

The Effects of Fusilade (Fluazifop-p-butyl) on Root and Shoot Growth of Lentil (*Lens culinaris* Medik.) Seedlings

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Abstract

The present study has been carried out to investigate the effects of the herbicide Fusilade (Fluazifop-p-butyl) on root and shoot growth of lentil seedlings. Four different doses of Fusilade (0.25%, 0.5%, 1% and 1.5%) were used in (Fluazifop-p-butyl) *Lens culinaris* seeds and leaves. The obtained results indicate that shoot growth and lateral root growth was reduced in Fusilade treated groups. Leaf deformations like chlorosis, curling, expansion and asymmetry was observed in Fusilade treated leaves. It was also seen that leaf treatment was more sensitive than seed treatment against the effects of herbicide Fusilade.

Key words: Herbicide, seed, leaf, treatment, germination.

INTRODUCTION

Approximately 10% of all plant species are weeds, or a total of some 30,000 weed species. Of these, 1,800 cause serious economic losses in crop production, and about 300 species plague cultivated crops throughout the world [1].

Fluazifop-p-butyl is actively taken up by plants and translocated throughout the plant. The compound accumulates in the actively growing regions of the plant (shoots, root rhizomes, stolons of grass) where it interferes with the plant cell's ability to produce energy. In plants, fluazifop-p-butyl is rapidly broken down in the presence of water to fluazifop-p [2]. Fluazifop-p-butyl kills annual and perennial grasses, but does little or no harm to broad-leaved plants (dicots). It kills by inhibiting lipid synthesis (lipids are necessary components of cell membranes), particularly at the sites of active growth. In the environment, fluazifop-p-butyl is degraded primarily through microbial metabolism and hydrolysis. It is not degraded readily by sunlight. The half-life of fluazifop-p-butyl in soils is one to two weeks.

After uptake by the leaves of plants, Fluazifop-p-butyl is rapidly broken down in the presence of water to fluazifop-p, which is translocated throughout the plant. The compound accumulates in the actively growing regions of the plant (meristems of roots and shoots, root rhizomes and stolons of grass), where it interferes with energy (ATP) production and cell metabolism in susceptible species.

Fayez and Kristen hypothesized that residues of some herbicide compounds would effect crop seedlings during very early stages of their development and they stated that the radicle is the first organ to come directly into contact with herbicide in the soil [3]. Boutin et al. reported that *Sinapis arvensis* L. and *Phaseolus vulgaris* L. exhibited marked effects on the vegetative growth and reproductive performance when sprayed at 10% label rate with metsulfuron methyl and the seedling stage was the most sensitive period for all species

tested [4]. The thiocarbamate herbicide, triallate caused root growth retardation 6 months after application to the soil [5].

Currently, little is known about the effects of Fusilade on seed germination and root and shoot growth of lentil. The aim of our study is to investigate and evaluate the effects of Fusilade on root and shoot growth of lentil.

MATERIAL AND METHODS

Seeds of *Lens culinaris* Medik. cv. Sultan were pretreated with 5% NaOCl for 10 minute for seed surface sterilization. Then they were placed under clean bench conditions in Petri dishes and filled with boiled tap water at room temperature for soaking and germination. Four different Fusilade doses % 0.25, % 0.5, % 1 and % 1.5 were used which were prepared in modified Hoagland nutrient solution [6]. The control groups were treated only with modified Hoagland nutrient solution. The experiment was repeated three times. The root tips were evaluated as germinated after 0.5 mm length.

The development of the lentil seedlings was first observed in vitro, and then they were planted in plastic pots (dimensions: 8 cm x 8.5 cm x 10 cm). The used soil consists of %40 Holland torph and %60 humus. 8 lentil seedlings were planted in each pot. Two different applications were made: seed treatment and leaf treatment with Fusilade. Some of the seeds were treated with Fusilade for 24 hours and then planted to pots; the others were treated with Fusilade during 6-10 flowered stage after the seedlings were 10 cm length. Seed treatment was made directly to the seeds by the nutrient solution and leaf treatment by spraying. Their photographs were taken with Fujifilm Fine Pix 1300 digital photo camera. All of these experiments were performed in the field in Trakya Agricultural Research Institute. The specimens in the field experiments were treated with the same process as laboratory studies. They were than sowed to the field which was parted to 10 different sections. The distances

between the sections were 1 m. The samples were taken from the field and compared with the laboratory findings.

Statistical analysis was performed with SPSS 11.0 software package. One way ANOVA and Duncan test was used in order to evaluate the daily effects of the Fusilade doses.

