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Araştırma Makalesi

Dikim Öncesi Herbisitler İle Domates Tarlalarında Yabancı Ot Mücadelesi

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Öz

Yabancı otlar; besin, su ve ışık için domates bitkisiyle rekabet ederek verimi azaltır. Ayrıca it üzümü, domuz pıtrağı ve horoz ibiği gibi yaygın geniş yapraklı otlar; böcek, hastalık ve virüslere konukçuluk etmektedir. Herbisitlerle yabancı ot kontrolü doğrudan veya dolaylı olarak ürünün yabancı otlarla ilgili rekabet kabiliyetini geliştirmeye odaklanmaktadır. Torpak herbisitlerinin yabancı ot ve domates (Alsancak F1) üzerindeki etkinliğini araştırmak için Siirt Üniversitesi Bahçe Bitkileri Bölümünün sebzecilik araştırma alanlarında Haziran-Ağustos 2016-17 arasında arazi çalışması yapılmıştır. Oxyfluorfen (480 g/l ai ha^{-1}) parsellerinde yabancı ot kontrol etkisi (WCE) 14. günde %86, 28. günde %79, 42. günde %65 ve 56. günde %52; yabancı ot endeksi (WI) %29 olarak tespit edildiğinden bu herbisit umut verici olarak tanımlanmıştır. Tüm yabancı ot kontrol süreçleri yabancı otların yoğunluğunu azaltmıştır. Bununla birlikte, clomazone (480 g/l EC 0.2 L ai ha^{-1}), fluometuron (500 g/l SC 2 L ai ha^{-1}) ve flurochloridone (250 g/l EC 2.5 L ai ha^{-1}) domates fidelerinde aşırı zararlanma oluşturmuştur. Clomazone, fluometuron ve flurochloridone yabancı otları değişik oranlarda kontrol etmelerine rağmen, aşırı ürün hasarı nedeniyle domateste kullanımlarının uygun olmadığı sonucuna varılmıştır. Oxyfluorfen (240 g/l EC 1 L a.i ha^{-1}) ve pendimetalin (450 g/l CS 3 L i ha^{-1}) nispeten ümitvar bulunmuş, ancak bu herbisitlerin uygulama zamanı ile toprak ve iklim koşullarına bağlı olarak fitotoksisite riskinin oluşabileceği göz ardı edilmemelidir.

Anahtar kelimeler: Oxyfluorfen, pendimethalin, ekim öncesi herbisitler, domates, yabancı ot kontrol etkinliği

Management of Weeds with Preplant Herbicides in Tomato Fields

Abstract

Weeds reduce yield competing with the tomato for nutrients, water, and light. Also, some common broadleaf weeds such as nightshade, cocklebur, and pigweed are hosts to bugs, disease, and viruses. Weed control with herbicides is focused directly or indirectly on improving the competitive ability of the crop with regard to the weeds. A field study was performed to investigate pre-plant and pre-emergence herbicide's efficacy on weeds and tomato cv. Alsancak F_1 at vegetable research fields of Department of Horticulture in Siirt University, in June-August 2016-17. Oxyfluorfen (480 g/l a.i ha^{-1}) active ingredient was identified as promising active ingredient because Weed Control Efficiency (WCE) was found 86% at 14 DAT, 79% at 28 DAT, 65% at 42 DAT, 56 DAT 52%, also Weed Index (WI) was detected 29%. All weed control processes have effectively reduced the density of weeds. However, clomazone (480 g/l EC 0.2 L a.i ha^{-1}), fluometuron (500 g/l SC 2 L a.i ha^{-1}), and flurochloridone (250 g/l EC 2.5 L a.i ha^{-1}) were extremely injured the tomatoes. Although these there active ingredient control weeds more effectively, it cannot be used for weed control in tomato fields because of excessive crop injury. Oxyfluorfen 240 g/l EC 1 L a.i ha^{-1} and pendimetalin 450 g/l CS 3 L i ha^{-1} were found relatively promising, these two can be used, but the risk of phytotoxicity depending on application period, climatic and soil conditions should not be ignored.

Key words: Oxyfluorfen, pendimethalin, preplant herbicides, tomatoes, weed control efficiency.

