maximum (76.67%) and minimum (53.13%) reductions were recorded in the lentil stem length compared to control plots by atlantis and total, respectively. Furthermore, the values of GR50 for sesame were significantly lower than those of lentil against the application of total, apirus, and atlantis, which were 0.5, 0.51, and 1.1 g ha^{-1}, respectively. Generally, sesame showed a higher sensitivity than lentil versus the application of total, apirus and atlantis. Therefore, utilization of sesame could be more effective tool compared with lentil in the bioassay studies.

Abbreviations: GR50, dose of herbicide required to reduce the plant dry weight up to 50% of control plants; HR50, dose of herbicide required reducing the plant height up to 50% of control plants

INTRODUCTION

Undoubtedly, weed infestation is one of the most important factors in reducing crop yield production (Zangoueinejad et al., 2016; Zangoueinejad et al., 2018b; Zimdahl, 1999). Historically, the application of chemical material goes back to before several centuries, while starting weed management by modern chemical materials began in the early 1940s (Smith, 1995). The new herbicide families have been introduced in recent years. These herbicide families have useful characteristics such as low application rate, low toxicity for mammals, and the ability to be absorbed through the shoot and root simultaniously so that they were rapidly considered by the farmers. New herbicide groups such as inhibitor ALS herbicides are important group that have long time activity in the soil (Secor, 1994). Inhibitor ALS herbicides can remain active in the soil for a long period; hence, these herbicides are efficent in weed management programs. Although the herbicide activity is useful, the activity of this group of herbicides in long term riases problems for crops in rotations (Alebrahim et al., 2017; Moyer and Hmman, 2001; Helling, 2005).

Generally, herbicide residues could diminish the growth of sensitive crops and pasture species in the range of 0.01 to 0.07 ng of herbicide per gram of soil (Moyer and Esau, 1996). Herbicides, with low molecular polar nature, remain in the soil, and subsequently, it would be problematic determining their effects on crops (James et al., 1999). High-performance liquid chromatography (HPLC) is the most commonly used method for quantitative detection of sulfonylurea herbicides and other herbicide families, although it is not the unique procedure to achieve this goal (Powley, 2003; Zangoueinejad, 2019a; Zangoueinejad et al., 2019b; Zangoueinejad et al., 2020). Despite the high accuracy of HPLC to determine the total amount of toxic substances in a sample, detection of real toxicdoses to sensitive plants is only possible by using a bioassay method like substrate imbibition, presoak or seedling spray methods as a rapid, cheap and practical procedure (Hall et al., 1990; Hall et al., 2000; Stork and Hannah, 1996; Zangoueinejad et al., 2018a; Zangoueinejad et al., 2019c).

Previous studies have shown conflicting results in the case of sulfonylurea herbicide effects on susceptibile crops. Hollawy et al. (1999) used the bioassay procedure to detect residues of sulfonylurea herbicides compared to some chemical techniques and found that these methods were complementary. Authors emphesized that bioassay could be adequate for quantifying biologically active residues of sulfonylurea herbicides from 0.1 to 1.0 µg ai kg^{-1}. Meanwhile, they reported that the HPLC technique used in this study was not as accurate as bioassay to measure herbicide residues of 3.0-10 µg ai kg^{-1} and would not be able to assess herbicde residues at or below 1.0 µg ai kg^{-1}. Smith et al. (2005) applied several crops such as corn (*Zea mays* L.), cotton (*Gossypium hirsutum* L.), sorghum (*Sorghum bicolor* L.) and soybean (*Glycine max* L.) to determine the persistence of imazaquin and pyrithiobac in the field bioassays. Six rates of each herbicide, including 11, 22, 43, 86, 173, and 690 g ha^{-1} were applied. The recorded injury was 18, 11, 29% for corn, soybean, and sorghum, respectively, at 9 weeks after application of pyrithiobac at the dose of 690 g ha^{-1}. Besides, the visual injury level was 27, 44, and 15% on the foliage of corn, cotton, and sorghum, respectively, at 9 weeks after application of pyrithiobac at the heighest dosage. It was concluded that the most sensitive crop was grain sorghum to pyrithiobac soil residues, followed by corn and then soybean, while sorghum was the most tolerant crop to imazaquin soil residues, followed by corn and then cotton.

Ortega et al. (2004) utilized the garden cress to recognize phytotoxic residues of hexazinone and simazine. The researchers investigated the impact of 6 doses of hexazinone, including 0, 0,005, 0.01, 0.02, 0.04, and 0.08 ppm as well as six simazine rates inclusive of 0, 0.025, 0.050, 0.075, 0.1, and 0.2 ppm. In both cases, the mortality of garden cress accedded to approximately 100% by increasing the herbicde rates up to the heighest doses. Hallaway et al. (2006) evaluate the susceptibility of several crops to some acetolactate synthase herbicides (chlorsulfuron, triasulfuron, metsulfuron-methyl, imazethapyr, and flumetsulam). It was unravealed that the sensivity of canola (*Brassica napus* L.) to imazethapyr was higher than pea (*Pisum sativum* L.) and lentil, while was less susceptible to the sulfonylureas. Contrastly, lentil was the most sensitive crop to sulfonylureas. It was also reported that no reduction was observed in bean (*Phaseolus vulgaris* L.) shoot dry weight or yield by foramsulfuron residues one year after application in corn (Robinson et al., 2006).

