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(Original Article)

Effect of Certain Herbicides and Mulching Treatments on Associated Weeds and Grapevine Productivity, with Estimation the Residues of these Herbicides

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Abstract

This study was conducted at Sids Horticultural Research Farm. Beni-Suef Governorate in Egypt in the 2021, 2022, and 2023 seasons to assess the effectiveness of eight treatments on Flame seedless grapevine productivity and weed control. At harvest, chemical herbicidal residues in the berries were monitored using high-performance liquid chromatography (HPLC) in a randomized complete block design with four replicates. The findings indicate that Roundup should be applied at 2.5 L/fed, Starane at 0.2 L/fed, black polyethylene mulch, and rice straw mulch. Additionally, Egyptian clover treatments provided 88.1–97.4% weed control. Furthermore, these treatments greatly enhanced grapevine growth and fruiting. The amount of herbicide residues was less than the maximum permitted limit. An analysis of the economics revealed that, growing grapevines with Egyptian clover, black plastic mulch, or rice straw mulch is a viable endeavor for producers. Mulching and Egyptian clover are both excellent, non-toxic options for controlling weeds in vineyards.

Keywords: *Hand hoeing, Herbicide, Mulching, Residues, Vineyards, Weed control*

Introduction

One of the most significant fruit crops for both domestic consumption and export is grapes. Mangoes and citrus are the next two most popular fruit crops, followed by grapes. The cultivated grapevine area rose quickly, reaching approximately 186404 feddans, especially in the reclaimed lands, and the total annual production reached 1790734 tons, according to (M.A.L.R. 2022).

The primary obstacle to grape production, after nutrition control, is thought to be the weed threat. When compared to cultivated plant species, weeds have a higher potential for propagation and are more adapted to harsh settings. Weeds reduce crop yield by competing with plants for resources like light, water, and nutrients from the soil. Certain plant pests and diseases are harboured and transmitted by weeds. One of the most crucial cultural techniques influencing vine growth in vineyard establishment is weed management (Wisler and Norris, 2005). Weeds have a negative impact on grape crops throughout the first three to four

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years of growth, and if they are not controlled, growth is slowed and yield is decreased. Furthermore, the output was lowered by roughly 29.1–45.2% because to the prevalent weeds in grape. Weeds' allopathic impacts on fruit trees could be the cause of this decline in vine growth and output (Abouziena and Haggag 2016). The conventional methods of controlling weeds are cultivation and hand hoeing. They are typically used to eradicate weeds from every field, which is the most costly method but causes excellent weed control (Ibrahim, 1981).

In a range of cropping systems, cover crops can help with weed control, organic matter increase, soil structure improvement, soil erosion reduction, and improved water penetration and retention. In comparison to weedy control, it reduced weed biomass in grapevines by 27% to 95% (Moursy *et al*., 2015). Colored mulches have a variety of effects on crop output, including changes to the crop's canopy, photosynthesis, and/or plant morphogenesis, all of which raise yields both early and overall. Controlling the microclimate surrounding plants by soil mulching has numerous benefits, all of which are directly related to the material's thermal characteristics, including its ability to reflect, absorb, or transmit solar radiation (Moursy *et al*., 2015 and Awal *et al*., 2016). Herbicides, mulching with black polyethylene, mulching with straw, and hoeing were among the weed control techniques used. When grapevines were rounded up to 4 L/fed, weed growth was considerably suppressed in comparison to the unweeded control group, and grapevine fruiting was enhanced (Hegazi, 2000).

Applied Roundup (glyphosate isopropyl amine salt 360 g/l) at 3 and 4 l/ha combined with mechanical weeding followed by manual weeding, gave control of weeds rates being over 90%. Also, application of glyphosate 42% SL alone or in combination BCSAA10717 (2%) + glyphosate 42% SC (85.0+1700 g/ha) treatment in Thompson vineyard significantly reduced the dry weight in all weeds both at 15 and 30 days after treatments compared to unweeded control. It also significantly increased bunch weight and grape yield per hectare with decreasing competition between grape vine and weeds (Ramteke *et al*., 2013). Using glyphosate at (6 L./ha), cover crop leguminous (clover) and wheat straw mulching reduction of weed population minimizing the competition of grapevine for water reserves (Susaj *et al*., 2013).). The total number of weeds per square meter in the grape vineyard was significantly lower after applying oxyfluorfen at (1.0 L/ha.) pre-emergent sprayed directly on the soil surface, glyphosate at (2.62 L/ha.), and tank mix post-emergent of oxyfluorfen at (1.0 L/ha.) + glyphosate at (2.62 L/ha.) than the weedy check at 30, 60, 90 and 120 days after spraying. Productivity per hectare raised dramatically (Nooli *et al*., 2020). Oxyfluorfen has a half-life of roughly 30 to 40 days, and a variety of factors, including grape textures, climatic circumstances, and herbicide characteristics, can affect how herbicides degrade on grape surfaces. On grapes, oxyfluorfen and trifluralin broke down more quickly than oxadiazon and norflurazon (Ying and Williams, 1999). Trifuralin and oxyfluorfen were not found in grape leftovers four days after treatment; trifuralin's half-life in surface soil was 27 days, while oxyfluorfen's dissipation half-life was the longest, at 119 days (Ying and Williams, 2000). The primary glyphosate breakdown process was the high soil adsorption of aminomethyl phosphonic acid

(AMPA). These factors have led to the prevalent perception that glyphosate is a pesticide that is safe for the environment (Duke and Powls, 2008). The maximum residue limits (MRL) for glyphosate in grapes and wine grapes have been determined by the European Commission at 0.5 mg/kg and 0.1 mg/kg, respectively. Despite the fact that the levels of glyphosate residues in wine samples were significantly lower than the MRL in grapes (Tot *et al*., 2019). Applied at a rate of one liter per fed., following a 21-day pre-sowing period during which weeds have germinated, and a two-week interval following the application of herbicide. When herbicide residues were chemically monitored using HPLC in both soil and seed coriander, they were found to be below the maximum residue level, meaning that, in the event of exportation, there was no risk of herbicide contamination in the seed or oil production (Hassanein *et al*., 2020).

