REPUBLIC OF TURKEY
ERCIYES UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
DEPARTMENT OF AGRICULTURAL SCIENCES AND TECHNOLOGIE

THE EFFECT OF FLOOR MANAGEMENT PRACTICES IN GRAPE ORCHARDS ON WEEDS, VINE GROWTH AND YIELD, POWDERY MILDEW AND SOIL PROPERTIES

Prepared By
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Supervised By
Prof. Dr. Doğan IŞIK
Prof. Dr. Wazeer A. HASSAN

M. Sc. Thesis

November 2018
KAYSERI

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SCIENTIFIC ETHICS SUITABILITY

I declare that all information in this work was obtained in accordance with academic and ethical rules. All results and material that not been at the essence of this work are also transferred and expressed by giving reference as required by these rules and behavior.

Mohammed Sabri YOUSIF

SUITABILITY FOR GUIDE

The M.Sc. thesis entitled "**The Effect of Floor Management Practices in Grape Orchards on Weeds, vine Growth and Yield, Powdery Mildew and Soil Properties**" has been prepared in accordance with Erciyes University Graduate Education and Teaching Institute Thesis Preparation and Writing Guide.

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ACCEPTANCE AND APPROVAL PAGE

This study entitled "**The Effect of Floor Management Practices in Grape Orchards on Weeds, Vine Growth and Yield, Powdery Mildew and Soil Properties**" prepared by Mohammd Sabri YOUSIF under the supervision of Prof. Dr. Dogan IŞIK was accepted by the jury as M.Sc. Thesis in Agricultural Science and Technology Department.

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That the acceptance of this thesis has been approved by the decision of the Institute's Board of Directors with the 27/11/2018 Date and 2018/54-05 numbered decision.

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Director of the Institute

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ABSTRACT

Investigation was carried out during May 2017 to September 2018 in irrigated vineyards to estimate the efficiency of alternative weed management practices including synthetic and organic mulches. These were compared with glyphosate for weed control, grapevine performance, soil health, and powdery mildew incidence.

The most abundant weeds were: *Echinochloa crus-galli*, *Phalaris minor and Digitaria sanguinalis*. Each of leaf litter (LL), woodchips (WCH), and wheat straw (WS) enhanced fresh shoot biomass by 44%. Application of rye cover crop and black polyethylene (BP) decreased winter dieback by 59.74% and 70.45%.

Buds viability ranged between 79% and 83% in the practiced plots. During the March 2018, shoot length was increased by 15.97-19.89% in plots applied with composted manure (CM), synthetic mulches of geotextile (GEO), BP, and hand weeding (HH). During April and May, these practices continued their effect and increased the shoot length by 16% and more than 19%.

After six months of mulching, there was no weed cover in May in plots of synthetic mulches and glyphosate. In July, the highest weed density of *C. acutum* (45.8%) was found in the HH plots.

Vine leaf area at bloom increased significantly to 177.45, 171.43, and 172.35 cm^2 when practiced with GEO, BP, and glyphosate. Leaf petioles contained high N and K in the vines mulched with BP and GEO whereas P content was non-significant.

The total root density developed to 0.498 mg/g soil at 20-40 cm soil depth and this depended greatly on woody roots and fine root density. At harvesting, WCH and CM were the best mulching in yields, and each vine produced 5.15 and 5.88 kg fruit, the average cluster weight was 271 g and 346 g. Grapes juice pH and TSS did not varied in most plots. The thicker mulch layer of CM was the best in preserving soil moisture (14.32%) compared to 7.31% in control, and elevated soil carbon to 2.29% and optimum C/N to 27.26. Finally, most of the mulching practices demonstrated inhibitory effects on disease incidence and severity of powdery mildew.