Overall, this study aimed to assess sesame susceptibility level to three herbicides including metsulfuronmethyl+sulfosulfuron (Total), sulfosulfuron (Apirus) and mesosulfuron + idosulfuron (Atlantis®) by using bioassay methods (utilizing an indicator plant with high sensitivity to the herbicides).

MATERIALS AND METHODS

This experiment was conducted in 2014 in order to study the sensitivity of sesame (*Sesamum indicum* L.) 'Darab 1' and lentil (*Lens culinaris* L.) 'Gachsaran' to determine residual effects of three herbicides including metsulfuronmethyl + sulfosulfuron (Total), sulfosulfuron (Apirus) and mesosulfuron + idosulfuron (Atlantis®)] in the soil at the Research Greenhouses in the School of Agriculture, Shiraz University (35° 52' E, 40° 29' N, altitude 1810 m asl), Shiraz, Iran. The germination rate of the selected sesame and lentil cultivars, which were provided by Research station of School of Agriculture, Shiraz University, were 90 and 87%, repectively The experimental design was a completely randomized design (CRD) in a factorial arrangement with three replications. Pots were filled with one kg of field soil (untreated field soil with herbicides) and transferred to the greenhouse. Experimental factors were included herbicides [metsulfuronmethyl + sulfosulfuron (Total), sulfosulfuron (Apirus) and mesosulfuron + idosulfuron (Atlantis)] and six concentration levels of each herbicide. Metsulfuronmethyl+sulfosulfuron in six levels; 0, 2, 6, 12, 24, and 48 g ha^{-1} equal to 0, 5, 15, 30, 60 and 120% of the total recommended dose (40 g ha^{-1}), respectively. Sulfosulfuron in six levels; 0, 1.33, 3.99, 7.98, 15.96, and 31.92 g ha^{-1} equal to 0, 5, 15, 30, 60 and 120% of the total recommended rate (26.6 g ha^{-1}), respectively. And mesosulfuron + idosulfuron in six levels; 0, 0.075, 0.225, 0.45, 0.9, and 1.8 L ha^{-1} equal to 0, 5, 15, 30, 60 and 120% of the total recommended dose (1.5 L ha^{-1}), respectively. Each herbicide was diluted ten thousand folds by adding one gram of the herbicide to distilled water and was used as the stock solution for making required concentrations to spray uniformly on the soil surface of each pot eventually. The sprayed herbicides were immediately incorporated into the soil thoroughly after the application. Six seeds of sesame or lentil were planted in each pot in their proper depth (0.5-0.7 cm) and was uniformly irrigated dialy. Moreover, the greenhouse tempretuare was 22-25/19-21 °C day/night. A week after seedling emergence, thinning was done at 2-3 leaf stage and the plant density was adjusted to 3 plants per pot. Thirty days after emergence the root length of the treated and control plants was measured. The root and stem of the plants were separated by putting in a paper bag and dried using an oven set at 60 °C for 48 hours. Root and shoot dry weights were also recorded by one-thousandth digital balance.

Data analysis was performed by using PROC GLM SAS 9.4 (SAS Institute, Cary, NC, USA) and means were compared utilizing Duncan's Multiple Range Test at 5% significance level. Because of differences of the herbicides toxicity for sesame and lentil, different dose range was chosen to each herbicide. For asmuch as, in a factorial experiment all levels of factors must be equal with together, all doses were divided into three levels including low (0 to 10% of the recommended dose), average (15 to 30% of the recommended dose) and high (60 to 120% of the recommended dose). Since data met normality conditions; therefore, data transformation was not done. Meanwhile, the Levene test was used to check the homogeneity.

Herbicide dose–response based on the values of plant height and dry weight were analyzed using a three-parameter log-logistic model (equation 1) to determine the effective dose of total, apirus, and atlantis that causes 50% height reduction (HR50) and dry weight reduction (GR50) compared to control plant.

$$Y = \frac{d}{1 + \exp\{b[\log(x) - \log(e)]\}} \quad (1)$$

Where, Y, d, *b*, *x*, and *e* are the plant response, the upper limit, the slope of the curve, the herbicide dose, and the effective dose that causes 50% height or dry weight reduction. Analyzing dose-response data and drawing its graphs were performed using Graph Pad Prism 8 software (Graph Pad Software, San Diego, CA, USA).

RESULTS AND DISCUSSION

Analysis of variance showed that the main effects, including herbicide types and herbicide residue levels as well as their interaction effects had significant impacts on all studied traits ($P < 0.01$) (Table 1).

The Sesame Stem Length

The sesame stem length was 12.57, 11.38, and 6.33 cm, under the treatment of total, apirus, and atlantis, respectively (Table 2). Also as expected, the lowest stem length (1.27 cm) was recorded under the high herbicide residue level (Table 2). At the low level of herbicide residue, the stem length was higher (up to 84.26%) than that at the high level of herbicide residue. Noteciably, the toxicity effect of metsulfuronmethyl+sulfosulfuron was more than 78.74% compared to sulfosulfuron (Table 2). The sesame stem length was significantly decreased by increasing the herbicide residue in the soil (Table 2). The most (91.21%) and lowest (52.50%) reduction of the stem length were observed at the high and low levels of herbicide residue, respectively (Table 2). Furthermore, the average level of herbicide residue reduced the stem length by 73.55 % (Table 2).