Introduction

Tomato (*Lycopersicon esculentum* L.) is one of the significant vegetables in agriculture because it is one of the most produced, consumed and traded agricultural crops in the world (Karipcin et al., 2016; TOB, 2021). It is one of the indispensable products in human nutrition and it has a wide range of usage areas such as frozen, canned, tomato paste, ketchup, pickles in food industry (FAOSTAT, 2021). Tomato has 10.06 B dollars as export market value (TRIDGE, 2021).

Regular monitoring of pests, diseases, weeds as well as climate and environmental factors is important for sustainable tomato production (Yardim et al., 1998; Karipcin et al., 2016). Broad-leaved weeds, especially in tomatoes, represent a serious problem and the competition with weeds is severe in the early stages (Giannopolitis, 2007). Poor competitive cultivars, wider row spacing, frequent watering and over-fertilization provide favorable conditions for increasing weed density, especially (Govindra Singh et al., 1984; Karipcin et al., 2016; Pala et al., 2017). Weeds contest with tomato plants for nutrients and water in the soil, light and canopy, thus reducing yields. Tomato yield loss due to weeds varies between 36 and 80% (Samant and Prusty, 2014). In addition, weeds can cause indirect damages such as by hosting pathogens and insects, by preventing harvest, and by infecting the crop (Capinera, 2015; Soares et al., 2018: Fidan et al., 2019).

In tomato cultivation, there are both limited (eg metribuzin and rimsulfuron) registered herbicides related to post-emergence weed control and there are some phytotoxicity problems about them in tomatoes. Therefore, pre-plant and pre-emergence herbicides come to the fore. There is still limited information on preventing the loss of tomato yield caused by weeds, so this research proposes to state the effectiveness of pre-plant active ingredients on weed management and tomatoes.

Material and Method

Research was performed twice in 2016-2017 at investigation area of Horticulture Department of Siirt University in Siirt, Turkey (situated at 37°57´46˝N latitude and 41°50´25˝E longitude). The soil analysis results; clay 33,85%, silt 51,67%, sand 11,01%, pH 7.45, lime 10.6%, loam with 1.53% organic matter. It was found that the trial area was suitable for tomato production. While widespread cultivation of Alsancak F1 tomato variety was twenty-eight days old, 40 x 90 cm planted in order of ridge and furrow, and the procedures were actualized in accordance with local agricultural techniques. It was paid attention to the presence of tomatoes in the test plots and weeds that were problematic in their fields and their homogenous distribution. Cultural operations (soil type, fertilization, tillage, cultivation, etc.) were homogeneous for all plots, which were carried out in accordance with local farming techniques. Instead of the experiment, it was recorded that the cultivated plant was tomato in the previous year. During the application rainfall, temperature, relative humidity and wind speed were taken from the nearest meteorological station. Because it was thought to have an impact on the effect and persistence of the herbicide, information about rainfall, temperature, weather and cloudy or sunny information was also recorded until a few days before application, but no excessive rainfall, late frost and hail. Spraying was carried out at windless and calm hours of the day.

The herbicides were performed for two years under the same ecological conditions. Field study was set up using Randomized Complete Block Design (RCBD) formed 7 treatments with 4 replications. T-1: clomazone 480 g/l EC 0.2 l a.i ha^{-1}, T-2: fluometuron 500 g/l SC 2 l a.i ha^{-1}, T-3: flurochloridone 250 g/l EC 2.5 l a.i ha^{-1}, T-4: oxyfluorfen 240 g/l EC 1 l a.i ha^{-1}, T-5: pendimethalin 450 g/l CS 3 l a.i ha^{-1}, T-6: check weedy, T-7: check weed free as pre emergence application before transplanting of tomatoes seedling. The active ingredient name and amount, formulation form and doses of the herbicides tested in this field study (Table 1).

Table 1. Treatments to weed control in tomatoes.