The primary objectives of this investigation were to investigate the effects of various herbicides and mulching techniques on weed control, grapevine fruiting, and pesticide residues in berries.

Materials and Methods

This study was conducted on Flame Seedless grapevines cultivated in a vineyard at Sids Horticultural Research Station (28°54'25.7"N 30°56'59.8"E), Beni-Suef Governorate, Horticultural Research Institute, Agricultural Research Centre, Egypt, in the years 2021, 2022, and 2023. Grapevines, planted 2 by 3 meters apart, are uniformly vigorous and 10 years old. For this investigation, sixty-four healthy vines with approximate shapes, sizes, and productivity were chosen.

Ten fruiting canes six eyes each, plus six renewal spurs two eyes each, resulted in 72 retained eyes on each vine after the vines were cane pruned using the Spanish Poron system. After berry set, the crop burden on all plants was reduced to 25 clusters per vine. Using four repetitions, each including two vines, the experiment was set up in a randomized complete block design (RCBD). There was a water table more than two meters below the surface of the clay-textured, well-drained orchard soil. Nile water was used for the surface irrigation system. Normal horticultural procedures were followed.

The experiment included the following eight weed control treatments arranged as follows:

1-Untreated (control).

2-Hand hoeing twice at 20 and 40 days after the first irrigation.

3-Roundup 48 % WSC (glyphosate-isopropyl ammonium) at 2.5 L/fed. applied as post- emergence from the first irrigation.

4-Starane 20 % EC (Fluroxypyr) at 0.2 L/fed followed by Roundup 48% WSC at 2.5 L/fed. applied as post-emergence at 21 and 30 days from the first irrigation respectively.

5-Goal 4F 48 % SC (Oxyflurofen) at 1L./fed. applied as post- emergence twice 30 and 60 days from the first irrigation.

6-Black polyethylene mulch by plastic sheets thickness 100 micron covering soil surface with up to 60 days from the first irrigation.

7-Organic Mulches with rice straw mulch at 10 tons/fed., by 25 kg/plot covering (20 cm high from soil surface) up to 60 days the first irrigation.

8-Legume cover crop (Egyptian clover) (*Triflium alexandrium)*

November's first week saw the planting of cover crops, while March's first week saw the application of polyethylene mulches and rice straw. When applying herbicide glyphosate isopropyl ammonium, the "Knapsack hand sprayer CP3 20 liter" with one nozzle (TK1) calibrated to deliver a spray volume of 125 L/fed is used. For the application of oxyflurofen and fluroxypyr, the "Knapsack hand sprayer CP3 20 liter" is outfitted with an even flat fan and one nozzle. Chemical grape and mechanism of action of herbicides are show in Table (1).

The following parameters were determined during the studded three season

1-The effect on weed control

At 120 days following the application of treatments, weeds were manually removed from one square meter, selected at random from each plot, and identified by species using Täckholm-Vivi (1974) and their fresh weight as gram per square were divided into the following groups:

1-Annual grassy weeds (g/m^2).

2-Annual broad-leaved weeds (g/m^2).

3-Total of annual weeds (g/m^2).

4-Perennial grassy weeds (g/m^2).

5-Total of annual and perennial weeds (g/m^2).

Percent reduction (%R) in weed fresh weight was calculated according to (Jaiswal and Grewal, 1991) as follow:

$$\% R = (B- A/B) x100$$

Where, A = fresh weight of weeds in sq. meter treated plots. B = fresh weight of weeds in sq. meter untreated control plots.

2- The effect on grapevines

a-Measurements of vegetative growth characters

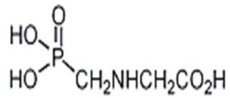
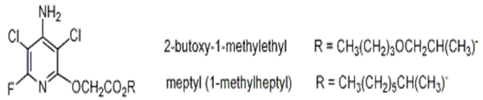
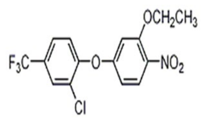
Ten current season, s shoots /vine were chosen and labeled to measuring the following growth aspects

1-Average leaf area (cm^2) was calculated as the following formula

Leaf area (cm^2) = 0.588 (L×W), where L = length of leaf blade and W = width of leaf blade according to Montero *et al.* (2000) and the leaf area (cm^2) was calculated.

2-Weight of pruning wood was recorded immediately after winter pruning and was expressed as kg/vine.

Table 1. Common, trade, chemical name, chemical group and mechanism of action of herbicides

*Trade name	Common name	Chemical group	Chemical name	Chemical formula	**Mechanism of action
Round up	Glyphosate-isopropyl ammonium.	Glycines	N-(phosphonomethyl) glycine		Enolpyruvyl Shikimate-Phosphate (EPSP) Synthase inhibitors: Inhibit 5-enolpyruvylshikimate-3-phosphate (EPSP) synthase which produces EPSP from shikimate-3-phosphate and phosphoenolpyruvate in the shikimic acid pathway.
Starane	Fluroxypyr	Pyridinecarboxylic acid	4-amino-3,5-dichloro-6-fluoro-2-pyridyloxyacetic acid		herbicides with a similar mode of action to endogenous auxin (IAA), while the exact mechanism is unclear. It is unknown which precise cellular or molecular binding site is important for the way in which auxin-mimicking herbicides and IAA work. However, these substances seem to primarily impact nucleic acid metabolism and cell wall flexibility.
Goal 4F	Oxyfluorfen	Diphenyl ether	2-chloro-1-(3-ethoxy-4-nitrophenoxy) -4-(trifluoromethyl) benzene		Protoporphyrinogen Oxidase (PPG Oxidase or Protox) Inhibitors: these substances seem to prevent the oxidation of protoporphyrinogen IX (PPGIX) to protoporphyrin IX (PPIX). Protoporphyrinogen Oxidase (PPG Oxidase or Protox) is an enzyme involved in the manufacture of heme and chlorophyll.