Regarding the interaction of the herbicide type and level of herbicide residue, it is mentionable that atlantis significantly diminished the sesame stem length more than othes (Fig. 1 and 2A). Results indicated that the heighest (91.61%) and lowest (0.75%) reduction in the sesame stem height were assessed at the high atlantis residue and low total residue leveles compared to control, respectively (Fig.1 and 2A). No significant difference was realized among the impacts of the low and medium total residue levels as well as low apirus level in diminishing the sesame stem length. Also, the effect of atlantis at the high residue level was significantly different compared with all other treatments (Fig. 1 and 2A).

In some studies, it was showm that variations of stem growth in response to herbicide residues in the soil was the most important parameter to evaluate the sensitivity of plant species (Alonso-Prados et al., 2002; Santin-Montanya et al., 2006). Alonso-Prados et al. (2002) indicated that barley (*Hordeum vulgare* L.) and common vetch (*Vicia sativa* L.) were not influenced by sulfosulfuron residues, although the shoot length of sunflower seeded was reduced up to approximatly 16.3-226% based on the herbicide rates. Sulfonylurea herbicides have introduced as herbicides with high persistence for several crops including mung bean (*Vigna radiata* L.), lentil (Alonso-Prados et al., 2002), squash (*Cucurbita pepo* L.) and canola (Moyer and Esau, 1996). After the application of sulfosulfuron at the rate of 0.0, 0.001, 0.01, 0.03, and 0.05 mg L^{-1}, the responses of flax (*Linum usitatissimum* L.), maize, onion (*Allium cepa* L.), tomato, barely, and vetch were evaluated (Santin-Montanya et al., 2006). The shoot growth percentage was reduced in flax, maize, tomato barely, and vetch up to 87.0, 76.3, 70.6, 46.7, 87.2, and 87.8%, respectively, by increasing herbicide rate from 0 to 0.05 mg L^{-1}. In general, the shoot growth in all studied crops was decliened by riasing the sulfosulfuron dose (Santin-Montanya et al., 2006).

The values of sesame stem dry weight were 0.058, 0.052, 0.033 g against the treatment with total, apirus, and atlantis residues, respectively (Table 2). Significantly, the stem dry biomass was declined by incresing the level of herbicide residues from low to high level, as it was 0.032, 0.013, and 0.04 g after exposing to the low, average, and high level of herbicide residues (Table 2). As determined, total compared to apirus and atlantis had a greater negetive effect on the sesame stem dry weight, as it was reduced up to 89.93% (Table 2).

The maximum dry weight reduction (by 52.51%) was observed under application of mesosulfuron + idosulfuron reduction compared to control (Table 2). Moreover, sulfosulfuron showed a high toxicity effect and sesame stem dry weight was reduced up to 80.47% under application of this herbicide compared to control (Table 2).

Table 1. Analysis of variance traits measured of sesame and lentil in bioassay (dose-response).

Source of variation	df	Mean of square							
		Sesame stem length	Sesame stem dry weight	Sesame root length	Sesame root dry weight	Lentil stem length	Lentil stem dry weight	Lentil root length	Lentil root dry weight
Herbicide type (A)	2	4711.7**	3604.54**	7233.05**	4456.33**	1445.99**	2254.49**	148.73**	484.69**
Herbicide residue (B)	2	5044.85**	4275.31**	3454.41**	4260.71**	5730.26**	5673.28**	3984.46**	2361.27**
Interaction (A*B)	4	616.64**	448.15**	395.35**	360.39**	257.03**	159.98**	18.59ns	31.08ns
Error	18	5.44	8.22	3.87	20.82	11.98	7.26	7.88	32.90
Total	26								
C.V		7.70	11.01	6.03	18.14	5.56	5.08	4.70	11.04

*, ** and ns significant at 1%, 5%, and no significant, respectively

Table 2. Comparison of main average effects on the measured traits of sesame and lentil in bioassay experiment (dose-response).

Factor	Level	Sesame stem length (cm)	Sesame stem dry weight (g)	Sesame root length (cm)	Sesame root dry weight (g)	Lentil stem length (cm)	Lentil stem dry weight (g)	Lentil root length (cm)	Lentil root dry weight (g)
Herbicide type	Total	12.57^{b*}	0.058^{b}	10.03^{b}	0.013^{b}	8.90^{d}	0.027^{c}	5.19^{d}	0.012^{c}
	Apyrus	11.38^{c}	0.052^{c}	9.19^{c}	0.012^{c}	8.21^{e}	0.025^{d}	5.02^{e}	0.012^{c}
	Atlantis	6.33^{e}	0.033^{d}	4.01^{e}	0.007^{d}	4.43^{g}	0.013^{g}	4.27^{g}	0.009^{e}
Herbicide residue	Low**	8.07^{d}	0.032^{e}	6.14^{d}	0.007^{d}	16.61^{b}	0.037^{b}	9.92^{b}	0.016^{b}
	Average	3.83^{f}	0.013^{f}	3.44^{f}	0.002^{e}	11.80^{c}	0.022^{e}	6.62^{c}	0.011^{d}
	High	1.27^{g}	0.004^{g}	1.67^{g}	0.001^{f}	7.02^{f}	0.014^{f}	4.96^{f}	0.009^{e}
Control		14.5^{a}	0.065^{a}	11.5^{a}	0.015^{a}	19.0^{a}	0.047^{a}	12.0^{a}	0.024^{a}

*Values in the same column sharing the same letter are not significantly different (Duncan's test 5%).