Apps*	Active ingredients of herbicides
T-1	Clomazone 480 g/l EC 2 ml a.i ha^{-1}
T-2	Fluometuron 500 g/l Sc 20 ml a.i ha^{-1}
T-3	Flurochloridone 250 g/l EC 25 ml a.i ha^{-1}
T-4	Oxyfluorfen 240 g/l EC 10 ml a.i ha^{-1}
T-5	Pendimethalin 450 g/l CS 30 ml a.i ha^{-1}
T-6	Weedy
T-7	Weed free

*Apps=Applications

All herbicide applications were performed and compared at the same time. The dimensions of the areas were 20 m^2 (4 m x 5 m). One meter between the blocks and 0.5-meter security strip between the plots. Two days before the transplantation of Alsancak F1 tomato seedlings, five herbicides were applied. Other weed characters were a weedy check and a weed-free control. Spraying was performed as recommended by the company (PPP, 2020). In order to ensure a homogeneous distribution throughout the experimental areas, applications were performed with a suitable machine. Herbicide treatments were performed using a Solax FT-900 Motorized backpack sprayer with multiple nozzles with a constant pressure (3 atm) flat fan nozzle. Factors that can directly affect biological efficiency (tank capacity 25, liquid draft capacity 8 (lt / min), fluid draft capacity set distance, engine model 1-33f / 1.36hp 2-stroke, engine power (kW / rpm) 1.0 / 6500, engine capacity (ml) 26, operating rope mode, working pressure (kg cm-2) 5-30, fuel capacity (1) 0.7, net weight (kg) 10,) were determined for the purpose. Spraying was carried out at once in the June 23 in two years. In the efficiency test, the dose was taken in decares and the amount of medicated water consumed for each plot was recorded as 300 l ha^{-1}. The amount of water to be used in a plot was determined by calibration before application to determine the appropriate herbicide norm. Pyraclostrobin against fungal diseases, metaflumizone against insects and calcium fertilizer caused by calcium deficiency were applied homogeneously to all plots.

WCE (Weed Control Efficiency, %) was evaluated using the dry weight calculation technique, ie on 14, 28, 42 and 56 DAT (Days After Transplanting), weed species were collected and dried at 72 °C for a period of 72 hours and weightiness was recorded. During this 2-year test period, after spraying, sampling was made from one square meter with the help of quadrate (Burril et al., 1976). WCE was counted on a dry weight based using the formula (*Eq. 1*) (Mani et al., 1976).

$$WCE(\%) = \frac{DWC-DWT}{DWC} \times 100 \text{ (Eq.1)}$$

The formula; WCE = Weed control efficiency (%), DWC: Dry weight of weeds in weedy check plot (g m^{-2}), DWT: Dry weight of weeds in treated plot (g m^{-2}). The data collected during the survey were analyzed by using frequencies and simple percentages.

The weed index, expressed as a percentage, expressed product loss because of the presence of weeds cross checked to weed status with the formula (*Eq. 1*) (Gill and Kumar, 1969).

$$WI\ (\%) = \frac{a-b}{a} \times 100 \text{ (Eq.2)}$$

The formula; WI = Weed index (%), a: Crop yield of the best treatment (kg), b: Crop yield of particular treatment for which index is compared (kg).

Table 2. Weed species founded in the experimental plots of tomatoes.

Weed types	Families	Scientific names	Common names
Broadleaves	Amaranthaceae	*Amaranthus retroflexus* L.	Redroot pigweed
	Asteraceae	*Xanthium strumarium L.*	Cocklebur
	Boraginaceae	*Heliotropium europaeum* L.	Heliotrope
	Euphorbiaceae	*Euphorbia prostrata* Aiton	Spurge
	Polygonaceae	*Polygonum convolvulus L.*	Black bindweed
	Portulacaceae	*Portulaca oleracea L.*	Purslane
	Solanaceae	*Solanum nigrum L.*	Nightshade
	Zygophyllaceae	*Tribulus terrestris L.*	Puncturevine
Grasses	Poaceae	*Cynodon dactylon* (L.) Pers	Bermuda grass
	Poaceae	*Echinochloa crus-galli* (L.) P. Beauv	Barnyard grass
	Poaceae	*Setaria verticillata* (L.) P.B	Bristly foxtail
	Poaceae	*Sorghum halepense* (L.) Pers.	Johnson grass

The visual Crop Injury (CI, %) was evaluated at 3, 5, 10 and 20 Days After Transplanting (DAT) using the measure of 0-100%, where zero is no crop injury and one hundred is plant death (Frans et al., 1986). In order to calculate tomato yield, tomato fruits from five square meters were collected from each plot, weighed, and then tomatoes yield was expressed on a per hectare basis. The yield was estimated according to the plant and fruit count. Statistical analysis of the data obtained was subjected to ANOVA conducted by JMP 5.0.1 The significance of differences between mean values was tested by LSMeans Differences Tukey HSD test values at a probability (P <0.05).

