Studies on using crops residues as a soil mulch in grape vineyards

By

Khairy Hassan Abd El – Rahman Hassan

B. Sc. Agric. Sc. (General Section), Mansoura University, 1993

A Thesis Submitted in Partial Fulfillment of

The Requirement for the Master Degree in

Environmental Science

Department of Agriculture Science

Institute of Environmental Studies & Research

Ain Shams University

APPROVAL SHEET

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Abstract

This investigation was conducted during two successive seasons of 2004 and 2005 on 15 years old Flame seedless grapevine (*Vitis vinifera*, *L.*) grown in a clay soil and drip irrigated. The tested weed control methods were: the two types of soil mulch i.e., organic mulch (corn straw, rice straw and dry banana leaves) & synthetic mulch (black polyethylene and buried used fertilizer polyethylene bags) as well as the herbicide Round up treatment (2.5L/150Lwater / Fadden twice a year) comparing with hand hoeing treatment (traditional methods). This study was planned to evaluate the effect of seven weed control methods on the associated weeds, soil moisture content, vegetative growth, leaf content of N, P, K, Ca and Mg, yield and berries quality expressed by SSC, total acidity, anthocyanin concentration and juice volume / 100g of berries Flame seedless grapevine.

1 - The highest efficiency in controlling annual and perennial weeds was recorded for soil mulching treatments. It also prevented subsequent re-growth perennial weeds controlling the existed weed species. Soil mulching treatments surpassed on hand hoeing and Round up with superiority for buried polyethylene and black polyethylene treatments.

2 - Mulching materials increased soil moisture content and the effect was more pronounced by plastic mulching treatments due to reducing evaporation of water from soil surface.

3 - All soil mulching materials caused significant increase in shoots length (cm), Leaf area (cm^2), weight of winter pruned wood (kg) during the growing seasons as well as fresh weight of fibrous roots (g) at 0-30 and 30-60 cm soil depth. Black polyethylene treatment produced the highest values and buried used fertilizer polyethylene bags mulch came the second , then followed by corn straw , rice straw , dry banana leaves

mulch treatments and Round up treatment respectively, in comparison with the hand hoeing treatment.

4 - The hand hoeing for vines recorded the lowest values of mineral contents in vine leaves N, P, K, Ca and Mg as compared with the other tested weed control treatments .The positive effect of soil mulching extended to increase the uptake of N, P, K, Ca and Mg nutrients.

5 - Soil mulching with black polyethylene, followed by buried used fertilizer polyethylene, corn straw, rice straw and dry banana leaves not only produced the highest yield as number and weight of clusters per vine, but also caused a significant improvement in most physical properties of cluster.

6 – Soil mulching with black polyethylene is considered the best treatment in weed control, it looks more expensive but if we take into consideration the use of black polyethylene for two seasons, its cost is far less than herbicides, soil mulching with (corn straw, rice straw, dry banana leaves) were also more effective for weed control, useful to add organic manure for soil and not expensive especially if the materials were available in the farm to reduce transportation cost.

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1- Introduction

The grape (*Vitis vinifera* L.) is a major fruit crop in its production in nearly all- Mediterranean countries. Its acreage in Egypt, reached about (154.685 feddan) producing about (1.391.749 tons) according to statistics of the ministry of agriculture (2006).

Grapes are widely used in Egypt in many ways as table fruit, juice, jam and raisins. Therefore, many efforts were done to improve grape quality and productivity. Most vineyards in Egypt are suffering from weed competition which leads to reduction in productivity of the grape vine. Weeds are serious competitors with vines for soil moisture and nutrients, even when it is grown at low density especially under the semi arid Egyptian condition. Besides many weed species serve as hosts for insects, nematodes, fungi, bacteria and virus. Since they act as source of infection, so they prevent vines from achieving full growth potential. Therefore, weed control treatments could be considered one of the most important agricultural practices in the irrigated semi arid vineyards.

