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Evaluation of the White and Red Cabbage Efficiency as Pre-Plants in the Control of Johnsongrass in Tomato Cultivation

Muhammad El Sekran**[1] and Tamer Ustuner [1]

[1] PhD in Weed Sciences, Department of Plant protection, Agriculture Faculty, Kahramanmaras Sutcu Imam University, Kahramanmaras, Turkey.

[2]Associate Professor, Department of Plant protection, Agriculture Faculty, Kahramanmaras Sutcu Imam University, Kahramanmaras, Turkey.

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ABSTRACT

The experiments were conducted in tomato fields and greenhouses in 2019 and 2020 to evaluate the allelopathic effects of white and red cabbage with and without mulch to control johnsongrass. The effect of these methods on Johnsongrass life cycle durations, density, length, fresh and dry weight of stems, and rhizomes were determined. Also, the effect of the treatments on the quantity and quality of tomato production was evaluated. In the greenhouse experiment, tomato seedlings were planted with johnsongrass seeds and rhizomes and were treated with plants' aqueous extracts at concentrations of 2, 5, and 10%. The germination and dry weight reduction percentage of johnsongrass were calculated. Isothiocyanates contained in white and red cabbage were identified by GC-MS. White and red cabbage with mulch reduced johnsongrass density by 69.1 and 65.9%, while the dry weight of stems and rhizomes were reduced by 78.2-74.2% and 71.3-68.0%, respectively. White and red cabbage with mulch treatments achieved an increase in tomato production by 632.1 and 621.8%. According to GC-MS analysis, the predominant isothiocyanate in white cabbage was 3-(methylsulfinyl) propyl (23.43%) and 4-(methylsulfonyl)butyl (10.79%) in red cabbage. The results of these experiments confirm that both white and red cabbage have allelopathic potential that can be used in weed control.

Keywords: Allelopathic, cabbage, isothiocyanate, johnsongrass, mulch, weed control.

INTRODUCTION

Johnsongrass is an invasive perennial weed belonging to the Poaceae family, it can be propagated by seeds and rhizomes. It is widely spread in the Mediterranean region, both in agricultural lands and beyond (Davis, 1988; Yazlik and Uremis, 2019). Johnsongrass produces thousands of self-fertile seeds. It can form about 60-90 m of rhizomes in a year. Under suitable conditions, it can produce 18.1 tons/ha of rhizomes and 500 kg/ha of seeds in 4 months (McWhorter, 1981; Sandulescu et al., 2000). Johnsongrass causes yield loss between 57 and 88% in economically important agricultural products (Peerzada et al., 2017). It was reported that it causes serious yield losses in economically important plants such as soybean, corn, cotton, and tomato (Lolas and Coble, 1982; Uludag et al., 2007; Barroso et al., 2016; Ustuner et al., 2023). Although johnsongrass control is currently done with chemical herbicides that have advanced features, recording the herbicides' resistance and the harms of these

* Corresponding author.E-mail :asdr.ag198024@gmail.com

herbicides to the environment and human health requires investigation of alternative control methods for herbicides to achieve agricultural sustainability (Johnson and Norsworthy, 2014; Ustuner et al., 2020; Yazlik and Uremis, 2022).

Allelochemicals contained in some plants can be used to control weeds due to their high efficacy and environmental safety (Belz, 2007). The allelopathic potential of plants belonging to the Brassicaceae family (especially *Brassica* spp.) can be used for weed control. It was reported that *Brassica* sp. has toxic effects on weeds and can be an alternative to herbicides (Jafariehyazdi and Javidfar, 2011; Bangarwa et al., 2011; Elsekran et al., 2023). In a tomato field, *Brassica rapa* L., *B. juncea* L. Czer. and *Sinapis alba* L. were incorporated into the soil then polyethylene mulch was applied, these crops achieved control of johnsongrass by 46% and improved tomato crop quality and quantity (Bangarwa and Norsworthy, 2014). White cabbage extract was found to be effective at a 3% concentration on both alfalfa dodder (*Cuscuta approximata* Bab.) and alfalfa germination (Ozkan, 2014). Cabbage and cauliflower crops were effective against *Orobanche ramosa* L. when used as a pre-plant in tomato cultivation and reduced the density of *O. ramosa* by 87.7 and 93.8%, respectively (Demirkan, 2005). Fresh white cabbage at a concentration of 50% prevented seed germination of *Amaranthus retroflexus* L., *Chenopodium album* L., and *Solanum nigrum* at percentages between 34 and 95% (Kural and Ozkan, 2020).

