ARTICLE INFO
Article history:
Received 6 April 2020
Accepted 30 September 2020
Available online 2 January 2021

Keywords:
Correlation
Seed emergence
Seed shattering

ABSTRACT- A field study was conducted to determine the influences of six mulch materials (organic and inorganic), including black plastic, transparent plastic, wheat straw, peat moss, coco peat, and sawdust, and besides, metribuzin on the vegetative and reproductive growth cycles of two weed species in a tomato field using a randomized complete block design with three replications at the Research Station of the Agricultural School, Shiraz University, Shiraz, Iran. According to the results of the analysis of variance, all evaluated traits of both weed species, and also tomato, were significantly influenced by treatments at p< 0.01. The longest and shortest time of redroot pigweed (Amaranthus retroflexus L.) emergence were recorded under the plastic mulch treatment at 28 days after transplanting (DAT) and organic mulches as well as metribuzin at 21 DAT, respectively. Plastic mulches deferred the time of lamb's quarters (Chenopodium album L.) emergence more than organic mulches up to 28.0%. Additionally, the longest time of lamb's quarters emergence was observed with coco peat at 29 DAT and the shortest time of its emergence was recorded under the application of plastic and sawdust mulches at 23.3 DAT. Results showed that, the highest marketable tomato yield (up to 19.2 kg m⁻²) was assessed in covered plots with plastic mulch, while the lowest marketable yield was detected by 3.02 kg m⁻² in the plots under the application of the sawdust. In general, results demonstrated that the plastic mulches, particularly the black plastic sheet, could be reliable alternatives for metribuzin to control weed infestations in tomato fields.

INTRODUCTION

In recent years, the application of non-chemical weed management methods has been increased to reduce the utilization of synthetic herbicides. Environmental concerns and herbicide resistance could be some main reasons why non-chemical weed control approaches have been attracting more nowadays (Alebrahim et al., 2017; Mohammadi, 2012; KhodamKahangi et al., 2014; Zangoueinejad et al. 2019a, b, c, d). Although herbicide-tolerant/resistant crops have been enhanced the productivity in agricultural production systems, there are serious issues regarding the developing cost of these kinds of crops, and besides, social concerns regarding their safety for consumers as well as environment. Therefore, scientists are required to seek some practical alternatives for weed chemical practices worldwide (Fagliari et al., 2005; Marple et al., 2007; Lovelace et al., 2007, Lovelace et al., 2009; Zangoueinejad et al., 2016; Zangoueinejad et al., 2018).

The application of non-living mulches is one of the non-chemical weed management practices to diminish weed infestations in organic agricultural systems. There is a variety of non-chemical weed management practices that are used in organic agricultural systems of which non-living mulches is one. Non-living mulches act as physical barriers to block some resources such as sunlight that weed depends on for germination, growth, and development (Read, 2013; Green et al., 2003; Scarascia-Mugnozza et al., 2006; Cirujeda et al., 2012; Bond and Grundy, 2001; Suojala, 2003). Also, mulches make it difficult for weed species to early establish and compete with crops, due to a delayed emergence time (Rask and Andreasen, 2007).

Rice (Oryza sativa L.) straw, barley (Hordeum vulgare L.) straw, maize (Zea mays L.) residue, absinth wormwood (Artemisia absinthium), black biodegradable plastic, and brown paper were compared with black polyethylene mulch and some herbicide options in terms of their effects on the weed infestations in tomato field during 2005-2007 (Anzalone et al., 2010). In 2005, the least percentage of the weed cover was statistically recorded in treated plots with paper, polyethylene, and biodegradable plastic mulches which were up to 14.3, 28.4, and 31.3%, respectively. However, paper by indicating 3.1 and 0.9% weed cover represented the lowest weed cover in 2006 and 2007, respectively. Moreover, paper reduced the total weed dry biomass up...
to 94.7, 74.7, and 94.9% compared to herbicide treatments in 2005 (rimsulfuron), 2006 (rimsulfuron + metribuzin), and 2007 (rimsulfuron + metribuzin), respectively (Anzalone et al., 2010). In general, it was concluded that paper, biodegradable plastic, and rice straw are potential alternatives for black polyethylene mulch and herbicides (Anzalone et al., 2010).