RESULTS

In the first day germination percentage was not enough to consider (the length of root tips were less than 0.5 cm) so the lengths of roots were measured and evaluated from the second day. The shoot growth began in the third day and than their lengths were measured. The effects of different doses of Fusilade on shoot growth were observed and evaluated for five days. The percentages of shoot growth and the mean shoot lengths are seen in table 1. The number of shoots were especially decreased by %0.5 Fusilade and the shoot lengths were decreased by %1 Fusilade. It was also observed that %1.5 Fusilade made a half reduction in the shoot length at the end of the third day.

The root length measurements which were made between the second and fifth days of germination were evaluated by SPSS 11.0 package program. The effects of Fusilade on root length means and standart deviations are seen in table 2. One way ANOVA and Duncan test is used in order to evaluate the daily effects of the doses (Table 3).

The means that are shown with different characters are meaningfull according to Duncan test. ($F= 124.374, P<0.01$)

When we compare the root and shoot growth of Fusilade treated and non-treated groups, shoot growth and lateral root growth was reduced in Fusilade treated groups (Figure 1).

The results of Duncan test of root lengths of Fusilade treated seeds are seen in table 3. According to these results the root lengths are in closer groups in the doses % 0.25 and % 0.5 and in different groups in the doses % 1 and % 1.5. As the doses of Fusilade increases the root lengths are decreased.

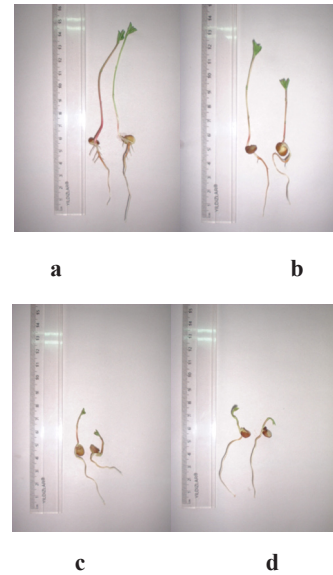


Figure 1. The root and shoot growth of *Lens culinaris* within ten days **a.** control, **b.** %0.25 Fusilade, **c.** %0.5 Fusilade, **d.** %1 Fusilade

Morphological observations from field experiments

In the field experiments, it was observed that the plants in the control group showed a normal and healthy growth (Figure 2 and 3). In the plantings carried out after the application of Fusilade in the seeds, it was observed that the number of the growing plants

Table 1. The effects of different doses of Fusilade on shoot growth

The treated Fusilade doses (ml)	Percentages of shoots (%)	Mean shoot lengths (cm)± Standart deviation				
		1 st day	2 nd day	3 rd day	4 th day	5 th day
Control	42	-	0.87±0.18	1.46±0.62	1.91±0.67	2.52±0.93
%0.25	40	-	0.74±0.18	1.14±0.28	1.40±0.37	1.80±0.45
%0.5	18	-	0.63±0.14	1.05±0.29	1.17±0.30	1.75±0.49
%1	12	-	0.76±0.16	1.10±0.58	1.38±0.36	1.55±1.25
%1.5	8	-	0.55±0.46	0.70±0.65	0.98±0.23	1.20±0.22

Table 2. The effects of different doses of Fusilade on root growth

The treated Fusilade doses (ml)	Percentages of roots (%)	Mean root lengths (cm)± Standart deviation				
		1 st day	2 nd day	3 rd day	4 th day	5 th day
Control	76	-	0.80±0.43	1.12±0.55	1.89±0.81	3.12±1.10
%0.25	92	-	0.80±0.52	1.22±0.97	1.50±0.91	2.71±1.36
%0.5	72	-	0.75±0.50	1.01±0.87	1.56±1.16	2.67±1.30
%1	46	-	0.75±0.59	0.84±0.52	0.91±0.73	1.27±1.01
%1.5	12	-	0.15±0.23	0.25±0.31	0.33±0.33	0.46±0.36

Table 3. The evaluation of root lengths of lentils treated with different doses of Fusilade with Duncan test

The treated Fusilade doses (ml)	The number of days that measurements were made				
	1 st day	2 nd day	3 rd day	4 th day	5 th day
Control	-	0.80 _i	1.12 _e	1.89 _c	3.12 _a
%0.25	-	0.80 _{hi}	1.22 _{ef}	1.50 _d	2.71 _b
%0.5	-	0.75 _i	1.01 _{fgh}	1.56 _d	2.67 _b
%1	-	0.75 _{hi}	0.84 _i	0.91 _i	1.27 _e
%1.5	-	0.15 _j	0.25 _j	0.33 _j	0.46 _j

reduced and the size of the plants became smaller. After the leaf application, paling, fading and drying of the some plants were observed. When the seed and leaf applications were compared with respect to doses, it was observed that seed application showed more negative effects during the late stages of plant growth that were parallel to the increase in Fusilade doses. While an increase on the number of the shoots and formation of red spots on the leaves in the 4th dose were observed during the seed application, some morphological abnormalities such as chlorosis, curling, widening and asymmetry on leaves were observed during the leaf application (Figure 4).