Weed control is an important part of the over all operation the production of grapes. Weeds are always controlled in the vine row. Weeds compete with the grapevines for nutrients and water. In newly planted vineyard weed will easily out grow young vines. As the vineyard comes into production, weeds will interfere with mechanical or hand harvest. This will increase harvest costs and reduce the quality of the grapes. The presence of weeds in the vineyard may increase insect problem, especially as the weeds dry and the insects move into green grapevines. Drying weeds will also produce seed that attracts birds which can also cause damage to the grapes. [**Mayer 1985 and Hifny et *al*., 1994].**

The intensive use of herbicides in order to minimize weed damages may results in an unfavorable balance in soil micro flora. On the other hand, soil cultivation (hand hoeing) is laborious and expensive.

Weeds under the vine rows can also be controlled using mulches. Organic mulches or synthetic mulches of polyethylene can be used around young vines. Mulches prevent the growth of weed, seed lings by blocking light and preventing it from reaching the soil surface. They create more uniform moisture conditions, which in turn promotes young vine growth and improving distribution of roots and their absorption of nutrients in grape vines **Zeerban, (2004)**

Thus physical methods are recommended for weed control to avoid hazards of herbicides, produce safe fruits and preserve environmental balance. Such methods include soil mulching with plastic cover or thick layers of crop residuals as rice straw, corn straw and dry banana leaves.

Mulching is also an important for economy in irrigation water, the water saving is the most important in the desert areas specially in the vineyards which using drip irrigation system from deep wells so water becomes the most expensive factor of production in such areas **Hegazi, (2000)**.

It could be recommended to use mulching in the infected vineyards for its economy, control of weeds, to protect the environment from pollution and most importantly to save water and increase the net income of the grower.

Growers are aware of the need to reduce costs of production. Weed control in the invested farms may account for a large amount of variable expenses, and economy should be considered in relation to other costs.

In view of the high infestation by weeds in the vineyards, this work was implemented in one of the farms using modern technologies of drip irrigation and was sponsored from the agricultural technology utilization and transfer project.

2 - Review of literature

The main interest of this study is to deal with the different methods of weed control and their effects on weeds, growth and yield of grape vine. Therefore, the literature of the previous studies reviewed as following :

1- Effect of soil mulching.
2- Effect of Round up herbicide.
3- Effect of hand hoeing.

2.1- Effect of soil mulching:

2.1.1. - Effect of soil mulching in weeds :

The purpose of mulching is to exclude light from weeds, there by eliminating the photosynthetic process within them. The most commonly used mulches are hay, manure, grass chippings, straw, sawdust, woodchips, black paper and black plastic film. The most effective mulching material is the kind applied a continuous sheet i.e. black plastic. **(Schlesselman *et al.*, 1985)**. Many investigators evaluated the effect of soil mulching on weed control in vineyards. They revealed that weeds were suppressed by using black polyethylene mulch. These results were confirmed by **Schumann and Sebastian, (1978); Kazanteseva *et al.*, (1983); Jing *et al.*, (1986); Abromova, (1984); Stevenson *et al.*, (1986) in Canada, Hassan *et al.*, (1986); Arafa (1991)** in Egypt; **Duncan *et al.*, (1992)** in USA; **Yandagni and Sharma (1992); Macias *et al.*, (1992); Abu-Irmaileh, (1994)** in Jordan; **Baghdady *et al.*, (1995)** in Egypt; **Hegazi, (2000) and El-Shamma and Hassan, (2001)** in Egypt.

Other investigators **Shehata *et al.*, (1988); Arafa, (1991); Baghdady *et al.*, (1995)** and **El-Shamma and Hassan, (2001**) in Egypt evaluated the influences of rice straw mulch on weeds control that grow

in vineyards. They found that rice straw mulch was effective in eliminating and reducing weed population in vineyards. **Hegazi, (2000)** reported that soil mulching with dry banana leaves was effective in eliminating the number of weeds. **Varga and Majer, (2004**) indicated that soil mulching with organic matter most effective for weed suppression.