Glucosinolates (GSLs) are secondary metabolite compounds produced by Brassicaceae plants. Although GSLs do not have toxic effects on weeds, hydrolysis product compounds, especially isothiocyanate (ITCs), have high biological activity that can be used in the control of weed species. ITCs are produced from the hydrolysis of GSLs by myrosinase activity and in pH-neutral conditions. Each ITC has a structure based on its precursor GSL, for example, benzyl-ITC results from benzyl-GSL hydrolysis (Rask et al., 2000; Jafariehyazdi and Javidfar, 2011).

This study aimed to determine the allelopathic effect of white and red cabbage as pre-plants with and without black polyethylene mulch to control johnsongrass and to detect the effect of these treatments on the quantity and quality of tomato yield under open field conditions. The greenhouse experiment was aimed to study the allelopathic effects at different concentrations of aqueous extracts of white and red cabbage on the germination and development of johnsongrass seeds and rhizomes.

Material and Method

Experiments Site and Design

The open field and greenhouse experiments were conducted at Kahramanmaras Sutcu Imam University in 2019 and 2020. The soil texture of the experimental area was clay loam, pH neutral (7.04), organic matter ratio of 3.32%, and potassium and phosphorus content relatively high. Plastic pots with an outer diameter of 21 cm, a height of 19 cm, and a base diameter of 12 cm, containing soil, sand, and peat in 1:1:1 ratios were used in the greenhouse experiment.

A field experiment was designed according to randomized complete block design (RCBD) with three replications. The dimensions of each plot were 2×5 m. The treatments of the experiment were white cabbage (WG), red cabbage (RG), white cabbage with mulch (WG+M), red cabbage with mulch (RG+M), black polyethylene (mulch), control 1 (Cnt1, without weeds), and control 2 (Cnt2, with johnsongrass).

The greenhouse experiment was set up in four replications twice in 2020 and 2021, according to the completely randomized plot design. White and red cabbage aqueous extracts were applied at different concentrations (2, 5, and 10%) against johnsongrass seeds and rhizomes, and only water was applied to the control plots. Rates of 20 seeds or 10 rhizomes with one tomato seedling were planted in the pots.

Experiments Materials and Procedure

Field Experiment

The cultivars used in this experiment were Yellow sarmalik for white cabbage, Mohrenkopf for cabbage, and

F1 Ege members for tomato. Seeds of these cultivars were obtained from the Teta-Tohumculuk-seed company in Turkey. The trial area was a natural population of johnsongrass so there was no need for infection. White and red cabbage seedlings were planted in January 2019 and 2020, then at the head formation stage the whole plants were incorporated into the soil using a disc plow (30 cm depth), at the same time, black polyethylene mulch was applied. The averages of dry biomass of white and red cabbage that was incorporated into the soil were 1.09 and 0.92 kg/m^2, respectively. Trial plots were prepared and tomato seedlings were planted, N.P.K (15, 15, 15) fertilizer at 500 kg/ha, and a drip irrigation system was applied. Tomato seedlings were planted with a spacing of 0.6 x 0.4 m.