Key Words: Weeds, mulches, vine, soil proporties

BAĞ ALANLARINDA ZEMİN YÖNETİM UYGULAMALARININ YABANCI OTLAR, BAĞ GELİŞİMİ VE VERİM, KÜLLEME VE TOPRAK ÖZELLİKLERİNE ETKİSİ

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ÖZET

Araştırma sentetik ve organik malçları içeren alternatif alternatif yabancı ot mücadele yöntemlerinin etkinliğinin belirlenmesi amacı ile sulama yapılan bağlarda Mayıs 2017-Eylül 2018 arasında yürütülmüştür. Bu uygulamalar, yabancı ot kontrolü, bağ performansı, toprak yapısı ve bağ küllemesine etkileri açısından glifosat uygulaması ile karşılaştırılmıştır.

Deneme alanında en yaygın bulunan yabancı otlar Echinochloa crus-galli, Phalaris minor ve Digitaria sanguinalis olmuştur. Kuru yaprak, ağaç kabuğu ve buğday samanı taze bağ biyokütlesini % 44 artırmıştır. Örtücü bitki olarak kullanılan çavdar ve siyah polietilen malç uygulaması kış geriye doğru ölümlerini % 59.74 ve% 70.45 oranında azaltmıştır.

Uygulamaların tomurcukların canlılığı üzerine etkileri % 79 ile% 83 arasında değişmektedir. Mart 2018'de, hayvan gübresi, sentetik jeotekstil malç, siyah naylon ve el çapası yapılan parsellerde sürgün uzunluğu % 15.97-19.89 oranında artmıştır. Nisan ve Mayıs aylarında, bu uygulamalar etkisini sürdürmüş ve sürgün uzunluğunu % 16 ve % 19'dan fazla artırmıştır.

6 aylık malç uygulamalarından sonra Mayıs ayında sentetik malç ve glifosat uygulanan parsellerde hiç yabancı ota rastlanılmamıştır. Temmuz ayında en yüksek yabancı ot yoğunluğu C. acutum ile (% 45.8) el çapası yapılan parsellerde tespit edilmiştir.

Bağ yaprak alanı, sentetik jeotekstil malç, siyah polietilen naylon ve gilifosat uygulanan parsellerde, 177.45, 171.43 ve 172.35 cm2'ye yükselerek önemli ölçüde artmıştır. Sentetik jeotekstil malç ve siyah polietilen naylon uygulanan parsellerde yaprak petiollerinin yüksek N ve K içerirdiği ancak P yönünden uygulamalar arasında istatistiki olarak bir farklılığın bulunmadığı tespit edilmiştir.

The thicker mulch layer of CM was the best in preserving soil moisture (14.32%) compared to 7.31% in control, and elevated soil carbon to 2.29% and optimum C/N to 27.26. Finally, most of the mulching practices demonstrated inhibitory effects on disease incidence and severity of powdery mildew.

Toplam kök yoğunluğu 20-40 cm toprak derinliğinde 0.498 mg/g toprağa kadar gelişmiştir ve bu büyük ölçüde odunsu köklere ve ince kök yoğunluğuna bağlıdır. Ağaç kabuğu ve hayvan gübresi uygulanan parseller verimi etkileyen en iyi parseller olarak tespit edilmiş olup, bu her bir bağ 5.15 ve 5.88 kg meyve üretmiş, ortalama salkım ağırlığı ise sırasıyla 271 g ve 346 g olarak tespit edilmiştir. Uygulamaların meyve suyu pH ve toplam kuru madde oranına etkisi açısından farklılık oluşmamıştır. Hayvan gübresinde daha kalın malç tabakası, toprak nemini (% 14.32), kontrolde % 7.31 ve toprak karbonunu% 2.29'a ve optimum C / N'den 27.26'ya kadar korumada en iyi sonucu vermiştir. Ayrıca malç uygulamaları hastalık oranı ve külleme şiddeti üzerinde inhibitör etki göstermiştir.