2.1.2. - Effect of mulching in soil moisture:

Many investigators evaluated the effect of soil mulching with black polyethylene on soil moisture content in vineyards. They confirmed that polyethylene mulching conserved soil moisture in the upper layer by reducing the evaporation rate from soil surface **Ramazanova, (1985)** on the South Crimean coast; **Jing *et al*., (1986); Srinivas *et al*., (1990)** in Indian**; Arafa, (1991); Zayan, (1991); Yandagni and Shama, (1992); Duncan *et al*., (1992**) in the San Joaquin valley of California; **Abu-Iramaileh, (1994); Hifny *et al*., (1994)** in clay soil; **Zayan *et al*, (1994)** in calcareous soil**; Walsh *et al*., (1996); Baghdady *et al*., (1995**) in clay soil**; Hegazi, (2000)** in sandy loam soil **Zeerban, (2004)** in soil that classified as clay silt and slightly alkaline (ph =8.2) and **Hipps *et al*., (2004).**

Other researchers evaluated the influence of soil mulching with straw on soil moisture content in vine yard. They declared that straw mulch enhance soil ability to conserve moisture. The previous results were obtained by **Dieter, (1977)** in Germany; **Huysteen and Webber, (1980) in dry land vineyard; Jombrova, (1989); Srinivas *et al*., (1990**) in Indian; **Arafa, (1991)** in clay soil; **Hifny *et al*., (1994)** in clay soil; **Walsh *et al*., (1996); Baghdady *et al*., (1995)** in clay soil; **Hegazi, (2000)** in sandy loam soil **and Zeerban, (2004)** in a clay silt alkaline soil and **Nemeth *et al*., (2004).**

2.1.3- Effect of soil mulching in vine growth:

Many investigators evaluated that the effects of soil mulching on vine growth parameter (bud burst, shoot length, leaf area, weight of winter pruned wood and root growth).

2.1.3.1. Effect of soil mulching in bud burst:

Abramova, (1984) reported that soil mulching with black polyethylene in vineyard resulted in 5-6 days earlier bud burst than control plots.

On contrary, **Ayaad *et al*., (1991**) found that vines treated by PE mulches the differences were not significant as compared to the control vines.

2.1. 3.2.- Effect of soil mulching in shoot growth and leaf area:

Many workers found that shoot growth and leaf area of vines were the greatest with black polyethylene mulch in vineyards. **Magherini** and **Sani, (1984)** in Italy**; Jazabec (1984)**, **Gromakovskii** and **Khachaturyan (1984); Kazantseva *et al*., (1986); Oh *et al*., (1986)** in Korea; **Arafa, (1991)** in Egypt; **Zayan *et al*., (1994)** on apple trees; **Hifny *et al*., (1994); Baghdady *et al*., (1995)** in Egypt; **Ibarra *et al*., (1996)** in Mexico; **Hegazi, (2000)** in Egypt; **El-Shamma and Hassan**, **(2001)** in Egypt; **Ezzahouani, (2003)** in Morocco; **Zeerban, (2004)** in Egypt and **Phadung *et al*., (2005)** in Thailand.

Many investigators evaluated the effects of soil mulching on vine growth. They observed that shoot growth of vines were the greatest with straw mulch in vineyards**. Huyssteen and Webber, (1980)** in South Africa; **Davison, (1982)** on apple trees; **Pool *et al*., (1990); Baghdady *et a*l., (1995); Zeerban, (2004) and Phadung *et al*., (2005)**. on the other hand, many investigators evaluated the effect of soil mulching with straw.