Greenhouse Experiment

Johnsongrass seeds and rhizomes were obtained from the field trial area in the autumn of 2019 and 2020. The rhizomes were washed with water and placed in nylon bags in the fridge at 4 °C. The seeds were treated with 1% NaOCl solution for 15 minutes, then dried, and placed in bags. Johnsongrass seeds dormancy was broken by mechanical method (AL Sakran et al., 2020). While rhizomes were cut 1 cm in length and each part contained one bud. The samples of white and red cabbage (whole plant) were taken from the field in the head formation stage and dried for a month in room conditions (25±2 ºC), then they were ground. Concentrations of 10% white and red cabbage were prepared by adding 100g of plant powder to 1 liter of water (other concentrations were prepared in the same way). They were left at room conditions for 24 hours and were manually agitated frequently. The extracts were filtered with raw cloth and filter papers (50×50 cm). Then 300 ml of the extracts were added to the pots and the same amount of water to the control pots that contained one tomato seedling and 20 seeds or 10 rhizome parts. The experiment continued for forty days in greenhouse conditions.

Effect of White and Red Cabbage Pre-Planting on Johnsongrass Growth and Tomato Yield in the Field Experiment

To calculate the life cycle duration of johnsongrass under the influence of the treatments, the date of germination and maturity of the seeds (when they turn brown) were recorded.

The density and length of johnsongrass stems were calculated by determination of 1m^2 in each plot randomly and counting the stems and the length of 30 stems was measured by a 2 m length ruler. Then the percentage reduction of johnsongrass density and length in each treatment were set over control 2 using formula (1):

The parameter reduction percentage over control =

$$[1-(D_x/D_0)]\times 100 \qquad (1)$$

Where, Dx is the parameter of johnsongrass in treatment x, and D0 is the parameter of johnsongrass in control 2.

After the last tomato harvest, all the johnsongrass biomass was cut at a soil surface level of 1m^2 per plot and the fresh biomass was recorded. Then the samples were dried in room conditions for 3 weeks and the dry biomass was determined. The fresh and dry weight reduction percentages of johnsongrass biomass above the soil surface were also calculated using the formula (1).

Using a hand hoe, 1 m^2 was excavated at a depth of 50 cm in each plot and the rhizomes were taken and cleaned from the soil (Fig. 1). The fresh weight of the rhizomes was determined, then they were dried under room conditions for a month, and the dry weight was calculated.

Figuar. 1. Collecting rhizomes from treatments

The johnsongrass fresh and dry weight reduction percentages of rhizomes were also calculated using the formula (1).

The total tomato yield was determined for all harvesting operations. Then, the increased percentage in tomato production was calculated over control 2 using formula (2):

$$\text{Tomato yield increase } \% = [(Y_x/Y_0) - 1] \times 100 \qquad (2)$$

Where Y_x is tomato yield in treatment x, Y_0 is tomato yield in control 2.

The tomato yield loss percentage caused by johnsongrass was also determined under the effect of each control method over control 1 by formula (3):

$$\text{Tomato yield loss } \% = [(x-y)/x] \times 100 \qquad (3)$$

Where, x tomato yield in control 1, y tomato yield in treatment.

Tomato samples (2 kg) from each treatment were taken and analyzed at Kahramanmaras University Sutsu Imam Research and Application Development Center (**USKİM**) for total sugar, protein, potassium, moisture percentage, and color depth.

Effect of White and Red Cabbage Extracts on Johnsongrass Germination and Growth in The Greenhouse Experiment

To calculate the johnsongrass germination percentage, the germinated seeds and rhizomes were counted and the germination percentage was calculated according to the formula (4) in all treatments at the end of the experiment.

$$\text{Germination } \% = (\text{number of germinated seeds or rhizomes / total number of seeds or rhizomes}) \times 100 \qquad (4)$$

The percentages of germination reduction for seeds and rhizomes were calculated using formula (1).

The stems of johnsongrass were dried at room conditions, and then the dry weight was determined. Using the formula (1), the percentage of reduction in dry weight of johnsongrass stems was determined.