Anahtar Kelimeler: Yabancı ot, malç, bağ, toprak özellikleri

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CHAPTER 1

INTRODUCTION

Grape is one of the most delicious, and refreshing fruit, it is a good source of calcium (Ca), phosphorus (P), iron (Fe) and vitamins B_1 and B_2. Grapes are grown in semitropical hot as well as cold to temperate regions. There are about 100 cultivars grown in Iraq, and most of them are in Kurdistan region (Abula_Qader, 2006)

Approximately 71% of world grape production is used for wine, 27% as table grapes, and 2% as dried grapes (raisins) (FAO, 2009). Weeds are major cause of yield reduction in vineyards, orchards, vegetables, field crops, and nurseries. Weeds compete crop plants for available nutrients, space, and water causing delay in flowering and fruiting (Stenger and Hatterman-Valenti, 2016). The diverse weeds can compete with the vines especially under conditions of water stress in continental climate (Monterio and Lopes, 2007). The economic losses caused by weeds surpassed those caused by other agricultural pests including insect pests, nematodes, diseases, rodents, etc.; the total annual losses by weeds reaches to 45% compared to other pests (Rao, 2000). On an international scale, yield losses in vine can reach to 43% if weeds were not controlled (Oerke, 2006). A severe weed interference reduces vine plant vigor and increases damage by facilitating winter dieback in grape vines.

Chemical weed control is widely used to control weeds compared to tillage. Herbicides are particularly effective to control weeds within rows in the vast vineyards where it is difficult to operate mechanically. Reduction in use of herbicides are inevitable because of widespread appearance of herbicide resistant weeds (Powles et al., 1997; Powles, 2014), the risk of environmental contamination (Mesnage et al., 2014) and more recently the very wide effects of herbicides on food quality and human and animal health (Myers et al., 2009).

Mulch by covering the soil with organic or synthetic materials is a safe method to control weeds and retain soil moisture (Frederikson et al., 2011) compared to the tillage (Steinmaus et al., 2008). Mulching improves the soil physical and chemical properties, preventing soil compaction (Némethy 2004), increasing soil organic matter and nutrients availability (Jacometti et al., 2007a; Thomson and Hoffmann, 2007). Mulching also facilitates regeneration dynamics of microorganisms and subsequently perpetuates the vine vigor (Mundy and Agnew, 2002).

The most common problems of mulches include the occurrence of vertebrate damages (Lanini et al., 1988) and specialized equipment are required for applying organic mulches, and polyethylene sheets (Sauvage, 1995). Furthermore, the layers of organic materials of at least 10 cm typically decays by 50-60% in the first season; this duration depends on the material and most mulches are required to be reapplied every two to three seasons (Lanini et al., 2011).

Several local materials can be used for mulching: Inorganic or industrial mulches include black polyethylene and colored geotextile sheets, whereas organic mulches include wheat, rice, and corn straw, trees bark and forests leaf litter, composts, manures, wood chips or saw dust, and various disassembled materials. Cover crops of living annual or perennial plants provide a groundcover suppressing or preventing weeds growth entirely. Synthetic mulches do not add organic matter and nutrients to soil and may create some damages in the soil texture through their refuses (Verdú and Mas, 2007). Literature demonstrated that the thickness of organic mulch layers and soil amendments used in this project may provide effective weed control by physical action of the layer thickness, and/or release of phytotoxic compounds. Organic mulches along the time decompose and provide organic matter and nutrients to the soil, and improve the soil water-holding capacity (Merwin et al., 1995).

The application of mulching practices is considered as a tool for sustainable use of waste materials such as olive mill disposal in the Mediterranean area, which after composting gave more positive effects on soil stability and properties (Brunetti et al., 2005; López-Piñeiro et al., 2008). Thus, we chosen this study since (1) the conventional practices of vineyard weed management particularly the soil tillage or disking can promote losses of soil quality and can cause erosion and reduce soil organic matter, (2) diminishing irrigation needs during the hottest soil months, in addition to perpetuating the soil health and vines vigor, (3) no side effects of most soil amendments and organic practices.