The weed density and dry biomass were evaluated under application of the black, white/black, gray, infrared transmitting brown, infrared transmitting green, and white plastic mulches under field condition in 2001 and 2002 (Ngouajio and Ernest, 2004). The white plastic mulch showed the highest weed density up to approximately 39.6 and 155.9 seedlings m⁻² in 2001 and 2002, respectively (Ngouajio and Ernest, 2004).

In another study, the effects of clear, black, and seven colored mulches were investigated in California organic and conventional strawberry production systems to assess their ability in diminishing the weed invasions. The recorded weed germination percentages were 46.0, 19.0, 27.0, 23.0, 32.0, 13.0, 22.0, and 28.0% in treated plots by clear, blue, red, brown, yellow, green, white, and black plastic mulch, respectively. Finally, the highest weed control percentage was observed in black plastic mulch up to 100.0%, while it was by 99.4 and 98.7% in treated plots with green and brown plastic mulches, respectively (Johnson and Fennimore, 2005).

The aim of current study was to compare the effects of non-living (organic and inorganic) mulches and metribuzin on vegetative and reproductive properties of *Amaranthus retroflexus* and *Chenopodium album*. Also, the influence of the mentioned treatments was examined on the marketable tomato yield.

**MATERIALS AND METHODS**

A field experiment was conducted in 2016 to compare the effect of six types of non-living mulches (black plastic, transparent plastic, wheat straw, peat moss, coco peat, and sawdust) with metribuzin using a randomized complete block design (RCBD) with three replications. The experiment was run at the Research Station of the School of Agriculture, Shiraz University (35° 52'E, 40° 29'N, altitude 1810 m a. s. l), Shiraz, Iran. No weed control and a weed-free treatment were included.

Land preparation, including plowing, diking, ridging was done, and also, fertigation was performed using 166 kg ha⁻¹ of a synthetic fertilizer containing 20% (w/w) N, P₂O₅, and K₂O. Plots were irrigated twice a week by a drip irrigation system. Each plot consisted of four 3 m long rows spaced 50 cm apart. Twenty-four tomato (cv. CH) seedlings (six-week-old) were transplanted into each plot on June 30, 2018. This tomato variety is an early ripening, dwarf and high-yielding variety that produces round and firm fruits. The fruit of this variety is very durable on the market, and it was resistant to root rot (*Verticillium wilt*).

The treatments consisted of four organic non-living mulches, including wheat straw, sawdust, coco peat, and peat moss so that applied at 8, 7, 6, 6 cm thickness, respectively, and two inorganic mulches, inclusive of black and clear plastic mulches with a thickness of 15 and 20 µm, respectively. Metribuzin was applied at the rate of 0.75 kg ha⁻¹, at five weeks after transplanting. Tomatoes were harvested thirteen weeks after transplanting to determine the marketable yield (kg m⁻²). The firm and free of any visual damage tomatoes were defined as marketable tomato yield.

The most abundant weed species in the field were redroot pigweed (*Amaranthus retroflexus*) and lamb's quarters (*Chenopodium album*). The weed density (WD), weed dry weight (WDW), time of weed emergence (TWE), time of weed flowering (TWF), time of weed seed shattering (TWSS) were measured for both weed species. The appearance of the plumule was taken as the time of emergence. The field was visited once a week from the time of the tomato seedlings transplanting until the harvesting time. The number of weeds was counted in four randomly fixed 0.25 m × 0.25 m quadrats in each plot, and then expressed as the number of weeds m⁻². All weed seedlings were carefully uprooted by hand, stored in polythene bags, and dried at 72°C for 48 h. The dried weed seedlings were weighed to calculate WDW.

Data was tested to evaluate the normality using plotting QQ [quantile-quantile] plots for residuals in JMP v. 13 (SAS Institute, SAS Campus Drive, Cary, NC 27513). All data were subjected to ANOVA using GLM SAS 9.4 (SAS Institute, Cary, NC, USA) and means were separated using Tukey's test at 5% level. The drawing of graphs was carried out using Excel 2010.