Tomato plant height was measured with a ruler (100 cm) 40 days after planting tomato seedlings. Then the percentage of increase in the length of the tomato seedlings over control was calculated using formula (2).

Determination of Isothiocyanates

Samples were prepared according to the method explained by Vaughn and Berhow (2005); and Elsekran et al. (2023), and they were prepared from plant powder obtained from the field and sent to Ataturk University, Department of Chemistry, for analysis by GC-MS to determine ITCs percentages.

Data Analysis

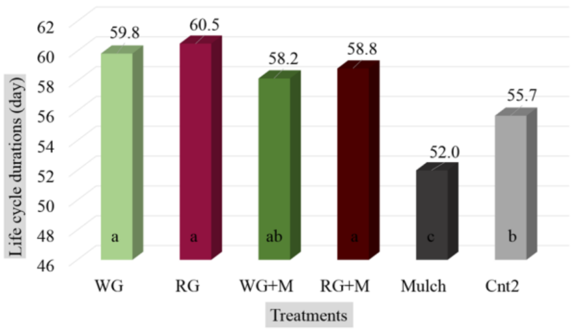
In the field experiment, the data of the control methods were subjected to a multivariate analysis of variance (MANOVA) test. Differences between values means were grouped using Duncan's multiple ranges (DMRT) tests ($P<0.05$). Greenhouse experiment data were subjected to a t-test for differences between plants. ANOVA and Duncan's test were used between the mean of concentrations ($P<0.01$). The data obtained from the two years of the experiments were compared using the t-test. According to this analysis, there was no significant difference between the data of the years of experiments, so the average data was analyzed. Data were analyzed statistically by IBM SPSS Statistics (version 24).

Results and Discussion

Field Experiment

Effect of White and Red Cabbage Pre-Planting on Johnsongrass Life Cycle Duration

The life cycle duration of johnsongrass from germination to seed ripening under the effect of treatments ranged between 52 days in the mulch treatment and 60.5 days in the RG treatment. All treatments had a significant effect on increasing the duration of the weed life cycle (Fig. 2). The reason may be due to the allelopathic effect of white and red cabbage. Bangarwa et al. (2011) reported that the emergence of weeds was delayed by 2 days with the effect of allelopathic plants. However, in the mulch treatment, the life cycle of johnsongrass was shorter than in control 2, which may be due to the increase in temperature under the mulch.



Figuar. 2 Effect of different treatments on johnsongrass life cycle duration (day). Similar letter(s) in the bars express no significant difference ($p<0.05$). WG, white cabbage; RG, red cabbage; WG+M, white cabbage with black polyethylene mulch; RG+M, red cabbage with black polyethylene mulch; Mulch, black polyethylene mulch; Cnt2 control with johnsongrass.

Effect of White and Red Cabbage Pre-Planting on Johnsongrass Biomass Characteristics

Table (1) shows the effect of different treatments on the biomarkers of johnsongrass. The highest percentage of reduction of johnsongrass density was achieved in the WG+M treatment (69.1%), while the lowest percentage of reduction was observed in the RG (40.2%), and mulch (42.9) treatments (Table 1). Some radish cultivars reduced johnsongrass density by 64.1% and 68.3% due to their ITCs contents (Sisek 2020), while black polyethylene reduced the density of johnsongrass by 28.3-56.1% (Hidayat et al., 2013; Mehmood et al., 2018).

The percentage of stem length reduction ranged between 25.7 and 31.9%. No significant difference was observed between the effect of different treatments on the stem length of johnsongrass.