The current work was aimed to investigate the influence of different weed control practices including some types of synthetic and inexpensive organic mulches. Organic mulches were wheat straw, composted manures, leaf litter and wood chips. These were compared to the most common herbicide glyphosate and hand weeding in addition to cover crops for their weed control effect. The effects of these on grapevine growth, soil quality of vineyard, and occurrence of grapevine disease of powdery mildew were also studied.

CHAPTER 2

LITTERATURE REVIEW

2.1. Weed Management and Soil Quality Relationship

Mulches in general suppress weeds and may improve soil properties through conserving soil water, increasing organic matter and subsequently reducing both of soil erosion and compaction (Dickerson, 2001). Mulches may also activate dynamics of soil biota and physiological functions.

Synthetic or inorganic mulches serve as an alternative to organic mulches as weed suppressants; their effects on soil conditions such as soil temperature and moisture contents may vary depending on the mulch type.

Soil quality is greatly correlated with weed management. The criteria of soil quality include improvement of physiochemical and biological soil properties and processes (USDA, 1999). Chemical soil properties include pH, cation exchange capacity (CEC), nutrient contents and their availability to plants.

Measureable physical properties include aggregate stability, bulk density or soil compaction, water infiltration or porosity and retention (Karlen et al., 1997).

Soil biota and their activities are critical components in the health and productive capacity of soils including nutrient cycling, organic matter decomposition, nitrogen fixation and production of soil humic substances, particle aggregation, and soil aeration (Dick et al., 1996; Sylvia et al., 2005).

Many of these indicators of soil quality are essential in maintaining soil fertility and vineyard productivity. For example, increase in bulk density or soil compaction has been associated with shoot growth, leaf area and number of inflorescences in container grown grapevines (Ferree and Streeter, 2004; van Huyssteen, 1988).

Soils with high nitrogen availability are undesirable because of subsequent stimulation and increase in grapevine succulent vegetative growth, which complicates canopy management, damages fruit quality, increases pests' density, and decreases yields by reducing bud fruitfulness (Wolf, 2008).

2.2. Safety Methods of Floor Management and Weed Control

Most organic growers apply the mechanical weeding in large farms or hand weeding in small areas as a safe method for controlling weeds. However, hand weeding is more expensive and involves a lot of labor to remove weeds. Hand weeding or hoeing is safe and very effective against annual and biennial weeds, but many failures of mechanical weeding are reported such as cultivation reduce the yields of several vegetables, field crops, and even fruit trees because of partial root pruning and crop damage (Gianessi and Reigner, 2007). Mechanical weed control may also have benefit of stimulating mineralization of soil-bound nitrogen, which could help to improve crop yield and quality if timed with the crops peak demand for nitrogen (Davies and Welsh, 2002).

Recently, mulching is widely used in the production of high value vegetables, field crops, fruits, medicinal and aromatic plants as well as nursery and ornamental plants. Mulches can be natural such as cereals straw, sawdust or wood chips, paper and plant residues or synthetic such as plastic or polyethylene sheets. Plastic mulching could be recommended in highly infested vineyards for its efficiency to control weeds and protect the environment from pollutants, save soil water, and increase the growers' net income. Plastic mulch could result in 50% water saving and increase crop performance under water stress (Tolk et al., 1999). Organic mulches include straw, weeds especially perennial grass, residues from perennial crops like banana, sugarcane straw and sawdust, newspaper and shredded paper (Silva et al., 2015).

Mulch system suppresses weeds through several mechanisms; their physical presence with soil surface (by shading, lowering soil temperature, allelopathic activity and blocking the sunlight penetration required for germination of many small-seeded weed species (Hussein and Radwan, 2004).

An increased incidence of fungal diseases such as powdery mildew, *Phomopsis* cane blight, and *Botrytis* rot due to increased soil water content might be expected in mulched vineyards. However, *Botrytis* bunch rot a major pathogenic disease on grape fruits did not increase when various mulch materials were used such as vineyard pruning, olive pomace, green waste, pine bark, animal manure, and mussel shells (Mundy and Agnew 2002). Another study compared mulches of olive pomace (marc) fermented either aerobically or anaerobically, grass clippings, and paper in a vineyard. The two olive pomace and paper mulches increased yield, berry skin strength, and berry resistance to *Botrytis* infection (Jacometti et al., 2007a; Jacometti et al., 2007b).