**The ranges of low, average, and high are including 0-10, 15-30 and 60-120 percent of the recommended dose, respectively

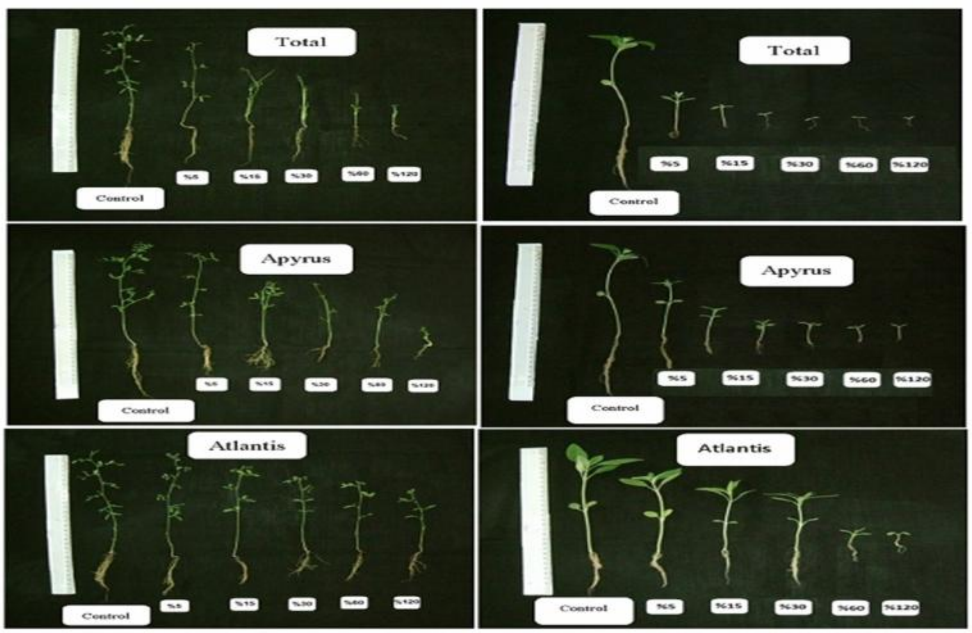


Fig. 1. Response of sesame (right) and lentil (left) against six concentrations of total, apyrus, and atlantis.

Moreover, it was revealed that the high residue level of atlantis had the most negetive effect and low residue level of total showed the least negetive effect in reducing the sesame stem dry weight that were up to 99.25 and 18.18%, respectively, compared to control plots (Fig. 1 and 2B). It was found that the sensitivity of sesame to the medium and high atlantis residue levels was much more than those of various residue levels of total and apirus (Fig. 1 and 2B).

The Sesame Root Length

As shown in Table 2, the sesame root length was reduced by the treatments of total, apirus, and atlantis up to 10.03, 9.19, and 4.01 cm compared to control plots. Additionally, the sesame root length was 6.14, 3.44, and 1.67 cm against the low, average, and high level of herbicide residues (Table 2). It illustrates that by increasing the amount of herbicide residue, its negetive effects were increased. Clearly, the root length was reduced by 45.55, 70.06 and 85.45% compared to control after tretment with the low, medium and high herbicide residue, respectively (Table 2). With regard to interaction of herbicide types and their residue levels, greater reductions in the sesame root length were discerned by increasing the atlantis residue levels compared to total and apirus (Fig. 1 and 2C). Accordinglly, high residue level of atlantis decreased the sesame root length up to 90.03% compared to control treatment (Fig. 2C). Furthermore, the low and medium residue levels of total reduced the sesame root length by 2.68 and 5.2% compared to control, which had no significant difference (Fig. 1 and 2C).

The Sesame Root Dry Weight

As demonstrated, the heighest sesame root dry weight value (0.013 g) was otained in treated plots with total, while the lowest one (0.007 g) was distinguished under the effect of atlantis residues (Table 2). Besides, increasing the herbicide residue level significantly reduced the sesame root dry weight from 0.007 to 0.001 g by chainging the residue level from low level to high level (Table 2). Metsulfuronmethyl + sulfosulfuron and sulfosulfuron decreased the root dry weight up to 81.67 and 69.15%, respectively, compared to control (Table 2).

Regarding the interaction of herbicide types and residue levels in the soil, the most damage was observed at high level of atlantis that was up to 80.26% compared to control treatment (Fig. 2D). The low residue level of total caused the least injury in the sesame root dry weight by 0.45% compared to control (Fig. 2D). In addition, by increasing the residue level of atlantis from low to moderate and high levels, its damage was increased significantly up to 65.29 and 70.03%, respectively (Fig. 2D).

The Lentil Stem Length

According to Table 2, the lentil stem length was measured up to 8.90, 8.21, and 4.43 cm in treated plots with total, apirus, and atlantis, respectively. Furthermore, the stem length was decreased by raising the herbicide residue level so that it was 16.61, 11.8, and 7.02 cm after exposing to the low, average, and high level of herbicde residues (Table 2). Besides, the low residue levels of total and apirus reduced the lentil stem length by 24.73 and 24.28%, repectively, compared to control, as lowest toxic herbicde residue values (Fig. 1 and 3A). However, the high level of atlantis and apirus represented the maximun destructive effects in decreasing the lentil stem length by 91.74 and 86.50%, respectively, compared to control (Fig. 1 and 3A).