WG+M and RG+M treatments achieved the best biomass reduction of johnsongrass both above and under the soil. The reduction of the fresh and dry weight of stems was 79.7-76.5% and 78.2-74.2% respectively in these treatments. Bangarwa and Norsworthy (2014) reported cover crops (*B. rapa*, *B. juncea*, and *S. alba*) with mulch decreased johnsongrass stem weight by 34-46% in the tomato field. The difference between these and our results is attributed to using different species of plants as pre-plants, which differ in their ITCs (%) content. In addition, it is known that the production of ITC compounds from GSL compounds occurs at a neutral pH (Wermter et al., 2020). The pH in our experiment was 7.04, while in Bangarwa and Norsworthy`s (2014) study was 6.1 so the averages of ITCs released in the soil may be different. Our results showed that the effect of WG+M and RG+M treatments can be an alternative to the use of chemical herbicides. Ustuner *et al.* (2023) reported that fluazifop-P-butyl (1.5 L/ha) reduced johnsongrass stems fresh weight by %68.8 and the fresh weight of rhizomes by 42.4%.

Table 1: Effect of white and red cabbage treatments on reduction of the biomarkers of johnsongrass (%).

Treat.	Density (%)	Stems length (%)	Stems fresh weight (%)	Stems dry weight (%)	Rhizomes fresh weight (%)	Rhizomes dry weight (%)
WG	43.3^{b}	31.9	63.3^{c}	61.9^{b}	46.7^{c}	46.5^{c}
RG	40.2^{b}	31.0	61.8^{c}	58.7^{b}	40.3^{d}	40.8^{c}
WG+M	69.1^{a}	30.6	79.7^{a}	78.2^{a}	71.5^{b}	71.3^{b}
RG+M	65.0^{a}	29.1	76.5^{b}	74.2^{a}	68.2^{b}	68.0^{b}
Mulch	42.9^{b}	25.7	58.3^{d}	57.7^{b}	8.2^{e}	7.3^{d}
Cnt1	-	-	-	-	93.8^{a}	94.4^{a}
F value	43.014	1.764	104.424	21.372	354.433	87.928

Sig.	0.000	0.483	0.000	0.000	0.000	0.000

Similar letter(s) in the same column express that no significant difference (p<0.05). WG, white cabbage; RG, red cabbage; WG+M, white cabbage with black polyethylene mulch; RG+M, red cabbage with black polyethylene mulch; Mulch, black polyethylene mulch; Cnt1 control without weeds.

The effect of mulch treatment on the fresh and dry weight of rhizomes was weak (8.2 and 7.3%, respectively). The growth of rhizomes was observed on the surface of the soil under the mulch (Fig. 3). Although the growth of johnsongrass was prevented throughout the season in control 1, it did not exhaust all the rhizomes in the soil, and survival of about 5% may be sufficient with the seed bank to cause a high density of johnsongrass in the following season.

Figure. 3 Growth and spread of rhizomes in the form of a net on the surface of the soil under the mulch

The use of mulch with white and red cabbage pre-planting increased its effect, and this may be due to the synergy of the allelopathic with the effect of mulch in inhibiting the growth of johnsongrass and retaining allelochemicals in the soil for a longer period. Bangarwa et al. (2011) found that growing Brassica species with mulch increases the effectiveness of ITCs in weed control.

Effect of White and Red Cabbage Pre-Planting on Tomato Yield and Quality

The highest increase in tomato production compared to the control with johnsongrass was achieved in WG+M, and RG+M treatments and they were 632.1 and 621.8%, respectively (Table 2). The lowest percentages of increase were in the treatments of RG and WG. Removing the effect of weeds in control 1 achieved an increase in tomato production by 872.3%.

Non-control of johnsongrass leads to high losses in the tomato yield, reaching 89.7% in control 2. The best treatments for reducing this loss were WG+M (24.5%) and RG+M (25.7%), while the least efficient treatments were RG (46.2) and WG (44.9) (Table 2).