**RESULTS AND DISCUSSION**

**Time of Weed Emergence**

The results showed that TWE was influenced by treatments (Table 1). Regarding redroot pigweed, the longest TWE was recorded in plastic mulch at 28 DAT, while the organic mulches and metribuzin were less effective to delay TWE (21 DAT). In contrast, the lamb's quarters seed germinated at 29 DAT in treated plots by coco peat. In other words, this raw material indicated the most performance to postpone the lamb's quarters seed germination. Clear plastic and sawdust showed the least effect on the lamb's quarters weed emergence time so that it was recorded at 23.3 DAT (Table 2). Jodaugiene et al. (2006) reported that various organic mulches reduced weed germination. Moreover, it was revealed that black plastic mulch inhibited the germination of annual bluegrass (*Poa annua* L.), common chickweed (*Stellaria media* L.), corn spurry (*Spergularia arvensis* L.), and Persian speedwell (* Veronica persica* L.) approximately up to 53.6 and 28.0% under greenhouse and field condition, respectively (Johnson and Fennimore, 2005).

**Time of Weed Flowering**

The effect of different treatments on TWF was significant (P < 0.01) (Table 1). The flowering time of redroot pigweed was delayed more by metribuzin (86.3 DAT) than by any of other the treatments. The redroot pigweed flowering time was at 49.0 DAT after the application of peat moss and wheat straw, as the least
effective treatments (Table 2). Furthermore, metribuzin was the most effective treatment to delay the lamb's quarters flowering time, since it was observed at 88.7 DAT. Besides, the shortest interval between the transplanting date and flowering time for lamb's quarters was assessed under the utilization of wheat straw treatment at 42 DAT (Table 2).

**Time of Weed Seed Shattering**

The analysis of variance showed a significant effect of treatments ($P < 0.01$) on TWSS (Table 1). Remarkably, wheat straw delayed the redroot pigweed seed shattering until 77 DAT, while metribuzin prevented its seed shattering by 135.3 DAT. No statistical significant difference was observed between two plastic mulches, and also, among all four organic mulches (Table 2). Plastic mulches were significantly more effective than the organic mulches to prevent the lamb's quarters seed shattering. The longest and shortest time of its seed shattering was recognized after the usage of metribuzin and organic mulches at 126 and 77.0 DAT, respectively. Plastic mulches were significantly less effective than metribuzin to postpone the lamb's quarters seed shattering time (Table 2).

**Weed Density**

The treatments significantly affected ($P < 0.01$) WD (Table 1). Clear plastic, black plastic, and metribuzin reduced the redroot pigweed density up to 1.60, 3.45 and 5.02 seedling $m^{-2}$, which had no significant differences (Fig. 1).

Besides, the highest WD was recorded in peat moss (17.50 seedling $m^{-2}$) and coco peat (16.79 seedling $m^{-2}$). Generally, the organic mulches showed a lower impact than the plastic mulches as well as herbicide in lessening the redroot pigweed density (Fig. 1). Moreover, the lowest lamb's quarters density was discerned in the treated plots with clear plastic (1.37 seedling $m^{-2}$). Likewise, the lamb's quarters density was 3.3 and 4.6 seedling $m^{-2}$ in black plastic and metribuzin, respectively (Fig. 1). Meanwhile, the highest lamb's quarters density was recorded in coco peat (14.0 seedling $m^{-2}$) and peat moss (12.9 seedling $m^{-2}$) (Fig. 1).

Ashrafuzzaman et al. (2011) reported that the lowest WD (52.2 seedling $m^{-2}$) was detected after application of the black plastic mulch in chili processing. This mulch sheet significantly reduced the WD up to 56.1 and 70.9% more than blue and transparent plastic mulches, respectively. Also, Johnson and Fennimore (2005) suggested that the black plastic mulch controls weed abundance by approximately 100% in the strawberry farm; however, often the black plastic mulch does not warm the soil as same as clear plastic mulch. It was emphasized that the effect of the mulch color on the transmittance of the photosynthetically active light (PAR; 400 to 700 nm) through the mulch sheets is the key factor for germinating weed seeds. The recorded PAR value was 180.5, 61.1, 19.3, 10.9, 10.6, 10.2, 2.6, and 0.1 W nm$^{-2}$ m$^{-2}$ for clear, blue, red, brown, green, yellow, white/black, and black plastic mulches, respectively. Thus, black plastic passed lower the PAR quantity up to 99.9% compared with clear plastic mulch. In fact, the black plastic mulch diminishes weed infestations due to this fact that weed could not be able to grow in the absence of PAR (Olson, 2002; Teasdale and Mohler, 2000).