The Lentil Stem Dry Weight

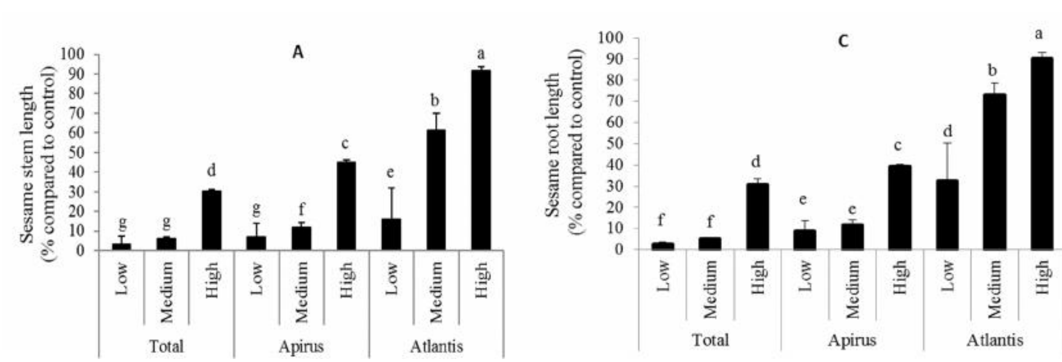
Importantly, the stem dry bimass value was 0.027, 0.025, and 0.013 g under the treatmnet of the residue of total, apirus, and atlantis, respectively (Table 2). Likewise, it was 0.037, 0.022, and 0.14 g in treated plots by the low, average, and high levels of herbicide residues (Table 2). The interaction between herbicide types and herbicide residue levels represented different impacts on the stem dry weight (Fig. 1 and 3B). The high level residue of atlantis created 88.98% reduction in the lentil stem dry weight (Fig.3B). On the other hand, the low residue levels of total and apirus recorded 17.45 and 19.05% reduction in stem dry biomass, respectively, compared to control (Fig. 3B)

The Lentil Root Length

As presented in Table 2, the recorded lentile root length was 5.19, 5.02, and 4.27 cm in treated plots with total, apirus, and atlantis, respectively. Notably, the lowest root length (4.96 cm) was realized when the herbicide residue level was high (Table 2). The investigating impacts of herbicide residues levels was revealed that the root length was decreased in relation to all three herbicides by increasing the level of residues in the soil (Table 2). The highest recorded lentil root reductions that were up to 84.98 and 82.19% compared to control were observed in the treated plots with the high residue levels of atlantis and apirus, respectively (Fig. 1 and 3C). In addition, the low residue levels of total and apirus caused the lowest reduction in root length by 39.66 and 38.77% compared to control, respectively (Fig. 1 and 3C). Hallaway et al. (2006) reported that despite to the lack of detection of residues of methylsulfuron via device analysis procedure, bioassay was a good approach to determine the impact of residues of methylsulfuron on the lentil root length.

The Lentil Root Dry Weight

Lentil represnted the heighest (0.012 g) and lowest (0.009 g) root dry weight in treated plots with total/apirus and atlantis, respectively (Table 2). As expected, the minimum value (0.009 g) of root dry biomass was observed under the treatments of high level of herbicide rsidues (Table 2). The levels of herbicides residue showed significant differences so that the lowest (29.75%) and greatest (60.65%) reduction of lentil root dry weight were observed at the low and high residue levels, respectively (Table 2). The moderate level of herbicide residues in the soil caused a reduction by 53.82% in the lentil root dry weight (Table 2). The greatest reduction in lentils root dry weight (76.70% compared to control) was detected at the high level of atlantis, follwed by the high residue level of apirus that was 68.83%, which had no significant difference (Fig. 1 and 3D). Meanwhile, the lowest reductin impact was observed in treated plots with the low and madium residue levels of total, and besides, low and medium residue levels of apirus, which diminished the lentil root dry biomass up to 38.01, 40.49, 33.74, and 40.04% compared to control plot, respectively (Fig. 3D). No significant difference was observed among these treatments (Fig. 3D).



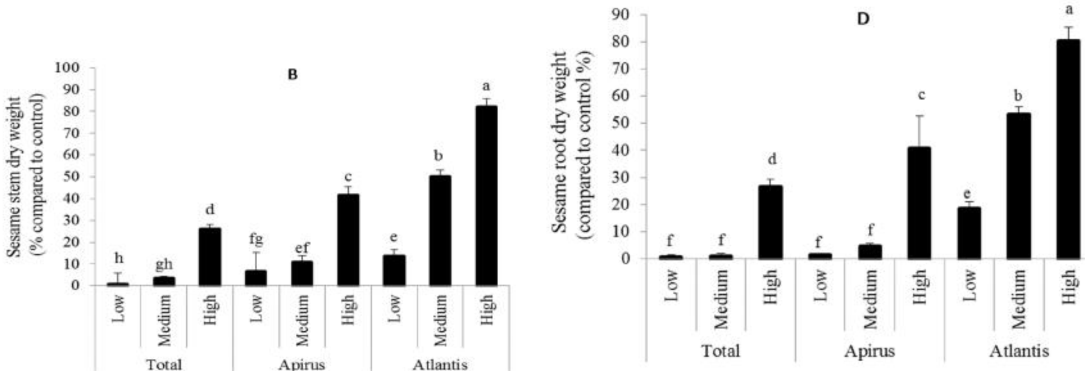


Fig. 2. Interaction effects of herbicide type and residue on the sesame stem length (A), stem dry weight (B), sesame root length (C), and sesame root dry weight (D). The means followed by the same letter are not significantly different (Duncan's test 5%).