* Pesticides manual (2012)

** Weed Science Society of America (WSSA) classification

3-Pigment content determination in leaves Chlorophylls and carotenoids were determined using the method described by (Mackinney, 1941 and Von Wetstein, 1957).

b-Yield and its components

At harvest time (1st week of July), the clusters were harvested and the yield components were recorded as follows: cluster and yield

-Average cluster weight (g).

c-Yield weight (kg/vine)

d-Physical and chemical characteristics

After harvesting a sample for each replicate, the following berry physical and chemical attributes were ascertained: From each vine, two clusters were chosen at random, and the following traits were identified.

1-Average berry weight (g)

2-Total soluble solids percentage (TSS %): by using a hand refractometer.

3-Total acidity percentage (T.A. %): was estimated as tartaric according to A.O.A.C. (2000).

4-Total anthocyanins, according to Onayemi *et al.* (2006) Results are expressed as mg anthocyanins equivalents/100 g of fresh samples.

5-Reducing sugars (%): in juice determined according to A.O.A.O. (2000).

e-Herbicides residues determination in (grape berries) at harvest:

Herbicide residues for Round up (Glyphosate-isopropyl ammonium), Starane (fluroxypyr**)** and Goal 4F (oxyfluorfen) in grape berries were determined in Central Laboratory for Pesticides, Agriculture Research Center, Dokki, Giza, Egypt.

Extraction and clean-up of grape samples

The effectiveness of herbicide extraction from grape samples is determined by homogenizing the samples using an organic solvent and a blender or homogenizer (Pareja *et al*., 2011). The amount of solvent employed, the number of extraction cycles, and the herbicide's solubility in the solvents all affect how effective solvent extraction is (Jin *et al*., 2012). A Waring blender was used to grind and blend grape samples until they resembled pulp. A Buchner funnel was used to filter the 200 ml of methanol/acetone (4/1) combination after it had been manually shaken for an hour using an electrical shaker. The grape samples had been combined. The combined solvent blends were lowered in pressure and dried using a rotary evaporator. In tiny vials containing five milliliters of methanol, the residue was quantitatively transferred. In order to preserve the vials at 15 o C until cleanup, the solvent was evaporated until they were completely dry. Three combinations for the elution of diethyl ether in petroleum ether (6.15.50%) were used to clean up the florisil column, as stated by (A.O.A.C. 2000). The conditions for the HPLC determination of residues, which were dissolved in one milliliter of methanol, are listed in Table (2).

Table 2. The conditions for the determination of Roundup (glyphosate), Starane (florxypyr) and Goal 4F (oxyflroufen) in grape berries by HPLC

Herbicides	Mobile phase	Wave Length (nm)	Flow Rate (ml/min)	Retention Time (min)	Detection Limit (ng)
Glyphosate-isopropyl ammonium	**Methanol/ Acetonitrile (5/95)**	235	1mil / min.	1.891	0.03
Fluroxypyr-	**Methanol/ Acetonitrile (5/95)**	235	1mil / min.	1.689	0.04
Oxyfluorfen	**Methanol/ Acetonitrile (5/95)**	235	1mil / min.	0.971	0.05

High Performance Liquid Chromatography (HPLC)

Herbicide residues were determined using HPLC water model Agilent Technologies 1260 Infinity solvent delivery system, quaternary pump chromatograph with UV spectrophotometer detector, and C18 stainless column (4.6×250 mm). The results were compared with the standard used glyphosate isopropyl ammonium (G-IPA), florxypyr, and oxyflroufen. Elutory was Methanol/Acetonitrile (5/95) solvent liquid chromatography grade (Merck business) at a flow rate of 1 ml/min. The corresponding detection limits for the above standards were 0.03 ng, 0.04 ng, and 0.05 ng.

Rate of recovery: By adding known amounts of tested herbicides to the tested samples and then repeating the extraction, cleanup, and analysis steps, the analytical method's dependability was assessed. The percentage rates of recovery for each of the three herbicides were 89% for glyphosate IPA and 96% for oxyflroufen and florxypyr.

f-Economic feasibility study

1-The budget for overall economic returns, both fixed and variable, was estimated. Cluster yield fed cost was calculated and contrasted across the eight treatments. Economic evaluations were conducted to evaluate profitability and returns using, somewhat modified from (Dunan *et al*. 1995), the following formula:

2-Gross income (GI) = total yield x price

3-Net income (NI) = gross income – total costs

4-Profitability (P) = {net income (NI) /total costs (TC)} x 100

5-Benefit/ costs ratio (B/C) = gross income (GI) / total costs (TC)

All data were statistically analyzed according (Gomez and Gomez 1984), using the computer "GENSTAT" microcomputer program, (VSN international 2016)

Results

Effect of weed control treatments

1- On weeds characters

In general view , weed survey in experimental fields showed that annual and perennial predominate weed species in three seasons were red-rooted pigweed (*Amaranthus retroflexus* L.), mexican fire plant spurge (*Euphorbia geniculata*, Ortega), black jack (*Bidens pilosa* L.), common cocklebur (*Xanthium strumarium* L.), lamb's quarters (*Chenopodium album* L.), prickly sida (*Sida alba* L.) and nalta jute, jews mallow (*Corchorus olitorius* L.); as annual broad-leaved weeds, jungle rice (*Echinochloa colonum* L. Link), signal grass (*Brachiaria repans* L.), green bristlea grass, green foxtail (*Setaria viridis* L.) as annual grassy weeds and marvel grass (*Dichanthium annulatum* L.) and bermuda grass (*Cynodon dactylon* L.) as perennial weed which were the most important weeds of flame seedless grapevine crop. The average over the course of three seasons indicates that the amount of weed infection in an unweeded check reached 8.65 tonnes of fresh weight per feed. The percentage of wide leaf, grassy and perennial weeds, respectively, showed the mixture of weed species. In other words, a high level of weed infestation in the experimental field aided in the efficient determination of weed management.