**Weed Dry Weight**

Clear plastic was the most effective mulch in reducing both redroot pigweed and lamb's quarters dry biomass which were up to 21.03 and 19.13 g $m^{-2}$, respectively (Fig. 1). Importantly, there was no statistically significant difference between the impact of black plastic, and besides, metribuzin on the both WDW compared to clear plastic. The redroot pigweed dry biomass was 23.6 and 24.1 g $m^{-2}$, respectively, in black plastic mulch and metribuzin. Additionally, it was 21.32 and 23.2 for lamb's quarters in treated plots with black plastic and metribuzin, respectively (Fig. 1). The highest redroot pigweed and lamb's quarters dry weights were up to 39.8 and 39.7 g $m^{-2}$, respectively, in peat moss. Ahmad et al. (2011) displayed that the recorded weed dry biomass in black plastic mulch was lower than those in transparent and blue plastic mulches which were up to 79.9 and 90.5%, respectively, in chili processing.

Rajabaliani et al. (2012) also demonstrated that the plastic mulches could reduce the weed biomass by 84–98%, so that silver/black plastic mulch decreased the total weed dry biomass up to 98.2%, as the best performance among all evaluated mulches.

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**Table 1**: Analysis of variance (ANOVA), degrees of freedom, and significance levels for some vegetative/reproductive traits of *A. retroflexus* and *C. album* and tomato marketable yield.

<table>
<thead>
<tr>
<th>Sources of variations</th>
<th>df</th>
<th>TWE</th>
<th>TWF</th>
<th>TWSS</th>
<th>WD</th>
<th>WDW</th>
<th>MTY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. retroflexus</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Block</td>
<td>2</td>
<td>5.44$^{**}$</td>
<td>7.25$^{**}$</td>
<td>12.70$^{**}$</td>
<td>5.69$^{**}$</td>
<td>0.72$^{**}$</td>
<td>-</td>
</tr>
<tr>
<td>Treatment</td>
<td>8</td>
<td>200.08$^{***}$</td>
<td>1514.00$^{**}$</td>
<td>3657.75$^{**}$</td>
<td>278.37$^{**}$</td>
<td>581.77$^{**}$</td>
<td>-</td>
</tr>
<tr>
<td>Error</td>
<td>16</td>
<td>5.44</td>
<td>5.21</td>
<td>10.66</td>
<td>2.87</td>
<td>13.96</td>
<td>-</td>
</tr>
<tr>
<td>CV</td>
<td></td>
<td>11.53</td>
<td>4.49</td>
<td>4.14</td>
<td>16.46</td>
<td>13.00</td>
<td>-</td>
</tr>
<tr>
<td><strong>C. album</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Block</td>
<td>2</td>
<td>23.59$^{**}$</td>
<td>12.70$^{**}$</td>
<td>7.25$^{**}$</td>
<td>1.81$^{**}$</td>
<td>3.70$^{**}$</td>
<td>-</td>
</tr>
<tr>
<td>Treatment</td>
<td>8</td>
<td>216.87$^{**}$</td>
<td>1557.56$^{**}$</td>
<td>3249.42$^{**}$</td>
<td>218.92$^{**}$</td>
<td>563.03$^{**}$</td>
<td>-</td>
</tr>
<tr>
<td>Error</td>
<td>16</td>
<td>33.80</td>
<td>14.74</td>
<td>9.30</td>
<td>2.80</td>
<td>17.98</td>
<td>-</td>
</tr>
<tr>
<td>CV</td>
<td></td>
<td>26.38</td>
<td>8.18</td>
<td>3.98</td>
<td>19.24</td>
<td>15.51</td>
<td>-</td>
</tr>
<tr>
<td><strong>Tomato</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Block</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.01$^{**}$</td>
<td>-</td>
</tr>
<tr>
<td>Treatment</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>88.41$^{**}$</td>
<td>-</td>
</tr>
<tr>
<td>Error</td>
<td>16</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.24</td>
<td>-</td>
</tr>
<tr>
<td>CV</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6.99</td>
<td>-</td>
</tr>
</tbody>
</table>

$^{**}$: Significant at $P < 0.01$ and ns refers to non-significant. TWE, TWF, TWSS, WD, and WDW refer to the time of weed emergence, time of weed flowering, time of weed seed shattering, weed density, and weed dry weight, respectively.
Table 2. Response of some vegetative/reproductive characteristics of *A. retroflexus* and *C. album* to different treatments at harvest time.