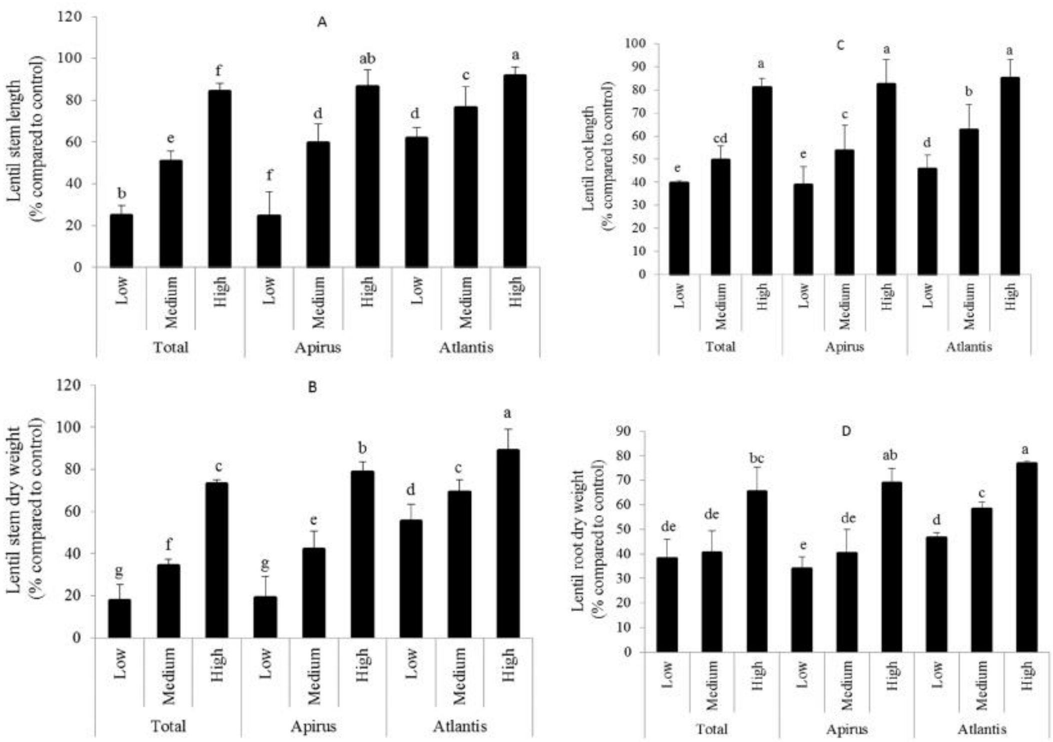


Fig. 3. Interaction effects of herbicide type and residue on the lentil stem length (A), stem dry weight (B), lentil root length (C), and root dry weight (D).The means followed by the same letter are not significantly different (Duncan's test 5%)

Evaluation of Sensitivity of Sesame and Lentil

Based on the results, the plant height and dry weight of sesame and lentil were decreased by increasing the herbicide (total, apirus, and atlantis) concentration in the soil (Fig. 4 and 5). According to Fig. 4 and 5, the general trend of sesame and lentile responses were the same to the application of all three herbicides (Fig. 4 and 5).

However, the most important point was the sensitiveness level of sesame to the application of all three herbicides. In fact, the values of GR50 of total, apirus, atlantis, and atlantis for sesame were 1.1, 0.51, and 0.5 g ha^{-1}, respectively; and HR50 were 1.6, 1.41, and 0.8 g ha^{-1}, repectively. In both cases, the values of sesame GR50 and HR50 were significantly ($P < 0.01$) lower than those of the lentil GR50 and HR50 quantities (Fig. 4 and 5). This result showed that the susceptibility of sesame was significantly higher than lentile against the application of all three herbicides (Fig. 4 and 5).

Based on the litreture, the using of ED50 was the most important evaluation index for studying and classification the plant sensitivity to herbicide residues (Santin-Montanya et al., 2006; Hallaway et al., 2006). The ED50 value of sulfosulfuron for flax, maize, onion, tomato, vetch, and barley were recorded to be 0.0004, 0.00065, 0.0013, 0.011, 0.0019, and 0.39 mg L^{-1} (Santin-Montanya et al., 2006). Clrealy, the aformentioned results explain that flax was the most sensetive crop and barley was the less sensetive one against application of sulfosulfuron. Importantly, the lowest quantities of ED10 (0.000053 mg L^{-1}) and ED30 (0.00019 mg L^{-1}) were discerned in flax. Equally important, these values were higher approximately up to 99.88% for barley, which illustrates its low sensitivity level versus the application of sulfosulfuron (Santin-Montanya et al., 2006).