Table 3. Effect of weed control treatments on fresh weight of total annual and perennial weeds (g/m^2) at 120 days from experimental start during 2021, 2022 and 2023 seasons

NO.	Total weeds								
	Seasons	2021		2022		2023		Mean	
	Treatments	g/m^2	% Reduction	g/m^2	% Reduction	g/m^2	% Reduction	g/m^2	% Reduction
1	Control (unweeded check)	2019.1 a	0.0	2081.4 a	0.0	2078.8 a	0.0	2059.8 a	0.0
2	Hoeing twice	458.4 b	77.3	371.4 b	82.2	350.9 b	83.1	393.5 b	80.9
3	Roundup	257.4 d	87.3	200.8 c	90.4	179.1 e	91.4	212.4 e	89.7
4	Starane + Roundup	229.3 d	88.6	185.0 c	91.1	114.7 f	94.5	176.3 e	91.4
5	Goal twice	354.6 c	82.4	300.9bc	89.1	306.7 c	85.2	320.4 c	85.6
6	Black plastic	87.6 e	95.7	43.8 d	97.9	27.7 g	98.7	53.0 f	97.4
7	Rice straw	90.2 e	95.5	48.5 d	97.7	30.4 g	98.5	56.4 f	97.3
8	Egyptian clover (berseem)	307.0 c	84.8	220.2 c	89.4	236.6 d	88.6	254.6 d	88.1
	LSD	48.03		111		42.7		40.63	

*Means had the same alphabetical letter were not differ significantly according to: Duncan multiple range test (Duncan 1955)

Table (3) presents data indicating a significant decrease in the fresh weight of total weeds as compared to an unweeded check over a mean of three seasons for all weed control methods. The effects can be sorted in descending order. Black polyethylene mulch and rice straw mulch treatments which gave the highest controlling percentage of total weeds which reduced fresh weight by 97.4 and 97.3%, respectively, followed by Starane + Roundup (0.2 L/fed. + 2.5 L/fed.), Roundup (2.5 L/fed.) and Egyptian clover (berseem) treatments which gave controlling percentage of total weeds which reduced fresh weight by 91.4, 89.7 and 88.1%, respectively. While Goal 4F twice (1L/Fed.) and hand hoeing twice treatments which gave lower controlling percentage of total weeds which reduced fresh weight by 85.6 and 80.9%, respectively.

Thus, for farming can be used black polyethylene mulch and rice straw mulch as bio- organic to control weeds in flame seedless grapevine.

2- On Grapevine growth and fruiting

a- Vegetative growth characters

As compared to the unweeded check, the results in Tables (4 and 5) clearly demonstrate how using various mulching, crop cover, mechanical weeding, and herbicide treatments to control weeds greatly boosted the vegetative growth characteristics of flame seedless grapevines. Weed control treatments significantly increased the leaf area (cm^2), pruning wood weight (kg/vine), total chlorophyll and carotenoids (mg/g fresh weight) as average of three seasons compared to unweeded check. Black polyethylene mulch and rice straw mulch gave the highest values without significant differences between them. On other hand, Starane at 0.2 L./fed. + Roundup at 2.5 L./fed. ranked second followed by Egyptian clover followed by Roundup at 2.5 L./fed. followed by Goal 4F at 1.0 L./fed. twice and hand hoeing twice treatments The value of leaf area (cm^2) was (137.2, 136.4, 128.4,126.1, 124.4,123.7 and 119.3 as an av. of the three studied seasons due to Black polyethylene mulch, Rice straw mulch, Starane plus Roundup, Egyptian clover, Roundup, Goal 4F and hand hoeing, respectively, compared to the untreated treatment gave the lowest values by (113.1). Hence, the corresponding increment percentage of leaf area attained (21.31, 20.60, 13.53, 11.49, 9.99, 9.37 and 5.48% compared to unweeded ones, respectively. The corresponding wood pruning weight (kg/vine) were attained (2.701, 2.662, 2.391, 2.085, 2.021, 1.951, 1.667 g/vine) compared to untreated weed control treatment which gave the lowest value of wood pruning weight by 1.304 kg/vine as an average for three seasons.

Also, the obtained total chlorophyll was (4.71, 4.56, 4.20, 4.05, 4.02, 3.94, 3.70 mg/g F.W due to the previously treatments, respectively against 3.35 mg/g on vine that unweeded ones, as an av. of the three studied seasons. As well as carotenoids were (1.23, 1.21, 1.13, 1.10, 1.09, 1.07 and 1.05, against 1.02 mg/g). Then, treated with weed control methods promoted all leaf photosynthetic pigment contents and gained the highest increment percentage of total chlorophyll (40.60, 36.12, 25.37, 20.90, 20.00, 17.61 and 10.45% as an av. of the three studied seasons due to Black polyethylene mulch, Rice straw mulch, Starane plus Roundup, Egyptian clover, Roundup, Goal 4F and Hand hoeing compared to unweeded ones, respectively.