<table>
<thead>
<tr>
<th>Treatment</th>
<th><em>A. retroflexus</em> TWSS</th>
<th><em>C. album</em> TWSS</th>
<th><em>A. retroflexus</em> TWF</th>
<th><em>C. album</em> TWF</th>
<th><em>A. retroflexus</em> TWE</th>
<th><em>C. album</em> TWE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black plastic</td>
<td>28.00a</td>
<td>25.66a</td>
<td>56.00c</td>
<td>44.33c</td>
<td>86.33bc</td>
<td>91.00b</td>
</tr>
<tr>
<td>Peat moss</td>
<td>21.00b</td>
<td>25.66a</td>
<td>49.00d</td>
<td>44.33c</td>
<td>84.00bc</td>
<td>77.00c</td>
</tr>
<tr>
<td>weedy</td>
<td>21.00b</td>
<td>21.00a</td>
<td>49.00d</td>
<td>42.00c</td>
<td>72.33d</td>
<td>74.66c</td>
</tr>
<tr>
<td>Clear plastic</td>
<td>28.00a</td>
<td>23.33a</td>
<td>63.00b</td>
<td>56.00b</td>
<td>93.33b</td>
<td>88.66b</td>
</tr>
<tr>
<td>Sawdust</td>
<td>21.00b</td>
<td>23.33a</td>
<td>51.33cd</td>
<td>44.33c</td>
<td>81.66cd</td>
<td>77.00c</td>
</tr>
<tr>
<td>Metribuzin</td>
<td>21.00b</td>
<td>21.00b</td>
<td>86.33a</td>
<td>86.66a</td>
<td>135.33a</td>
<td>126.00a</td>
</tr>
<tr>
<td>Coco peat</td>
<td>21.00b</td>
<td>25.66a</td>
<td>53.66cd</td>
<td>51.33b</td>
<td>79.33cd</td>
<td>77.00c</td>
</tr>
<tr>
<td>Weed-free</td>
<td>0.00c</td>
<td>0.00b</td>
<td>0.00e</td>
<td>0.00d</td>
<td>0.00e</td>
<td>0.00d</td>
</tr>
<tr>
<td>Wheat straw</td>
<td>21.00b</td>
<td>21.00b</td>
<td>49.00d</td>
<td>42.00c</td>
<td>72.33d</td>
<td>77.00c</td>
</tr>
</tbody>
</table>

The quantities in each column for each weed species followed by the same letter are not significantly different (Tukey’s test 5%). TWSS, TWF, and TWE refer to the time of weed seed shattering, time of weed flowering, and time of weed emergence, respectively.

Fig. 1. Response of weed density (a) and (b) weed dry weight to different treatments at the harvest time (Tukey’s test 5%). The means followed by the same letter are not significantly different (Tukey’s test 5%). WD and WDW refer to weed density and weed dry weight, respectively.

In agreement, Grassbaugh et al. (2004) uncovered that the black plastic mulch resulted in a 66.7, 42.8, 63.6, and 83.3% reduction in the weed biomass compared to newspaper, wheat straw, bark mulches, and bareground, respectively. Moreover, Ngouajio and Ernest (2004) observed the lowest weed biomass (0-10 g m⁻²) in black plastic mulch when the light transmission was around 2%.

**Marketable Tomato Yield**

MTY was 19.2, 7.3, and 5.7 kg m⁻² in treated plots with black plastic mulch, clear plastic mulch, and metribuzin, respectively, which were significantly higher than those of the control plots (0.98 kg m⁻²) as well as organic mulches (Fig. 2). This suggests that MTY would be increased higher by using the plasticulture (Zegbe-
Dominguez et al., 2003, 2006). Garry et al. (2010) concluded that the highest marketable okra yield (15.4 t ha$^{-1}$) was obtained under the black plastic mulch compared to blue (13.5 t ha$^{-1}$), red (12.6 t ha$^{-1}$), silver (12.5 t ha$^{-1}$), and white (12.8 t ha$^{-1}$) plastic mulches. Meanwhile, Rajablariani et al. (2012) indicated that the application of the colored plastic mulch significantly increased the marketable tomato yield up to 24-65% compared to bare soil. Also, silver/black, black, and blue plastic mulches recorded 40.0, 38.0, and 35.0 t ha$^{-1}$ MTY, respectively, which had no significant differences. Besides, red and clear plastic mulches showed 32 and 31 t ha$^{-1}$ MTY, respectively.