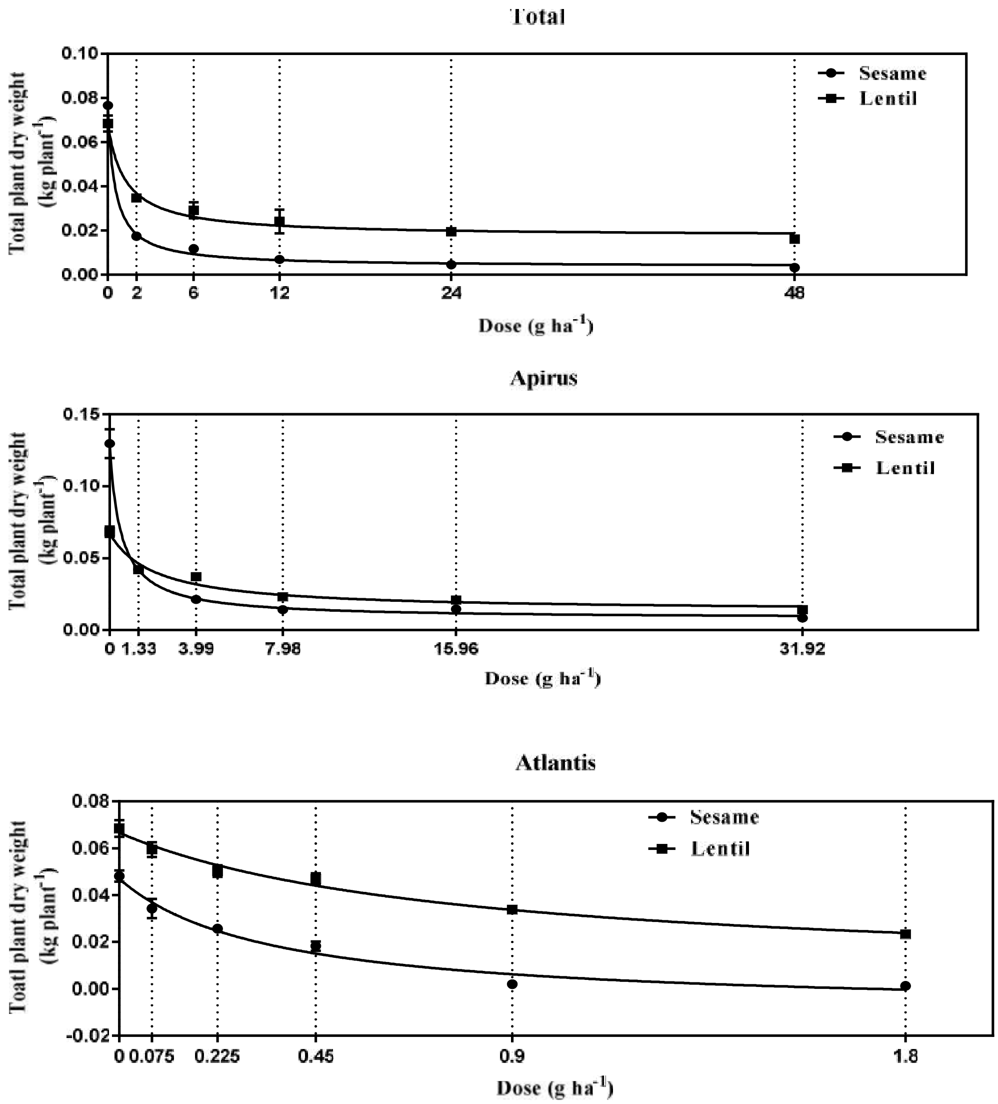
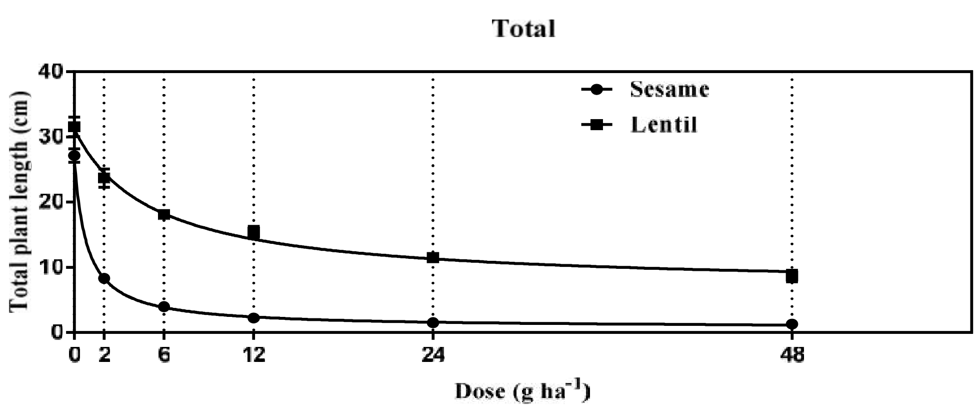


Fig. 4. Responses of sesame and lentil based on the level of total plant dry weight after total, apirus, and atlantis applications