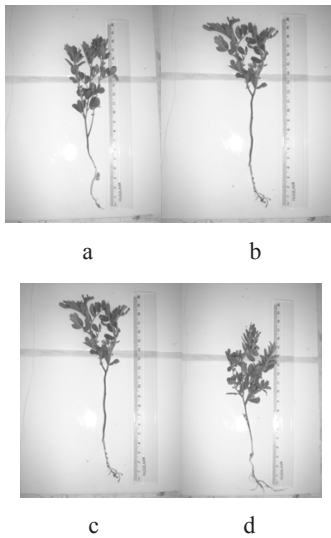


Figure 2. The general view of *Lens culinaris* seedlings after seed treatment with Fusilade (1 month after sowing) **a.** Control, **b.** % 0.25 Fusilade, **c.** %0.5 Fusilade

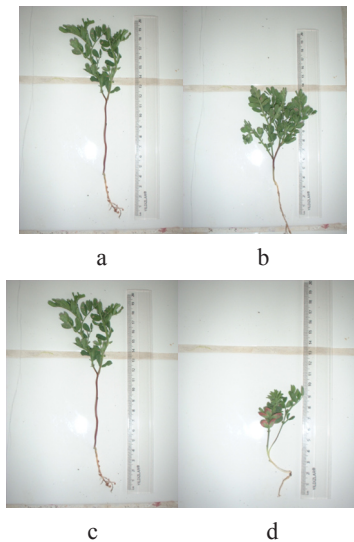


Figure 3. The general view of *Lens culinaris* seedlings after seed treatment with Fusilade (1 month after sowing) **a.** Control, **b.** %1 Fusilade, **c.** %1.5 Fusilade

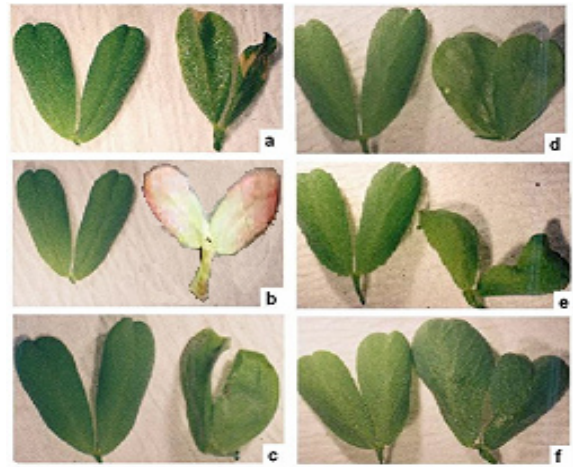


Figure 4. The leaf deformations of *Lens culinaris* after treatment with Fusilade (1 month after sowing) **a.** Assymetry and curling (%1.5 Fusilade) **b.** chlorosis on the leaf (%1.5 Fusilade), **c.** curling (%1 Fusilade), **d, e.** become shorten, expansion and curling (%0.5 Fusilade), **f.** expansion and asymmetry (%0.5 Fusilade)

Morphological observations from laboratory experiments

After seed treatment in Hoagland's nutrient solution for two weeks, the root growth decreased while the shoot growth increased on the seedlings (Figure 5.). At all doses, a reduction in plant growth was observed, whereas no growth was observed in %1.5 Fusilade.

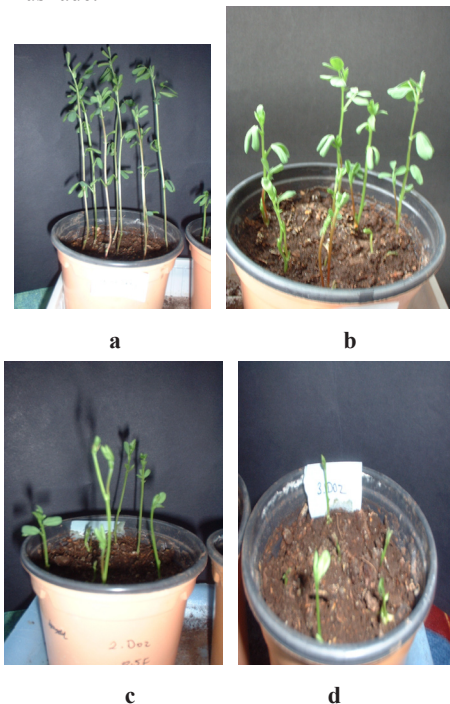


Figure 5. The development of *Lens culinaris* seedlings treated with Fusilade in two weeks (seed treatment) **a.** control **b.** %0.25 Fusilade, **c.** %0.5 Fusilade, **d.** %1 Fusilade

In the plants that were taken into pots after 2 weeks, a growth and maturing reduction was observed (Figure 5). When the seedlings reached 8-10 cm length, Fusilade was applied to the leaves. In a few days after the application, it was observed that some of the plants died (Figure 6). In all doses

applied under laboratory conditions, various abnormalities on leaf morphology were observed. These abnormalities were approximately similar with the field experiments (Figures 4, 5 and 6).