The authors proposed that increasing in yield as well as the weed control level is probably associated with the conservation of moisture and improved microclimate in the above and under the soil surface. In other words, one of the benefits of the black plastic mulch is to enhance the soil temperature, which promotes the crop development (Hochmuth, 2008). Kumara and Dey (2011) reported higher root growth and nutrient uptake after the application of various mulching treatments, which resulted in significant yield rocket in strawberry. The maximum root length density (9.6 km m$^{-3}$) was found with black plastic, and followed by rye mulch (5.0 km m$^{-3}$), while the minimum growth was observed in control plots (3.2 km m$^{-3}$) under rainfed irrigation condition. Besides, the black plastic enhanced the N, P, and K uptake up to 14.2, 24.1, 20.7%, respectively, compared to hay mulch. Consequently, the berry yield was higher in the treated plots with black plastic mulch up to 33.3% than treated ones by hay mulch (Kumara and Dey, 2011).

![Fig. 2. Comparison of MTY under different treatments. The means followed by the same letter are not significantly different (Tukey’s test 5%). MTY refer to the marketable tomato yield.](image)

In support of the mentioned results, it was emphasized that the black polyethylene plastic mulch is the standard plastic mulch in vegetable production (Gordon et al., 2010). It was revealed that the black plastic altered the plant growing environment by increasing the soil temperature (Díaz-Pérez et al., 2000; Hanna et al., 2003) so that by utilizing this kind of mulch sheet the crop yield production would be improved significantly (Leib et al., 2002; Summers and Stapleton, 2002). More importantly, the harvest time could take place earlier after using the black plastic mulch (Ibarra et al., 2001; Brown and Channell-Butcher, 2001; Loughrin and Kasperbauer, 2002).

The Correlation Between Traits

According to the results, the redroot pigweed emergence time was correlated with TWF ($r = 0.80$, $p < 0.01$), and also, the TWSS ($r = 0.79$, $p < 0.05$).

Moreover, the positive correlation was observed between the redroot pigweed flowering time and TWSS ($r = 0.99$, $p < 0.01$) (Table 3). Also, the positive correlation was recorded between the time of redroot pigweed flowering and TWSS ($r = 0.99$, $p < 0.01$) (Table 3). Meanwhile, the significant correlation was distinguished between the redroot pigweed dry weight and its density ($r = 0.85$, $p < 0.01$) (Table 3).

Regarding lamb’s quarters, the time of weed emergence represented the positive correlation with TWF ($r = 0.78$, $p < 0.05$), TWSS ($r = 0.85$, $p < 0.01$), and weed dry weight ($r = 0.69$, $p < 0.05$). Likewise, the correlation was assessed between TWF and TWSS ($r = 0.97$, $p < 0.01$) (Table 4). Importantly, the weed density was related to the weed dry weight ($r = 0.83$, $p < 0.01$) (Table 4).

CONCLUSION

Overall, all treatments tested in this study, including six various mulches and metribuzin, controlled the density of lamb’s quarters better than that of redroot pigweed. Although the clear plastic lessened the density of both weed species more than all other treatments, it had no significant difference compared with the black plastic mulch as well as metribuzin. All treatments, except wheat straw and peat moss mulches, decreased the dry weight of lamb’s quarters more than that of redroot pigweed. Furthermore, the clear plastic mulch, black plastic mulch, and metribuzin had no significant
differences in diminishing the weed species dry weight. Taking everything into consideration, the positive effects of plastic mulches to increase MTY along with their remarkable role to suppress the vegetative and reproductive redroot pigweed and lamb’s quarters growth demonstrated that these mulches could be reliable alternatives, as the non-chemical weed control approaches, for the metribuzin in tomato production industry.

Table 3. Correlation coefficient (r) between the time of weed emergence, flowering, seed shattering, density, and dry weight of *A. retroflexus*.