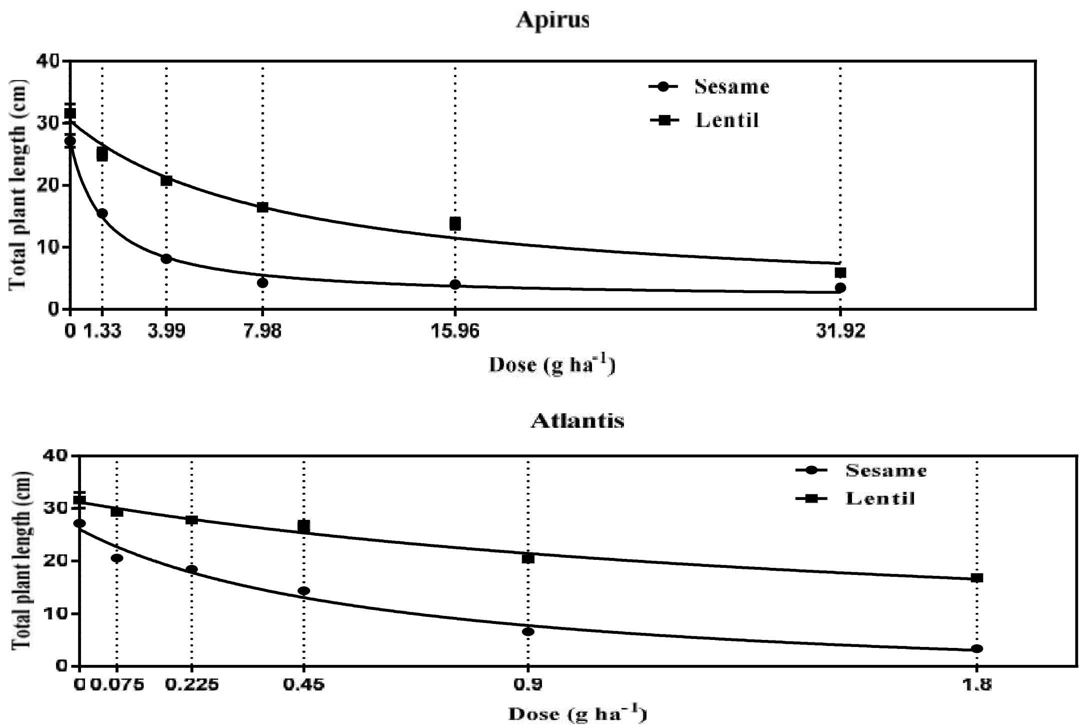


Fig. 5. Responses of sesame and lentil based on the total plant length after total, apirus, and atlantis applications

CONCLUSIONS

Generally, sesame could be selected as a benchmark plant in the future studies because of its higher sensitivity than lentil to all three herbicides used in this study. Remarkebly, it was uncovered that the sesame root length was the most sensitive section of this crop to response to the studied herbicdes, oweing to the highest recorded influences of total, apirus, and atlantis residues to damage this plant part in the soil. Thus, using this section of sesame plant as a benchmark trait would be efficient in bioassay studies. However, as the measuring of the sesame stem height seems to be easier than root length, and also, as the sensitivity of sesame stem and root length were not significantly different, therefore, utilizing the sesame stem height in lieu of root length could be a practical alternative in bioassy studies.

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مقاله علمی- پژوهشی

مقایسه حساسیت کنجد و عدس در برابر اثرات باقیمانده‌های خاکی علف‌کش‌های توتال، آپیروس و آتلانتیس

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واژه‌های کلیدی:
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بقایای علف‌کشی
HR50
طول ریشه
طول ساقه

چکیده - این پژوهش به منظور مطالعه میزان حساسیت کنجد (*Sesamum indicum* L.) و عدس (*Lens culinaris* L.) در مقابل بقایای خاکی سه علف‌کش توتال، آپیروس و آتلانتیس تحت شرایط گلخانه‌ای صورت پذیرفت. طرح آزمایشی از نوع طرح کاملا" تصادفی در پایه فاکتوریل با سه تکرار بود. صفات مورد مطالعه در این آزمایش طول ساقه و ریشه و همچنین وزن خشک ساقه و ریشه در مورد هر دو گونه گیاهی بود. بر اساس نتایج مشاهده شد که بیشترین مقدار بقایای آتلانتیس سبب کاهش طول ساقه کنجد به میزان ۹۱/۶۱ درصد در مقایسه با کرت‌های شاهد شد. این علف‌کش سبب کاهش وزن خشک ساقه کنجد به میزا ن ۸۸/۹۳ درصد در مقایسه با کرت‌های شاهد شد که این میزان به طور معنی‌داری با مقادیر کاهش ایجاد شده به وسیله علف‌کش‌های توتال و آپیروس بیشتر بود. نتایج نشان دادند که بیشترین (۷۶/۶۷ درصد) و کمترین (۵۳/۱۳ درصد) میزان کاهش در طول ساقه عدس در مقایسه با کرت‌های شاهد به ترتیب توسط علف‌کش‌های آتلانتیس و توتال ایجاد گردید. ضمنا" مقادیر GR50 مربوط به علف‌کش‌های توتال، آپیروس و آتلانتیس که به ترتیب به میزان ۰/۵، ۰/۵۱ و ۱/۱ گرم در هکتار بودند برای گیاه کنجد در مقایسه با عدس به طور معنی‌داری کمتر برآورد شدند. به طور کلی کنجد حساسیت بیشتری در مقایسه با عدس در مقابل کاربرد علف‌کش‌های توتال، آپیروس و آتلانتیس نشان داد. بنابراین کاربرد گیاه کنجد در مطالعات زیست‌سنجی در مقایسه با گیاه عدس می‌تواند ابزار موثرتری باشد.