Soil mulching with plant and animal wastes or synthetic mulches is one of the management practices for weed control that reduces soil evaporation; it increases water retention which improves root development (Hegazi, 2000; Awodoyin et al., 2007). As organic mulch decomposes and humus is added to soil, which increases its water holding capacity, maintaining soil structure, controlling soil erosion, enhancing soil chemical properties. It also brings an increase in the cation exchange capacity, i.e., the soil capacity to store nutrients (Unger et al., 1997). Mulch stimulates the activity of soil organisms and organic matter is protected and enhanced. The soil life and availability of phosphorus (P), potassium (K) and magnesium (Mg) were significantly enhanced through mulching that lead to increased crop yield. Straw mulching i.e. use of wheat straw as mulch after harvesting the ears significantly depressed weeds, increased soil microbial quantity and activity, and avoided powdery mildew (Xu et al., 2009).

According to Oliveira et al. (2014), the physical inhibitory effect of organic mulch on weeds may be due to reduced solar radiation and temperature range on soil surface. The application of synthetic mulches rather than organic ones meets the demands of both broad and small farming at relatively low costs, and these mulches have significant effects on yield and weed control (Abdul-Baki and Teasdale, 1993). For example, the use of 15 mm thick cellulose sheets for weed and insect control has been reported as the best mean for use in small orchards (Benoit et al., 2006). A synthetic woven, black cloth roll is available for mulching and can be applied by machine when trees are planted. It is easy to spread and prevents the emergence of most annual weed seedlings (Zimdahl, 2013).

Hifny et al. (1994) have reported the application of polyethylene either black or clear in five-year-old (Banaty) Thomson seedless grapevine for controlling weeds and increasing the yield components compared to non-mulched control plots. Bond et al. (2016) concluded that white and green coverings had little effect on the weeds, and brown, black, blue, and white on black (double colors) films prevented weeds from emerging.

Cultivation is the most traditional practice for controlling weeds which also eliminates crusting of soil surface, leading to less water runoff (Merwin et al., 1994). This has been a recent practice for weed control particularly between the vine rows as a mean to reduce side effects of herbicides (Gaviglio, 2007). However, tillage has disadvantages of soil compaction, loss of soil fertility and organic matter, damage to vine roots, wounding of trunks and arms (Salazar and Melgarejo, 2005; Steenwerth and Belina, 2008a). Cultivation may bring weed seeds to the surface and affects decomposition and mineralization of existing soil organic nitrogen pools and plant residues, thereby providing a pool of inorganic nitrogen for vine uptake (Calderón et al., 2001 Bàrberi, 2002). Higher content of nitrogen in grape leaves and juice with higher yields and pruning weights in response to cultivation than to other floor management practices were observed in various trials (Rodriguez-Lovelle et al., 2000b; Afonso et al., 2003).

The cover crops are living groundcovers planted prior to or after vineyard establishment, cover crops may be intercropped and/or tilled into the soil as a source of green manure. The roles of cover crops in the weed management are:

1. Cover crops may inhibit weed growth, and/or provide a habitat for beneficial decomposer organisms in the soil (Derr, 2008).

Recently, cover crops have become a common vineyard floor management practice due to: (A) Soil protection from erosion and crusting, improvement in soil structure and fertility, increase in water-holding capacity and support to the vine growth. (B)

Increased soil biological diversity, weed suppression, habitat for beneficial predators, and early firm footing for other cultural practices (Monteiro et al., 2008; Fourie, 2010).

2. In contrast, increasing coverage of grass cover crops was noted to impair grapevine root growth. In California, Ingels et al. (2005) found reduced pruning weights and petiole nitrogen content in grapevines intercropped with native grasses.