They confirmed that growth parameters of grapevine showed little response to straw mulch **Arafa, (1991); Baghdady *et al*., (1995)** and **El-Shamma and Hassan, (2001).**

2.1.3.3 Effect of soil mulching in weight of winter pruned wood:

Many workers evaluated the effect of soil mulching with black polyethylene on weight of winter pruned canes. They revealed that soil mulching with black polyethylene has increased weight of winter pruned canes **Godden and Hardie, (1981)** in Australia; **Magherini and Sani, (1989); Jazabec, (1984); Gromakovskii and Khachaturyan, (1984); Hassan *et al*., (1986) in Egypt; Stevenson *et al*., (1986)** in Canada; **Arafa, (1991)** in Egypt; **Macias *et al*., (1992); Hifny *et al*., *(*1994); Baghdady *et al*., (1995)** in Egypt; **Iberra *et al*., (1996) and Pinamonti, (1998).**

2.1.4. Effect of mulching in leaf minerals content:

Many investigators evaluated that the effect of soil mulching in leaf minerals N, P, K, Ca and Mg contents as compared with hand hoeing. They found that soil mulching treatments increased leaf minerals N, P, K, Ca and Mg contents especially soil mulching with organic materials, which gave better results than BPE mulching material**.** These results were confirmed by **Neilsen *et al*., (1986); Lord *et al*., *(*1986)** on apples; **Zayan *et al*., *(*1994); Niggli *et al*., (1985); Thakur *et al*., (1997)** on apples; **El-Shamma and Hassan, (2001); Varaga and Magar (2004) and Zeerban, (2004).**

2.1.5. Effect of soil mulching in Root growth:

The previous investigators declared that soil mulching with black polyethylene increased the weight of fibrous roots. **Steinberg and Abel, (1974); Schumann and Sebastian, (1978)** in Germany**; Davison, (1982)**

on apple trees; **Jazbec (1984); Gromakovskii and Khachaturyan (1984); Ramazanova, (1985)** on the south Crimean coast; **Mikhalake, (1987); Moldavia and Robinson, (1988) in Australia; Zayan *et al*., (1991)** and **Zeerban, (2004)** in Egypt.

2.1.6. Effect of soil mulching in vine yield:

Many investigators evaluated the effect of soil mulching with black polyethylene plastic on vine yield. They stated that using black polyethylene mulch to control weeds increased the yield of vines and gave an early production. These results were confirmed by **Steinberg and Abel, (1974) in Germany; Godden and Hardie, (1981) in Australia, Kazantseva *et al*., (1983)** in Russia; **Jazbec, (1984); Niggli *et al*., (1985); Ramazanova, (1985)** on the South Crimean coast; **Kazantseva *et al*., (1986); Niggli and Potter, (1986) ;Oh *et al*., (1986) in Korea; Hassan *et al*., (1986); Arafa, (1991); Yandagni and Sharma, (1992); Zayan *et al*., (1994)** on apple trees; **Baghdady *et al*., (1995)** in Egypt; **Hegazi (2000); El- Shamma and Hassan, (2001) in Egypt; Zeerban, (2004) and Phadung *et al*., (2005)** in Thailand. Contrarily**, Ezzahouani, (2003)** reported that the use of plastic cover advanced the harvesting date by month however crop weight as number and cluster weight per vine were not significantly affected by covering soil.

Many workers estimated the influence of soil mulching with straw mulch on vine yield. They indicated that straw mulch increased vine yield. **Dieter, (1977) in Germany; Niggli *et al*., (1985); Niggli and Potter, (1986); Pool *et al*., (1990)** in USA; **Srinivas *et al*., (1990), Arafa, (1991); Hifny *et al*., (1994); Zayan *et al*., (1994)** on apple trees; **Baghdady *et al*., (1995)** in Egypt; **Buckerfield and Webster, (1996); Hegazi *et al*., (2000)** in Egypt; **Shamma and Hassan, (2001)** in Egypt; **Zeerban, (2004); Phadung, *et al*., (2005)** in Thailand and **Deng-Yun**

Cun and Deng-Xiaoping, (2005) in China. In contrast, **Schorder *et al.*, (1987)** in Germany, suggested that there was no clear increase in grape yield obtained by using straw mulch to control weed in vineyards.