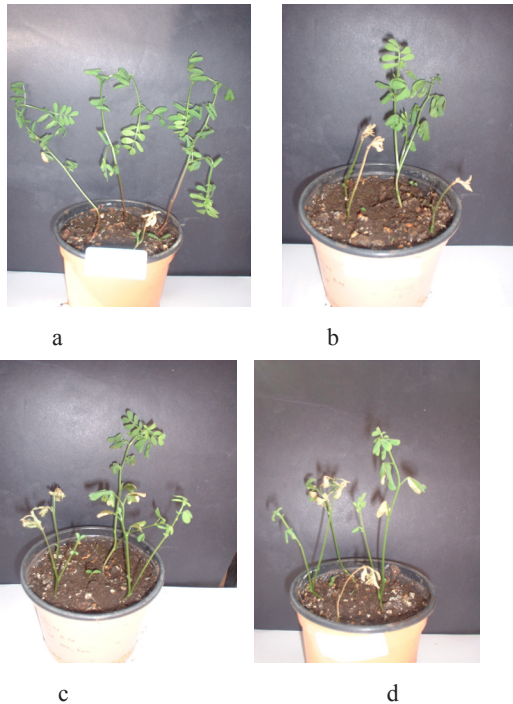


Figure 6. The development of *Lens culinaris* seedlings treated with Fusilade in two weeks (leaf treatment) **a.** %0.25 Fusilade, **b.** %0.5 Fusilade, **c.** %1 Fusilade, **d.** %1.5 Fusilade

DISCUSSION

The observed morphological effects of Fusilade on lentil are reduction in both root length and number of lateral roots. Similar results were seen in lentil treated with chlorsulfuron and metsulfuron herbicides [7]. Coşkun determined that treatment with an insecticide Decis reduced root length in *Alium cepa* [8]. Chopra and Singh reported that treatment with 2,4-Dinitroasetic acide reduced plant development in *Guizotia* [9]. Cireli found that colchicine and cumarin treatment reduce root length and increase width of roots in *Lens culinaris* [10].

Bayer et al. reported that the herbicide trifluralin made an inhibition on lateral root growth and shoot length in gossypium and maize [11]. Previous studies showed that after treatment with a herbicide firstly the development of roots and shoots of the herbaceous plants were inhibited and then the other observable symptoms were determined [12].

In this study after seed treatment with Fusilade, red spots were observed in leaves of lentil seedlings. It is also determined

that leaf treatment was more sensitive than seed treatment. Because after leaf treatment it was observed that lentil seedlings die within 10 days. In a similar study conducted by Sasaki et al., atrazine and simazin treatment caused death of plants after 20th day of application [13]. Chopra and Singh reported that some morphological changes occurred in leaves of *Guizotia* like curling and assymetry after treatment with 2,4-dinitrophenoxy asetic acide [9]. It was also determined that after herbicide application red spots (anthocyanin formation) were observed on leaves of plants and in time, these necrotic regions spread out to the whole plant [11]. Sasaki and Kozlowski reported that application of atrazine, simazine, propazine and 2,4-dinitrophenoxy asetic acide to pine seedlings caused curling and chlorosis in leaves, seedling developmental problems and red spot formation on stems [14].

From the literature we know that injury from translocated toxic chemicals is primarily to the foliage. Plant injury generally progresses from the lower, older foliage to the top. Individual leaves show the greatest injury (chlorosis) along their tips and margins or along the veins [15]. Examples of xylem-translocated herbicides include photosynthetic inhibitors such as triazine, urea, and uracil herbicides. In this study it was found that root and shoot growth was decreased as the dose of herbicide Fusilade was decreased. The shoot inhibitors cause malformed and twisted tops with major injury at the tips and edges of the leaves. Looping of the leaves may occur because the base of the leaf may continue to grow while the leaf tips remain twisted together. Some herbicides cause these symptoms on both grasses and broadleaves. Alachlor and metolachlor herbicides cause similar injury symptoms on grasses.

Quantifying toxicity is a complex issue because a “toxic effect” will always depend on how you characterize it. Death is probably the most common endpoint for toxicity testing. Fusilade caused death of lentil seedlings after leaf treatment while it reduced plant development after seed treatment. We observed that lentil seedlings were more sensitive to leaf treatment than seed treatment.

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