<table>
<thead>
<tr>
<th></th>
<th>TWE</th>
<th>TWF</th>
<th>TWSS</th>
<th>WD</th>
<th>WDW</th>
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<td>TWE</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TWF</td>
<td>0.80**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TWSS</td>
<td>0.79*</td>
<td>0.99**</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WD</td>
<td>0.17**</td>
<td>0.09**</td>
<td>0.08**</td>
<td>1</td>
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<tr>
<td>WDW</td>
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<td>0.44**</td>
<td>0.45**</td>
<td>0.85**</td>
<td>1</td>
</tr>
</tbody>
</table>

* and **: Significant at P< 0.05 and 0.01, respectively, and also, ns refers to non-significant. TWE, TWF, TWSS, WD, and WDW refer to the time of weed emergence, time of weed flowering, time of weed seed shattering, weed density, and weed dry weight, respectively.

Table 4. Correlation coefficient (r) between the time of weed emergence, flowering, seed shattering, density, and dry weight of *C. album*.

<table>
<thead>
<tr>
<th></th>
<th>TWE</th>
<th>TWF</th>
<th>TWSS</th>
<th>WD</th>
<th>WDW</th>
</tr>
</thead>
<tbody>
<tr>
<td>TWE</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TWF</td>
<td>0.78*</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TWSS</td>
<td>0.85**</td>
<td>0.97**</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WD</td>
<td>0.30**</td>
<td>0.02**</td>
<td>0.10**</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>WDW</td>
<td>0.69**</td>
<td>0.33**</td>
<td>0.46**</td>
<td>0.83**</td>
<td>1</td>
</tr>
</tbody>
</table>

* and **: Significant at P< 0.05 and 0.01, respectively, and also, ns refers to non-significant. TWE, TWF, TWSS, WD, and WDW refer to the time of weed emergence, time of weed flowering, time of weed seed shattering, weed density, and weed dry weight, respectively.

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Zangoueinejad, R. (2019a). Study the mechanism(s) of tolerance to herbicides in selected tomato lines [Doctoral dissertation, University of Mohaghegh Ardabili, Ardabil, Iran. (In Persian)].


بررسی اثرات مالچه‌های غیرزنده و علف‌کش متربی‌زون بر علی-های تاج‌خروس و سلمه‌تره در مزرعه گوجه‌فرنگی

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چکیده- مطالعه‌ای به منظور تعیین اثرات نش نشگاه (ارگانیک و غیرارگانیک) و علف‌کش مارچوبین بر تعداد رشد ریشه و بزرگی علیفه‌های گروه‌های فرآیندیک در قابل طرح بلیک کامپل تصادفی با سه تکرار در ایستگاه تحقیقات دانشگاه کشاورزی دانشگاه شیراز انداخته شد. براساس نتایج تجزیه واریانس، میزان صفات ورودی‌های علیفه به علیفه‌سازی و همچنین گوجه‌فرنگی به طور مشکی دارای در صطح احتمال ۰/۰۵ نمودند. نتایج نشان داده که در میزان‌های تکرار مصرف علف‌کش‌های حلگر روز از انتقال گیاه‌های گیاه‌پروری ۶۰ روز به‌سوی انتقال گیاه‌های گیاه‌پروری ۲۱ روز از انتقال گیاه‌های گیاه‌پروری ۰/۲۰ کیلوگرم در مترمربع، کاهش معنی‌داری نشان دادند. نتایج نشان داده که در میزان‌های تکرار مصرف علف‌کش‌های حلگر روز از انتقال گیاه‌های گیاه‌پروری ۶۰ روز به‌سوی انتقال گیاه‌های گیاه‌پروری ۲۱ روز از انتقال گیاه‌های گیاه‌پروری ۰/۲۰ کیلوگرم در مترمربع، کاهش معنی‌داری نشان دادند. نتایج نشان داده که در میزان‌های تکرار مصرف علف‌کش‌های حلگر روز از انتقال گیاه‌های گیاه‌پروری ۶۰ روز به‌سوی انتقال گیاه‌های گیاه‌پروری ۲۱ روز از انتقال گیاه‌های گیاه‌پروری ۰/۲۰ کیلوگرم در مترمربع، کاهش معنی‌داری نشان دادند.

اطلاعات مقاله

تاریخچه مقاله:
تاریخ دریافت: ۱۳۹۹/۱/۱۸
تاریخ پذیرش: ۱۳۹۹/۸/۹
تاریخ دسترسی: ۱۳۹۹/۱۰/۱۳

واژه‌های کلیدی:
همتیکی
ظهور بذر
ریزش بذر