2.1.7. Effect of soil mulching in berries quality:

Many investigators evaluated the effect of soil mulching with black polyethylene plastic on berries quality of grapevines. They recognized that mulched vines with black polyethylene film had more highly colour berries and higher concentration of soluble solids. They also observed that fruit quality of vines was improved (i.e. acid content,. juice volume and anthocyanin), **Ramazanova (1985)** on the South Crimean coast; **Oh *et al.*, (1986)** in Korea; **Arafa, (1991); Hifny *et al.*, (1994); Baghdady *et al.*, (1995)** in Egypt; **El-Shamma and Hassan (2001); Ezzahouani, (2003);** However, **Hegazi, (2000); Zeerban, (2004) and Phadung *et al.*, (2005)** indicated that most chemical juice properties such as S.S.C/ acid ratio were not significantly affected by black polyethylene mulching. Contrarily **Yandagni and Sharma, (1992)** reported that black polyethylene mulch decreased S.S.C and increased acid content in berries. Meanwhile, many workers estimated the effects of soil mulching with straw on berries quality in vine yard. They stated that straw mulch improved fruit quality of grapes. **Dieter, (1977)** in Germany; **Pool *et al.*, *(*1990)** in USA; **Arafa, (1991); Hifny *et al.*, *(*1994); Baghaday *et al.*, (1995)** in Egypt; **El Shamma and Hassan (2000)** in Egypt and **Deng-Yun Cun and Deng-Xiaoping, (2005*)*** in Chaina. *In contrast,* **Muller and Reimberr, (1979); Zayan *et al.*, *(*1994) on apple trees; Robin *et al.*, (1996); Hegazi, (2000); Zeerban (2004) and Phadung *et al.*, (2005)** in Thailand found that straw mulch has not generally influenced fruit quality of vines. **Lord *et al.*, (1986**) and **Zayan *et al.*, (1994)** on apple

fruit reported that colour degree was better by organic mulching material than that of P.E. mulching material and soil.

2.2. Effect of Round up (Gluphosate) herbicide :

2.2.1. Effect of Round up (Gluphosate) herbicide in grape vine weeds:

Round Up (Gluphosate) [N-(Phosphonomethyl) glycine] an aliphatic herbicide is post- emergence, non selective, broad –spectrum control of many annual, biennial, perennial weeds and woody plants. Also as a general post plant, pre-emergence herbicide for weed control in many fruits and vegetable crops **(Gowgani and Holmes, 1985)**. Several investigators reported that Gluphosate proved to be more effective in controlling weeds than hoeing in vineyards but not recommended as the resulted environmental pollution. The previous investigators recommended different concentrations of glyphosate according their circumstances for best weeds management in vine orchards as follow: and **Talbert Kennedy, (1974)** 2L / acre; **Lorenz and Mullverstedt, (1974)** 15L / ha; **Bargioni *et al*., (1977)** 5kg/ha; **Shaulis *et al*.,(1978) 2-8 lb / acre; Daniell and Lane, (1978)** 4.5kg/ ha; **Stalder and Potter, (1978)** 10 L/ ha; **Kenndy *et al*.,(1979)** 2.2 kg/ha; **Andjelic, (1979)** 10-12l/ ha; **Daris, (1979)** 4.8 kg/ ha; **Rayan *et al*., (1979)** 2-4Ib/ acre; **Albuquerque and Albuquerque, (1983)** 0.25 L/ ha; **Dadaeva and Dorozhkina, (1984)** 10 L/ ha; **Borisenko; (1985); Sparacino *et al*., (1986)** 5L/ ha; **Paspatis, (1987)** 2.85 kg/ ha; **Johnson and Talbert, (1989); Barida and Miailhe, (1990); Bajaw *et al*., (1993a)** at 4kg/ha; **Dunst *et al*., (1995)** 2lb/ acre; **Prathibha *et al*., (1995); Zaldea, (1997); Heinzl *et al*., (1996)** 1.44 kg/ ha; **Elmore *et al*., (1997); Itoh *et al*., (1997)** 3.6- 4 kg/ ha; **Stefan, (1999);Cernusko and Hronsky, (2000)** 6 L /ha; **Lavezzi, (200 1)** 720 g/