3. Groundcovers represent a way to control overly vigorous grapevines and to avoid more growth of succulent tissues which become more susceptible to pests attack. This is often an undesirable feature of grapevine growth in locations with fertile soils and excessive moisture (Monteiro and Lopes 2007; Wheeler et al., 2008; Giese et al. 2008).

4. Cover crop application is recognized to influence yield, fruit composition, and wine quality (Mackenzie and Christy, 2005; Giese et al., 2008).

2.3. Chemical control of weeds in vineyard

The effectiveness of herbicides depends upon their correct choice and use at recommended doses. The main risks of herbicides include evolution of herbicide resistant weeds and the potential for herbicide residues leaching to waterways.

Post-emergence herbicides (glyphosate 2% a.i., plus oxyfluorfen 1% a.i.) required fewer chemical applications than pre-emergence herbicides (simazine, 2 kg a.i./ha) or cultivation (Tourte et al., 2008). When various common floor management treatments under the vine were compared over a two-year period, a pre-emergence herbicide (diuron) coupled with a post-emergence systemic herbicide (glyphosate) was the most effective and least expensive treatment (Elmore et al., 1997). The fall cultivation was paired with a single post-emergence herbicide treatment in spring (glyphosate 5.6 kg a.i./ha), a weed control similar to two herbicide applications was achieved (Baumgartner et al., 2007).

Some weeds in vineyards have recently shown resistance to glyphosate such as horseweed (*Conyza canadiensis*) (Shrestha et al., 2010) and Italian ryegrass (*Lolium multiflorum*) (Jasienuk et al., 2008). *Senecio vulgaris* and ryegrass (*Lolium rigidum*), both found in vineyards, have also been reported to evolve a resistance (Institute

National de la Recherche Agronomique, 2008). Recently, 194 weed species are resistant to herbicides. There is need to use alternative methods however, few studies were found that addressed management of herbicide resistant weeds in vineyards and their impacts on vine growth (Alcorta et al., 2011a, 2011b).

Some weed species that tended to be susceptible to herbicide treatments varied widely across trials, in some cases due to the specific mode of action of the herbicide (Sanguankeo and Leon, 2011). Timing of herbicide application can also shift the weed community, especially if applied when weeds are less susceptible to chemical control (Baumgartner et al., 2007).

CHAPTER 3

MATERIALS AND METHODS

3.1. Vineyard site

An experiment was conducted during 2017-2018 in a vineyard (cv. Kamali) established in 2011 at Bare-Bihar village, north of Duhok city, Kurdistan region, Iraq (latitude 36.54°N; longitude 43.09°E; and altitude 792 m) (Fig.1).

Figure 3.1. Location of experimental site of grapevine management in Bare-Bihar, Duhok, Iraq.

The local climate is continental and the growing season extends from March to October. Temperature and precipitation data were provided by Agro-metrological station in Duhok and shown in (Table 3.1)

Table 3.1. Meteorological data of the experimental location during 2018

Month	Rainfall (mm)	Temperature °C		Humidity (%)
		Max.	**Min.**	**67**
January	102.3	14.0	6.6	66
February	66.2	15.0	.5.9	58
March	32.7	21.3	10.3	53
April	29.5	24.o	12.8	51
May	39.8	31.2	16.6	46
June	1.2	37.8	22.8	34
July	-----	40.6	27.3	26
August	-----	43.2	28.4	23
September	4.8	36.5	23.5	29
October	11.4	28.3	17.7	42

***Data were collected from Agro-meteorological station at Duhok city center, This is the station nearest to research site.

The cultivar

Kamali cultivar is one of the most common Iraqi table grapes particularly in the central and irrigated vineyards in Duhok. This has excellent commercial properties of cluster shape and size. The berries are oval, rose or purplish in color at maturity, and consist of 2-4 seeds, and the pulp is sweet with little acidity. The leaves compose of five lopes. Flowers are functionally female, full bloom occurs in May, the fruit ripens in September and consumed as fresh table grapes, sweet juice, or may be dried to make the best black raisins.