Results and Discussion

The difference between visual predictions of weed entry controls in herbicide treatments was observed in both years. The calculations were made by taking the average. The results and discussions obtained from this study are summarized in the tables below. Eight broad-leaved weeds and four grass species were found in the test area (Table 2). Sırma et al. (2001) observed *Amaranthus retroflexus* L., *Portulaca oleracea L., and Solanum nigrum L. as broadleaved weeds; Cynodon dactylon* (L.) Pers, *Echinochloa crus-galli* (L.) P. Beauv, and P.B*, Sorghum halepense* (L.) Pers. similar to our findings*,* grass frequently. Hillger et al (2006) noticed that *Echinochloa crus-galli* (L.) which is from the grass weeds seen in traditional experiment is problem in organic tomato fields. WCE showed the change in weed dry weight of weed control plots compared to plots where weed check. WCE value was found to decrease when the harvest time approached (Table 3).

Table 3. Weed management parameters of the five pre-plant herbicides in tomatoes.

Treatments	Weed Control Efficiency (%) in DAT**								Weed Index (%)
	14		28		42		56		
	H-Dose	F-Dose	H-Dose	F-Dose	H-Dose	F-Dose	H-Dose	F-Dose	
T-1	77[bc*]	92[b]	69[bcd]	85[b]	55[c]	74[b]	36[cd]	54[d]	92[a]
T-2	81[b]	94[b]	72[b]	87[b]	65[b]	76[b]	47[b]	69[b]	86[b]
T-3	73[cd]	86[c]	65[d]	79[c]	51[cd]	65[c]	35[cd]	52[d]	96[a]
T-4	71[d]	86[c]	66[cd]	79[c]	49[d]	65[c]	32[d]	52[d]	29[e]
T-5	78[b]	92[b]	70[bc]	86[b]	63[b]	75[b]	39[c]	64[c]	51[d]
T-6	0[e]	0[d]	0[e]	0[d]	0[e]	0[d]	0[e]	0[e]	76[c]
T-7	98[a]	98[a]	99[a]	99[a]	100[a]	96[a]	100[a]	97[a]	0[f]

*Levels not linked by the same letter are notably dissimilar in the same column (Alpha = 0.050, Q = 3.3044).
**DAT: Day after treatments, H-Dose: Half dose, F-Dose: Full dose

WCE (%) is decrease in dry material of weed plants in crosscheck to weedy. The efficacy of herbicide can be measured by values of WCE. The greater the values, the higher the efficacy of herbicides to the weeds. At 14, 28, 42 and 56 DAT, the treatment T-7 (weed free hand weeding, almost 100% control enabled) recorded greatest weed control efficiency followed by T-2 (fluometuron 500 g/l SC 2 l a.i ha^{-1}) and T-5 (pendimethalin 450 g/l CS 3 l a.i ha^{-1}). This might because of lowest weed density and dry weight recorded in the plots. It means better efficacy and longer durability to control weeds by application of oxyfluorfen and pendimethalin herbicides preemergence. The change in percentage of activity may be due to the herbicide tolerance of weeds or the development of some herbicide-resistant weeds. Sajjapongse et al. (1983) were reported oxyfluorfen effectively suppressed broadleaves. The efficacy of herbicides was evaluated based on weed index values. Minimum values were recorded in the T-4 (oxyfluorfen 240 g/l EC 10 ml a.i ha^{-1}), came after T-5 (pendimethalin 450 g/l CS 3 l a.i ha^{-1}). This could be due to maximum yield recorded in T-4 (oxyfluorfen 240 g/l EC 1 l a.i ha^{-1}) following the weedy check (T-7). It might be due to poor yield recorded in T-1 (clomazone 480 g/l EC 0.2 l a.i ha^{-1}) and T-2 (fluometuron 500 g/l SC 2 l a.i ha^{-1}) and plots because of extreme phytotoxicity of Imazethapyr. Hatat et al. (1994) in conformity with this recorded Oxyfluorfen outcomes. Crop injury rating and crop yield were given in Table 4.