Table 2. Effect of white and red cabbage treatments on tomato yield (%)

Treat.	Increase in tomato yield (%)	Reduction in tomato yield(%)
WG	435.3^{d}	44.9^{c}
RG	422.2^{d}	46.2^{c}
WG+M	632.1^{b}	24.5^{a}
RG+M	621.8^{b}	25.7^{a}
Mulch	475.6^{c}	40.7^{b}
Cnt1	872.3^{a}	-
Cnt2	-	89.7
F value	349.502	965.008
Sig.	0.000	0.000

Similar letter(s) in the same column express that no significant difference (p<0.05). WG, white cabbage; RG, red cabbage; WG+M, white cabbage with black polyethylene mulch; RG+M, red cabbage with black polyethylene mulch; Mulch, black polyethylene mulch; Cnt1, without weeds; Cnt2 control with johnsongrass.

Concerning the content of the nutrient substances and coloristic properties of tomato fruits, treatment WG + mulch and RG + mulch gave the best outcomes, while mulch treatment was the most minimal containing of the nutrient substances (Table 3).

Table 3. Effect of treatments on tomato fruits nutrients content and coloristic properties

Treat.	Total sugar (%)	Protein (%)	Potassium (g/kg)	Total humidity (%)	Color depth (%)		
					L*	a*	b*
WG	4.71	4.71	28.74	95.20	38.13	32.41	29.23

RG	4.66	4.50	28.65	95.30	38.71	31.50	28.33
WG+M	5.53	5.20	28.72	95.10	37.41	32.64	28.30
RG+M	5.42	5.04	28.88	95.30	38.62	33.11	27.10
Mulch	4.58	5.10	28.51	94.80	37.11	33.23	28.10
Cnt1	5.4	5.32	29.76	94.60	37.21	33.80	27.92
Cnt2	2.01	4.03	28.22	95.30	39.26	30.18	25.47

*D65 was created using daylight and a perspective of 10 degrees. Tomato fruit color depth indicators were L (brightness; ↑ white, ↓ black), a (↑red; ↓ green), and b (↑ yellow; ↓ blue), and were measured on the cheek area (Kaymak et al., 2010). WG, white cabbage; RG, red cabbage; WG+M, white cabbage with black polyethylene mulch; RG+M, red cabbage with black polyethylene mulch; Mulch, black polyethylene mulch; Cnt1, without weeds; Cnt2 control with johnsongrass.

The highest quantity and best quality of tomato crop were obtained from the most efficient treatments (WG+M and RG+M) of johnsongrass control. This means that these methods are unlikely to hurt the growth and development of tomato plants.

Greenhouse Experiment

Effect of White and Red Cabbage Extracts on Johnsongrass Germination

White cabbage (WG) had a higher effect on the germination reduction of johnsongrass seeds and rhizomes than red cabbage (RG) at a concentration of 10%, while the effect of the two plant extracts was statistically similar at concentrations 2 and 5%. A stimulating effect on seed germination was observed in RG treatment at 2% concentration (6.4%), also the effect of WG at this concentration was weak in reducing the percentage of germination. The percentage of germination reduction for both seeds and rhizomes increased with increasing concentration of two plant extracts (Table 4), as indicated by several studies (AL Sakran et al., 2021; Almhemed et al., 2021).

Table 4. Effect of white and red cabbage extracts on johnsongrass germination reduction (%)

Treat.	Seed					Rhizome				
	2%	5%	10%	F value	Sig	2%	5%	10%	F value	Sig
WG	0.8^{a}_{3}	16.8^{a}_{2}	58.4^{a}_{1}	97.125	0.000	16.1^{a}_{2}	20.0^{a}_{2}	48.8^{a}_{1}	9.617	0.006
RG	-6.4^{a}_{3}	13.6^{a}_{2}	36.0^{b}_{1}	38.816	0.000	6.5^{a}_{2}	10.4^{a}_{2}	40.4^{b}_{1}	14.752	0.001
t value	2.635	0.577	4.583			1.340	1.083	3.926		
Sig.	0.039	0.585	0.006			0.231	0.320	0.009		

Values followed by the same letter(s) in the same column and values followed by the same number(s) in the same row are not significantly different from each other ($p < 0.01$). WG, white cabbage; RG, red cabbage.