Table 4. Effect of weed control treatments on leaf area (cm^2) and wood pruning weight (kg/vine) of Flame seedless grapevine during 2021, 2022 and 2023 seasons

NO.	Treatments and Herbicidal rate / fed.	Leaf area (cm^2)				Wood pruning weight (kg)			
		2021	2022	2023	Mean	2021	2022	2023	Mean
1	**Unweeded control**	114.4 d	113.0e	111.9 d	113.1e	1.093 g	1.418 e	1.400 e	1.304 g
2	**Hand hoeing twice**	115.8 d	118.5d	123.6c	119.3 d	1.674 e	2.036 c	2.144 c	1.951 e
3	**Roundup at 2.5 L.**	121.8bc	124.2 c	127.3bc	124.4 c	2.156 b	2.046 c	2.053 c	2.085 c
4	**Starane at 0.2 L. + Roundup at 2.5 L.**	124.4 b	128.7b	132.2 b	128.4 b	2.010 c	2.581 b	2.583b	2.391 b
5	**Goal 4F at 1.0 L. twice**	118.9cd	124.7c	127.5bc	123.7 c	1.399 f	1.789 d	1.815d	1.667 f
6	**Black polyethylene mulch**	134.6 a	136.5a	140.3a	137.2 a	2.475 a	2.798 a	2.829a	2.701 a
7	**Rice straw mulch**	134.1a	135.4a	139.6 a	136.4 a	2.420 a	2.769a	2.799a	2.662 a
8	**Egyptian clover (berseem)**	123.6 b	125.9bc	128.9 b	126.1bc	1.869d	2.159 c	2.036 c	2.021 d
	LSD	4.4	3.7	4.6	2.4	0.090	0.122	0.120	0.060

*Means had the same alphabetical letter were not differ significantly according to: Duncan multiple range test (Duncan 1955)

Table 5. Effect of weed control treatments on total chlorophyll (mg/g fresh weight) and carotenoids (mg/g fresh weight) of Flame seedless grapevine during 2021, 2022 and 2023 seasons

No.	Treatments & Herbicidal rate / fed.	Total chlorophyll (mg/g fresh weight)				Carotenoids (mg/g fresh weight)			
		2021	2022	2023	Mean	2021	2022	2023	Mean
1	**Unweeded control**	3.06 e	3.38 e	3.62 e	3.35 g	1.03 c	1.01 d	1.01e	1.02 f
2	**Hand hoeing twice**	3.15 e	3.90 d	4.05 d	3.70 f	1.02 c	1.05 cd	1.09 d	1.05 e
3	**Roundup at 2.5 L.**	3.80cd	4.05 c	4.20 c	4.02 d	1.04c	1.10bc	1.13bc	1.09 cd
4	**Starane at 0.2 L. + Roundup at 2.5 L.**	4.12b	4.14 c	4.32 b	4.20 c	1.11 b	1.12 b	1.15 b	1.13 b
5	**Goal 4F at 1.0 L. twice**	3.65 d	4.01cd	4.16 cd	3.94 e	1.03 c	1.06bcd	1.10cd	1.07 de
6	**Black polyethylene mulch**	4.54 a	4.80 a	4.79a	4.71 a	1.17 a	1.24a	1.29 a	1.23 a
7	**Rice straw mulch**	4.41 a	4.59b	4.68 a	4.56b	1.15ab	1.22 a	1.27 a	1.21 a
8	**Egyptian clover (berseem)**	3.88 c	4.08 c	4.17 c	4.05 d	1.06 c	1.10 bc	1.13bcd	1.10 c
	LSD	0.15	0.13	0.11	0.07	0.05	0.05	0.04	0.03

*Means had the same alphabetical letter were not differ significantly according to: Duncan multiple range test (Duncan 1955).

b- Yield components

Data present in Table (6) show the effect of the weed control treatments on yield/vine and cluster weight of Flame grapevines during 2021, 2022 and 2023 seasons.

All mulching, crop cover, herbicide and hand hoeing treatments markedly produced higher average of yield/vine and cluster weight (g) than unweed ones. Black polyethylene and rice straw mulching recorded the greatest average yield/vine (15.557 & 15.700 kg) and cluster weight (628.0 and 622.3 g) as compared with the other treatments without significant differences. On other hand, Egyptian clover and Starane at 0.2 L./fed. + Roundup at 2.5 L./fed. ranked second without significant differences between them followed by Goal 4F at 1.0 L./fed. twice followed by Roundup at 2.5 L./fed. and hand hoeing twice, respectively. In contrary, the lowest value of average yield/vine and cluster weight were recorded on vines that unweeded check (6.943 kg) and (277.4 g).

The obtained yield/vine was (12.157, 12.514, 14.586, 13.014, 15.700, 14.771 and 6.943 kg/vine as an av. of the three studied seasons) due to hand hoeing, Roundup, Starane plus Roundup, Goal 4F, Black polyethylene mulch, Rice straw mulch, Egyptian clover and untreated ones, respectively. Hence, the corresponding increment of yield/vine percentage due to previously treatment compared to untreated ones attained (75.10, 80.24, 110.08, 87.44, 126.13, 124.08 and 112.75%), respectively.

Table 6. Effect of weed control treatments on yield cluster weight (g) and yield (kg/vine) of Flame seedless grapevine during 2021, 2022 and 2023 seasons

No.	Treatments & Herbicidal rate / fed.	Cluster weight (g)				Yield (kg/vine)			
		2021	2022	2023	Mean	2021	2022	2023	Mean
1	Unweeded control	300.49 e	279.50 d	253.15 e	277.4 e	7.512 e	6.987 d	6.329 e	6.943 e
2	Hand hoeing twice	464.68 d	505.70 c	488.48 d	486.3 d	11.617 d	12.642 c	12.212 d	12.157 d
3	Roundup at 2.5 L.	494.39 c	529.36 c	477.96 d	500.6 cd	12.360 c	13.234 c	11.949 d	12.514 cd
4	Starane at 0.2 L. + Roundup at 2.5 L.	579.03 b	632.00 a	539.25 bc	583.4 b	14.476 b	15.800 a	13.481 bc	14.586 b
5	Goal 4F at 1.0 L. twice	497.87 c	545.86bc	517.98 cd	520.6 c	12.447 c	13.647 bc	12.950 cd	13.014 c
6	Black polyethylene mulch	629.11 a	650.38 a	604.50 a	628.0 a	15.728 a	16.260 a	15.113 a	15.700 a
7	Rice straw mulch	620.63 a	640.82 a	605.40 a	622.3 a	15.516 a	16.021 a	15.135 a	15.557 a
8	Egyptian clover (berseem)	581.57 b	609.43ab	581.57 ab	590.9 b	14.539 b	15.236 ab	14.539 ab	14.771 b
	LSD	21.48	64.42	43.86	24.9	0.537	1.611	1.096	0.623