Table 4. Crop injury and yield parameters by pre- emergence herbicides in tomato cv. Alsancak F₁.

Treatments	**Crop injury (%) in DAT****								**Fruit Yield (t ha^{-1})**
	3		**5**		**10**		**20**		
	H-Dose	**F-Dose**	**H-Dose**	**F-Dose**	**H-Dose**	**F-Dose**	**H-Dose**	**F-Dose**	
T-1	28^{a*}	36^{c}	39^{a}	44^{b}	38^{a}	47^{c}	34^{b}	51^{b}	4de
T-2	19^{b}	78^{a}	32^{b}	88^{a}	37^{a}	91^{a}	48^{a}	89^{a}	2^{e}
T-3	12^{c}	49^{b}	23^{c}	42^{b}	23^{b}	53^{b}	28^{c}	46^{c}	7de
T-4	5^{d}	17^{e}	11^{e}	26^{d}	9^{c}	29^{e}	13^{e}	27^{d}	36^{b}
T-5	23^{b}	28^{d}	17^{d}	37^{c}	21^{b}	38^{d}	22^{d}	43^{c}	25^{c}
T-6	0^{e}	0^{f}	0^{f}	0^{e}	0^{d}	0^{f}	0^{f}	0^{e}	9^{d}
T-7	0^{e}	0^{f}	0^{f}	0^{e}	0^{d}	0^{f}	0^{f}	0^{e}	51^{a}

*Levels not linked by the same letter are notably dissimilar in the same column (Alpha = 0.050, Q = 3.3044).
**DAT: Day after treatments, H-Dose: Half dose, F-Dose: Full dose

Phytotoxicity values of tomato plants 3, 5, 10 and 20 days after pre-plant herbicides were compared; on the 3rd day, it was determined that phytotoxicity started to progress and reached the most severe value on the 10th day of the transplanted tomatoes seedlings (Figure 1-5). Sajjapongse et al. (1983) were noticed oxyfluorfen at 1.0 kg ha^{-1}, supplied encouraging outcomes and raised product by 95 percent, respectively, over the untreated check, phytotoxicity was severe, and product from the oxyfluorfen spraying was the least as the result of serious injury at the preliminary growing state. T-4 (oxyfluorfen 240 g/l EC 1 l a.i ha^{-1}) and T-5 (pendimethalin 450 g/l CS 3 l a.i ha^{-1}) weed management practices gave higher yield of tomatoes per ha over T-7 (weedy check). T-2 (fluometuron 500 g/l SC 2 l a.i ha^{-1}) was injury to the tomatoes the lowest production was recorded in this application.

Figure 1. Tomato injured 10 DAT (clomazone)

Figure 2. Tomato injured 10 DAT (fluometuron)

Figure 3. Tomato injured 10 DAT (flurochloridone)

Figure 4. Tomato injured 10 DAT (oxyfluorfen)

Figure 5. Tomato injured 10 DAT (pendimethalin)

Conclusions

The difference between visual predictions of weed entry controls in herbicide treatments was observed in both years. The calculations were made by taking the average. The results and discussions obtained from this study are summarized in the tables below. Eight broad-leaved weeds and four grass species were found in the test area (Table 2).

A study conducted by Sırma et al. (2001) *Amaranthus retroflexus* L., *Portulaca oleracea L., and Solanum nigrum L. as broadleaved weeds; Cynodon dactylon* (L.) Pers, *Echinochloa crus-galli* (L.) P. Beauv, and P.B*, Sorghum halepense* (L.) Pers. as grass frequently observed similar to our findings. Hillger et al (2006) noticed that *Echinochloa crus-galli* (L.) which is from the grass weed species seen in our traditional field tomato production experiment is mayor problem in organic tomato fields. WCE showed the change in weed dry weight of weed control plots compared to plots where weed check. WCE value was found to decrease when the harvest time approached (Table 3).