The effects of WG and RG extracts at a concentration of 10% were high in reducing the dry mass of johnsongrass stems that were emergent from seeds (89.7-66.1%) and rhizomes (87.2-82.8%). There was no significant difference between the effect of the two plant extracts at different concentrations, except for 10% on the seeds (Table 5).

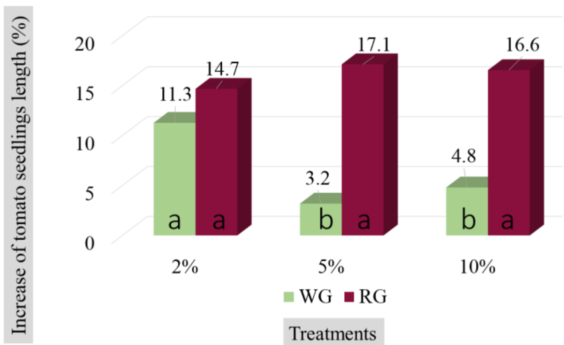
Table 5. Effect of white and red cabbage extracts on johnsongrass stems dry weight reduction (%)

Treat.	Seed					Rhizome				
	2%	5%	10%	F value	Sig	2%	5%	10%	F value	Sig
WG	-4.6^{a}_{3}	22.7^{a}_{2}	89.7^{a}_{1}	155.68	0.000	22.4^{a}_{3}	42.7^{a}_{2}	87.2^{a}_{1}	73.475	0.000

RG	-16.7^{a}_{3}	16.6^{a}_{2}	66.1^{b}_{1}	100.11	0.000	18.3^{a}_{3}	36.6^{a}_{2}	82.8^{a}_{1}	74.663	0.000
t value	1.198	0.574	6.015			2.271	0.945	1.553		
Sig.	0.276	0.587	0.000			0.064	0.381	0.171		

Values followed by the same letter(s) in the same column and values followed by the same number(s) in the same row are not significantly different from each other ($p < 0.01$). WG, white cabbage; RG, red cabbage.

The extracts of both plants increased the average length of tomato seedlings compared to the control. The percentage of increase under the influence of WG extracts ranged between 3.2-11.3%, and it was in the RG treatments between 14.7-16.6% (Fig. 4).



Figuar. 4 Effect of plant extracts on tomato seedling length (%). Similar letter(s) in the bars express no significant difference ($p<0.01$). WG, white cabbage; RG, red cabbage.

According to GC-MS analysis, the total percentage of 4 ITCs that were detected in white cabbage was 32.57%, and the predominant ITC was 3-(methylsulfinyl)propyl. As for the red cabbage, it was found that there were 6 ITCs with a total percentage of 26.87%, and the dominant ITC was 4-(methylsulfonyl)butyl (Table 6). Although the effect of the two plants was similar in affecting the biomarkers of johnsongrass in general, white cabbage was more effective on some of these biomarkers. The reason may be due to the difference in the total percentage of ITCs, as well as the type and quantity of the dominant ITS in both plants. According to Wermter et al. (2020), the most dominant ITCs in white and red cabbage were 3-(methylsulfinyl)propyl, 4-(methylsulfinyl)butyl, 3-butenyl and [(S)-2-hydroxy-3-butenyl].

Table 6. ITCs in white and red cabbage and their averages as a percentage of the total substances present in the extracts according to GC-MS analysis (%)

White cabbage		Red cabbage	
ITCs	Percentage (%)	ITCs	Percentage (%)
2-Propenyl	4.42	3-Butenyl	2.76
3-(Methylsulfinyl)propyl	23.43	[(S)-2-Hydroxy-3-butenyl]	4.62
4-(Methylsulfonyl)butyl	2.79	2-Propenyl	4.16
Indol-3-ylmethyl	1.93	3-(Methylsulfinyl)propyl	2.61
		4-(Methylsulfonyl)butyl	10.79
		Indol-3-ylmethyl	1.93
Total	32.57		26.87