*Means had the same alphabetical letter were not differ significantly according to: Duncan multiple range test (Duncan 1955)

c- Physical and chemical characteristics

1. Berry weight (g)

The effect of the tested weed control treatments on berry weight (g) was presented reported in table (7) during of three seasons. Applying the weed control methods significantly increased berry weight as compared with the unweeded control. The maximum values of berry weight were produced by black polyethylene mulch (4.04 g), rice straw mulch (3.97 g), Egyptian clover (berseem) (3.95 g) and Starane at 0.2 L. + Roundup at 2.5 L. (3.86 g) without significant differences between them, respectively, followed by Goal at 1.0 L. twice (3.59 g) followed hand hoeing twice (3.50 g) and Roundup at 2.5 L. (3.33 g). Meanwhile, the lowest values obtained from the unweeded check (2.05 g) in average of three seasons, respectively.

2- Chemical constituents of berry juice

Data presented in Tables (7 and 8) showed the effect of different weed control methods on chemical constituents of berry juice during 2021, 2022 and 2023 seasons. Based on data, it was shown that all weed control techniques considerably enhanced the berry juice's chemical composition, with total soluble solids rising, sugar and anthocyanin concentrations falling, and overall acidity falling when compared to unweeded berries.

The highest values were recorded due to black polyethylene or rice straw mulching followed by Egyptian clover. The unweeded check treatment came at the last order and had the lowest values of these studied traits as an average of the three studied seasons.

On other hand, the highest acidity percentage content were found in berries that harvested from the unweeded check vines, while berries of black polyethylene or rice straw mulching had the least acidity contents.

Table 7. Effect of weed control treatments on berry weight (g) and total soluble solids (TSS) of Flame seedless grapevine during 2021, 2022 and 2023 seasons

No.	Treatments & Herbicidal rate / fed.	Berry weight (g)				Total soluble solids (TSS)			
		2021	2022	2023	Mean	2021	2022	2023	Mean
1	**Unweeded control**	2.11 c	1.92 d	2.11 d	2.05 d	15.90 e	15.98 e	16.06 e	15.98 g
2	**Hand hoeing twice**	3.27 b	3.41 bc	3.83 ab	3.50 bc	17.28 d	17.38 d	17.5 d	17.39 f
3	**Roundup at 2.5 L.**	3.25 b	3.31 c	3.41 c	3.33 c	17.57 cd	17.59 d	17.79 cd	17.65 de
4	**Starane at 0.2 L. + Roundup at 2.5 L.**	3.83 a	4.02 a	3.73 b	3.86 a	17.65 cd	17.62 d	17.87 cd	17.71 d
5	**Goal 4F at 1.0 L. twice**	3.32 b	3.58 abc	3.88 ab	3.59 b	17.41 d	17.43 d	17.63 d	17.49 ef
6	**Black polyethylene mulch**	4.01 a	4.04 a	4.06 a	4.04 a	18.84 a	18.89 a	19.06 a	18.93 a
7	**Rice straw mulch**	3.89 a	3.93 a	4.10 a	3.97 a	18.36 b	18.38 b	18.58 b	18.44 b
8	**Egyptian clover (berseem)**	3.84 a	3.85 ab	4.15 a	3.95 a	17.98 bc	18.00c	18.2 bc	18.06 c
	LSD	0.24	0.47	0.31	0.33	0.40	0.38	0.40	0.21

*Means had the same alphabetical letter were not differ significantly according to: Duncan multiple range test (Duncan 1955)

Table 8. Effect of weed control treatments on reduce sugars, total anthocyanin and acidity of Flame seedless grapevine during 2021, 2022 and 2023 seasons

NO.	Treatments & Herbicidal rate / fed.	Reduce sugars%				Total anthocyanin (mg/100g skin)				Acidity %			
		2021	2022	2023	Mean	2021	2022	2023	Mean	2021	2022	2023	Mean
1	**Unweeded control**	13.52 f	13.87 d	13.54 d	13.64 f	13.16 h	13.28 h	13.62 g	13.35 h	0.564 c	0.600 a	0.636 a	0.600 a
2	**Hand hoeing twice**	14.81 e	14.73 c	14.95 c	14.83 e	18.80 f	24.06 f	24.68 e	22.51 f	0.560 c	0.544 ab	0.517 cd	0.540 cd
3	**Roundup at 2.5 L.**	15.06 cd	15.00 bc	15.01 c	15.02 de	27.38 d	27.35 e	28.03 d	27.59 d	0.589 b	0.591 a	0.561 bc	0.580 ab
4	**Starane at 0.2 L. + Roundup at 2.5 L.**	15.17 c	15.37 bc	15.40 bc	15.31 cd	31.90 c	27.82 c	28.51 c	29.41 c	0.521 d	0.605 a	0.575 b	0.567 bc
5	**Goal 4F at 1.0 L. twice**	14.91 de	15.40 bc	15.03 c	15.11 de	17.42 g	18.93 g	19.41 f	18.59 g	0.618 a	0.577 ab	0548 bc	0.581 ab
6	**Black polyethylene mulch**	16.61 a	16.51 a	16.49 a	16.54 a	34.30 b	34.96 b	34.98 b	34.74 b	0.526 d	0.450 c	0.427 e	0.468 e
7	**Rice straw mulch**	16.12 b	15.92 ab	16.28 a	16.11 b	36.58 a	35.84 a	36.69 a	36.37 a	0.526 d	0.450 c	0.440 e	0.472 e
8	**Egyptian clover (berseem)**	15.24 c	15.76 ab	15.68 b	15.56 c	22.10 e	27.55 d	28.19 d	25.95 e	0.570 c	0.506 bc	0.481 de	0.519 d
	LSD	0.23	0.84	0.47	0.35	1.34	0.18	0.21	0.45	0.016	0.076	0.053	0.029