WCE (%) is decrease in dry material of weed plants in crosscheck to weedy. The efficacy of herbicide can be measured by values of WCE. The greater the values, the higher the efficacy of herbicides to the weeds. At 14, 28, 42 and 56 DAT, the treatment T-7 (weed free hand weeding, almost 100% control enabled) recorded greatest weed control efficiency followed by T-2 (fluometuron 500 g/l SC 2 l a.i ha^{-1}) and T-5 (pendimethalin 450 g/l CS 3 l a.i ha^{-1}). This might because of lowest weed density and dry weight recorded in the plots. It means better efficacy and longer durability to control weeds by application of oxyfluorfen and pendimethalin herbicides prior to emergence in tomato fields. The change in percentage of activity may be due to the herbicide tolerance of weed species or the development of some herbicide-resistant weed species. Sajjapongse et al. (1983) were reported oxyfluorfen effectively suppressed broadleaf weeds. The efficacy of herbicides was evaluated based on weed index values. Minimum values were recorded in the T-4 (oxyfluorfen 240 g/l EC 10 ml a.i ha^{-1}), came after T-5 (pendimethalin 450 g/l CS 3 l a.i ha^{-1}). This could be due to maximum yield recorded in T-4 (oxyfluorfen 240 g/l EC 1 l a.i ha^{-1}) following the weedy check (T-7). It might be due to poor yield recorded in T-1 (clomazone 480 g/l EC

0.2 l a.i ha^{-1}) and T-2 (fluometuron 500 g/l SC 2 l a.i ha^{-1}) and plots because of extreme phytotoxicity of Imazethapyr to the tomato crop. Hatat et al. (1994) in conformity with this recorded Oxyfluorfen outcomes. Crop injury rating and crop yield were given in Table 4.

Phytotoxicity values of tomato plants 3, 5, 10 and 20 days after pre-plant herbicides were compared; on the 3rd day, it was determined that phytotoxicity started to progress and reached the most severe value on the 10th day of the transplanted tomatoes seedlings (Figure 1-5). Sajjapongse et al. (1983) were noticed oxyfluorfen at 1.0 kg ha^{-1}, supplied encouraging outcomes and raised product by 95 percent, respectively, over the untreated check, phytotoxicity was severe, and product from the oxyfluorfen spraying was the least as the result of serious injury at the preliminary growing state. T-4 (oxyfluorfen 240 g/l EC 1 l a.i ha^{-1}) and T-5 (pendimethalin 450 g/l CS 3 l a.i ha^{-1}) weed management practices gave higher yield of tomatoes per ha over T-7 (weedy check). T-2 (fluometuron 500 g/l SC 2 l a.i ha^{-1}) was injury to the tomatoes the lowest production was recorded in this application.

Active ingredients in tomatoes registered metribuzin and rimsulfuron herbicides are available in Turkey. However, these herbicides cannot provide a tomato production area cleaned from weeds. Clomazone is used in sunflower, canola and paddy; fluometuron is used cotton; flurochloridone is used in sunflowers, carrots, chickpeas and potatoes; oxyfluorfen is used in pears, sunflowers, cauliflower, citrus and onions; pendimethalin is used in sunflower, beans, carrots, corn, cotton, onions and tobacco crops in our country are registered herbicides against grass and broadleaved weeds. As can be seen, these 5 herbicides are still not registered for use in tomato fields. In tomato production areas, existing herbicide applications cannot produce the expected results, and due to labor shortage and timely accessibility problems in hand picking and hoeing, using these alternative herbicides together with cultural practices can be a practical solution for an economically efficient and effective herb management. Herbicides should be taken to prevent them from being dragged into the tomato crop, or pendimethalin 450 g/l CS 3 l a.i ha^{-1} may be applied in these cases if they develop technologies to prevent contact. It was concluded that the active ingredient oxyfluorfen 240 g/l EC 1 l a.i ha^{-1} was promising for management of weeds in tomato fields in point of WCE, crop tolerance and crop production. It was concluded that studies on the miscibility and biological efficacy of this herbicide and surfactant, safener and other herbicides are needed. It has been found that it is important to carry out research in which the biological and biotechnical control methods, which are prominent in the recent periods, are integrated into the physical and mechanical control and other cultural measures in which the chemical control alone is insufficient.

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