Despite the difference in species and percentage of ITC compounds in the two plants, their effect on several biomarkers of johnsongrass growth was similar. The reason may be that the different types of ITCs work synergistically in suppressing the germination and growth of weeds, also Norsworthy and Meehan (2005) indicated that aliphatic ITCs are more efficient in controlling weeds than aromatic ITCs. Elsekran (2022) reported that the effectiveness of ITCs in inhibiting the germination and growth of weeds is related to several factors; the total percentage of ITCs in the plant, the dominant type of ITCs and its percentage, and the type (aliphatic, aromatic, and indole) and the number of other ITCs.

Conclusion

The results of these experiments showed that white and red cabbage have an allelopathic effect, suppressing the germination and development of johnsongrass at different averages. The effect of these plants also increased when used with mulch. It was found through greenhouse experiments that increasing the concentration of the extracts and therefore the ITC concentrations led to the suppression of the germination and growth of johnsongrass at higher averages. Therefore, the use of species and cultivars of cruciferous plants with a higher content of ITCs, in addition to finding a way to increase the permanence period of ITCs in the soil, may lead to the control of johnsongrass with a higher efficiency that reaches levels achieved by herbicides (90%) according to Karkanis et al. (2022) and may surpass them.

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تقييم كفاءة الملفوف الأبيض والأحمر كنباتات مسبقة في السيطرة على الحليان في زراعة الطماطم

محمد السكران[1]*، تامر أُستنر[2]

[1]دكتوراه في علوم الاعشاب، قسم وقاية النبات- كلية الزراعة- جامعة كهرمانمرعش سوتجو إمام، تركيا.

[2]أستاذ مساعد، قسم وقاية النبات، كلية الزراعة- جامعة كهرمانمرعش سوتجو إمام، تركيا.

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ملخص

تم تنفيذ التجارب في حقول البندورة والدفيئات الزراعية في عامي 2019 و 2020 لتقييم التأثيرات الاليلوباثية للملفوف الأبيض والأحمر مع وبدون غطاء لمكافحة الحليان. تم تحديد تأثيرات هذه الطرق على دورة حياة الحليان، كثافته، طوله، والوزن الطازج والجاف للسيقان والريزومات. كما تم تقييم تأثير المعاملات على كمية ونوعية محصول البندورة. في تجارب الدفيئة، زرعت شتلات البندورة مع بذور وريزومات الحليان وعوملت بالمستخلصات المائية للنباتات بتركيزات2، 5، و 10%. تم حساب نسبة تخفيض الإنبات والوزن الجاف للحليان. كما تم تحديد الايزوثيوسيانات الموجودة في الملفوف الأبيض والأحمر بواسطة GC-MS. قلل الملفوف الأبيض والأحمر مع الغطاء من كثافة الحليان بمعدل 69.1 و 65.9% ، بينما انخفض الوزن الجاف للسيقان والجذور بنسبة 78.2-74.2% و 71.3-68.0% على التوالي. حققت معاملات الملفوف الأبيض والأحمر مع الغطاء زيادة في إنتاج البندورة بنسبة 632.1 و 621.8%. بين تحليل GC-MS أن الإيزوثيوسيانات السائدة في الملفوف الأبيض هي 3- (ميثيل سلفينيل) بروبيل (23.43%) و 4- (ميثيل سلفونيل) بيوتيل (10.79%) في الملفوف الأحمر. تؤكد نتائج هذه التجارب أن لكلا الملفوف الأبيض والأحمر إمكانات أليلوباثية يمكن استخدامها في مكافحة الحشائش.

الكلمات الدالة: ملفوف، الحليان، اليلوباثي، ايزوثيوسيانات، تغطية، مكافحة الحشائش

* الباحث المعتمد للمراسلة: asdr.ag198024@gmail.com