*Means had the same alphabetical letter were not differ significantly according to: Duncan multiple range test (Duncan 1955)

The total soluble solids were (17.39, 17.65, 17.71, 17.49, 18.93, 18.44 and 18.06% as an av. of the three studied seasons) due to use hand hoeing, Roundup, Starane plus Roundup, Goal 4F, Black polyethylene mulch, Rice straw mulch and Egyptian clover, against (15.98%) for unweeded ones, respectively.

Hence, the corresponding increment percentage of total soluble solids due to treated compared untreated ones attained (8.82, 10.45, 10.82, 9.56, 18.46, 15.39 & 13.02%), respectively.

Also, the corresponding reducing sugars values was (14.83, 15.02, 15.31, 15.11, 16.54, 16.11 and 15.56, against 13.64%) and anthocyanin (22.51, 27.59, 29.41, 18.59, 39.74, 35.37 and 25.95, against 13.35 mg/100g), respectively.

Hence, the corresponding increment percentage of anthocyanin contents attained (68.61, 106.67, 120.29, 39.25, 160.22, 164.94 and 94.38%), respectively. On other hand, the corresponding total acidity values was (0.540, 0.580, 0.567, 0.581, 0.468, 0.472 and 0.519, against 0.600%), respectively.

So, in general view, it could be seen that all tested weed control treatments significantly improved the chemical quality and berry skin anthocyanin dye compared to unweeded done.

Herbicides residues determination

The findings presented in Table 9 demonstrate that the herbicide residues in grapes harvested at harvest time were below the maximum residual level (MRL) permitted by EU, which was 0.2 µg /g for Round up 48% (glyphosate) at 2.5 L/fed. 0.000326 µg /g and 0.02 µg /g for Starane 20% (fluroxypyr) at 0.2 L/fed. 0.000242 µg /g. This was followed by Round up 48% (glyphosate) at 2.5 L/fed. 0.001184 µg /g, and 0.05 µg /g for Goal F4 48% (oxyfluorfen) at 0.000494 µg /g. In grapes, the fluroxypyr treatment left fewer residues than glyphosate and oxyfluorfen, both of which were below the maximum residue limit. The amount and activity of soil microbes, as well as soil components like organic matter and clay, can affect how quickly these herbicides degrade. In addition to these, other elements that affect herbicide breakdown include temperature, pH of the soil, and other environmental factors.

Table 9. Residues for Round up (glyphosate), Starane (fluroxypyr) and Goal F4 (oxyfluorfen) in grape berries at harvest

Herbicides & rate / fed.	Retention time	Herbicide residues µg /g	Maximum residue level (MRL) µg/g
Round up (glyphosate) at 2.5 L.	1.891	0.000326	0.2
Starane 20% (fluroxypyr) at 0.2 L. followed by	1.689	0.000242	0.02
Round up (glyphosate) at 2.5 L.	1.891	0.001184	0.2
Goal F4 (oxyfluorfen) at 1.0 L. twice.	0.971	0.000494	0.05

a- Economic feasibility study

The data on the economic analysis of cluster yield (ton/fed) of that all the treatments showed on Table (10). The price for cluster yield was 6500 L.E /ton. Price as black polyethylene mulch for kilogram (kg) (4 x10 m^2) = 54 L.E, Rice straw mulch for ton = 400 L.E, Egyptian clover (berseem) for (kg) = 46.7 LE, Roundup (1 liter) = 330 L.E, Starane (0.2 Liter) = 150 L.E, Goal 4F (1 liter) = 534.3 L.E, and two hoeing = 2400 L.E, respectively and three hoeing = 3600 L.E.as average of three season.

In addition to all fixed costs of land rents, fertilisers, irrigation, ploughing land, pruning and other costs of pest control and harvest, etc., studied economic criteria namely total variable cost as hand labor wages, mulching (black plastic and rice straw) prices, cover crop seed prices, and herbicide prices were estimated under each treatment. There include estimates for benefit/cost ratios, likelihood percentages, and gross and net earnings. The overall costs of various weed control treatments tended to be higher than those of untreated treatments, particularly when it came to mulching with black polyethylene mulch, rice straw mulch, Egyptian clover, and double hand hoeing. In contrast, the cost of various herbicide applications was lower, particularly when Roundup, Goal 4F, and Starane were used. The black polyethylene mulch, rice straw mulch, Egyptian clover, Starane, Roundup, and Goal 4 F all twice recorded increases in yield, which were determined by 226.9, 225.0, 213.8, 210.6, and 188.5%, respectively, as average of three studied seasons, as compared to untreated treatment, according to a comparative economic analysis of each treatment table (10).

Table 10. Economic evaluation of the effect of weed control treatment average three studied 2021,2022 and 2023 seasons

No.	Treatments & Herbicidal rate / fed.	Yield (ton/fed.)	Relative yield of untreated	Gross income (.(L.E/fed	Total costs (L.E/fed.)	Net income (L.E/fed.)	Profitability %	Benefit / costs ratio
1	**Unweeded control**	4.860	100.0	31236.8	35666.7	-4429.8	-12.39	0.88
2	**Hand hoeing twice**	8.510	176.2	55403.3	38066.7	17336.7	44.45	1.44
3	**Roundup at 2.5 L.**	8.760	180.9	56694.0	36731.7	19962.3	53.71	1.54
4	**Starane at 0.2 L. + Roundup at 2.5 L.**	10.210	210.6	65862.5	37131.7	28730.8	76.97	1.77
5	**Goal at 1.0 L. twice**	9.110	188.5	59253.2	37213.3	22039.8	58.11	1.58
6	**Black polyethylene mulch**	10.990	227.0	71157.8	42126.7	29031.2	68.36	1.68
7	**Rice straw mulch**	10.890	225.0	70593.2	38570.0	32023.2	82.18	1.82
8	**Egyptian clover (berseem)**	10.340	213.8	74902.0	38750.0	36152.0	92.34	1.92

Data indicated that Egyptian clover. black polyethylene mulch, rice straw mulch, Starane followed Roundup and Goal 4 F twice recorded highest gross income by LE per fed. by 74902.0, 71157.8, 70593.0, 65862.5 and 59253.0. The profitability % was attained 92.34, 68.36, 82.18, 76.97 and 58.11 and benefit/costs ratio was 1.92, 1.68, 1.82, 1.77 and 1.58, respectively, meanwhile the benefit/costs ratio in untreated check were minus. Egyptian clover treatment achieve the highest economic return although black polyethylene and rice straw mulching treatments gave high relative yield than Egyptian clover treatment because the gross income from the Egyptian clover treatment includes the income from grapes, plus additional income from clover, and additional black polyethylene treatment was the higher total cost from all treatments.

Discussion

Because grapevine is highly susceptible to weed competition in the first half of the growth season, weeds must be controlled during this crucial time due to a significant weed infestation that appeared early in the growing season. The presence of weeds between grape rows causes weeds to compete with the vines for water, nutrients, and light. It also affects vegetative growth, such as leaf area, total chlorophyll and carotenoids content, as well as the weight of pruning wood, and leads to a decrease in yield and fruit quality (Abouziena and Haggag 2016 and Wisler & Norris, 2005). Therefore, weed management is a good way to reduce weed competition and improve the crops ability to make optimal use of the main growth factors (water, nutrients, light and space) which leads to increasing the plants efficiency in the photosynthesis process, which directly focuses on increasing the vegetative growth of the plant and thus improving yield and both physical and chemical characteristics of berries of flame seedless grapevine compared with unweeded control. Using different strategies, whether by manual hoeing or herbicides have a different mechanism of action or by mulching the soil with synthetic black polyethylene, or organic rice straw, or by planting leguminous cover crops such as Egyptian clover Gowda and Hassanein (2011), Ramteke *et al*. (2013), Nooli *et al*. (2020) and Vasic *et al*. (2023)]. In addition, the use of various methods to control weeds in vineyards leads to improving the berries physical and chemical and herbicidal residues were lower than their maximum residual level (MRL) Hegazi (2000), Ying and Williams (2000), Leu (2007), Duke and Powles (2008), Gowda and Hassanein (2011) and Tot *et al*. (2019).

Conclusions

The findings demonstrate safe, cost-effective alternatives to mechanical weed control in vineyards that yield good yields and herbicidal residues that are below their maximum residual level (MRL) can be used fairly in organic farming conditions in Egypt. These alternatives include hand hoeing twice, using black polyethylene, rice straw mulches, cover crops like Egyptian clover,

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تأثير بعض مبيدات الحشــائش ومعاملات التغطية على الحشــائش المصــاحبة وإنتاجية العنب مع تقدير متبقيات تلك المبيدات

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الملخص

يعتبر صـنف العنب الفليم سيدلس من الأصـناف المفضـلة في مصـر لمذاقه الحلو وخلوه من البذور ويتأثر المحصـول وجودته بوجود الحشـائش ومنافسـتها له لذا أجريت هذه الدراسـة بمزرعة محطة بحوث البسـاتين بسـدس التابعة لمركز البحوث الزراعية بمحافظة بني سـويف بمصـر خلال مواسم 2021 ،2022 ،2023 ، بهدف تقييم فعالية ثمانية معاملات لمكافحة الحشائش على محصـول العنب الفليم سـيدلس ومكوناته والحشـائش المصـاحبة له مع اقتفاء متبقيات مبيدات الحشـائش في حبات العنب عند الحصـاد باسـتخدام جهاز التحليل الكروماتوجرافى السـائل عالي الأداء HPLCوذلك في تصميم قطاعات كاملة العشوائية في أربع مكررات. أوضحت النتائج أن معاملات التغطية بالبولي إيثيلين الأسـود، التغطية بقش الأرز، سـتارين بمعدل 0.2 لتر/فدان + روانداب بمعدل 2.5 لتر/فدان زراعة البرسـيم أعطت من 88.1-97.4% في مكافحة الحشـائش الكلية مع زيادة في النمو الخضـري ومحصـول الكرمة (كجم/كرمة). كما تحسـنت الخواص الفيزيائية والكيميائية لحبات العنقود مقارنة بمعاملة الكنترول. وكانت متبقيات المبيدات اقل من الحد المسموح به دوليا في حبات العنب عند الحصـاد. أوضـح التقييم الاقتصـادي أن المعاملات السـابقة أدت إلى زيادة في محصـول العنب وكذلك أعلى عائد إقتصـادى لذا توصـى هذه الدراسـة بإمكانية إدارة الحشـائش باسـتخدام الطرق السـابقة لمكافحة الحشـائش في حقول بسـاتين العنب مما يتيح استخدام استراتيجيات نظيفة للتخلص من منافسة الحشائش لمحصول العنب سواء باستخدام التغطية بالبلاسـتيك الأسـود أو قش الأرز أو زراعة البرسـيم في مكافحة الحشـائش مما يتيح إنتاج العنب كمحصول تصديري عالي الجودة وخالي من متبقيات مبيدات الحشائش.