3.2. Plant Materials and Experimental Design

The vines of Kamali cv. were 8 years old and spaced 2 × 2 m inter and intra rows, trained on (T) trellis system, and drip-irrigated from May to September (600–800 m^3/ha). A single irrigation pipeline for each row was prolonged under vines at 25 cm height from the soil with a single dripper connected at 30 cm from each vine. Different floor vineyard practices were used in vine rows while the alleys were mowed or disked.

Weed control treatments including most common and non-expensive organic mulches of wheat straw, mixture of pine leaf litter and bark, inorganic mulches of non-woven geotextile and black polyethylene in addition to soil amendments of rye cover crop, composted manure, and woodchips. Details are as follows:

1. Chopped wheat straw (WS) was obtained from a crop grown in the previous year.

2. For cover crop of rye (*Secale cereal*) (CP), seeds were planted in a 1.2 m wide strip within vine rows, the seedbeds were prepared by roto-tilling with a 120 cm tiller and plots were seeded in the early November 2017 by hand strewing. The seeding rate was 24.66 kg/ donum. Seeded areas were allowed to grow through winter and then mowed the following spring (25 May 2018). The mowed residues with their weed contents were isolated for computing weed coverage.

3. Composted manures; this included the most common mulches used by local growers (CM) after decomposition for at least 8 months.

4. Wood chips (WCH) mostly composed of poplar wood and obtained from carpentry workshop.

5. Mixture of chopped pine leaf litter and trees bark (LL & PB). Both of 4 and 5 was provided by Forestry Department, College of Agriculture, University of Duhok.

6. Inorganic mulches consisted of synthetic landscape fabric mulches including non-woven blue geotextile 1.5 mm (0.06 inch) in thickness as polypropylene (Non- woven Industries, Peschiera Boromeo, Italy) (GEO).

7. Black polyethylene 10 micometer (Polietilenenero; Si.Sac., Ragusa, Italy) (BP).

8. Periodic cultivation of weeds i.e., two-three times per year during May, June, and July by hand weeding (HH) to 5 cm depth.

9. Chemical control using glyphosate (Roundup Power Max™, Monsanto Company, at 1080 g a.i./ha (20 ml/L), applied two times in autumn and spring (CC). The herbicide was applied within a 1.0 m wide area underneath the vineyard row, while a 2m-wide strip of alley was cultivated.

10. Non-managed control (Control).

The application of WS, CM, WCH, and LL was performed at the early rainfall of winter 2017. These organic mulches were applied with a thickness of about 10 cm. Each GEO and BP sheets were applied in one meter width and 10 m length in October for covering the plot floor; sheet margins were buried gently in the soil to avoid the damage of wind currents.

The experiment was a randomized complete block with ten treatments, and replicated in three plots; each treatment consisting of one row 8.5 × 1.0 m with four vines treated as experimental units.

3.3. Vineyard Soil

Random soil samples of irrigated and non-irrigated vineyards were taken from 20-40 cm in depth, air dried and sieved before physic-chemical analysis according to (A.O.A.C.1995). The soil in non-irrigated orchards was 46.6% clay, 28.4% sand, and 25% silt, pH = 8.1, EC. = 0.21dsm^{-1}, organic matter = 1.06 %, total N = 2.38%, available P and K each 0.231 ppm. The physical and chemical properties in the irrigated orchards of our experimental are shown in (Table 3.2).

Table 3.2. Physical and chemical properties of the irrigated vineyard soil

Properties	No.	Properties		Reading	
Physical properties	1	Texture	Clay	442.6 g kg^{-1}	Clay texture
	2		Silt	251.5 g kg^{-1}	
	3		Sand	302.9g kg^{-1}	
	4	Bulk density		1.13 g cm^{-3}	
	5	Field capacity		25.7%	
Chemical properties	6	pH		7.65	
	7	EC		0.57 dS.m^{-1}	
	8	Available nitrogen (N)		23.5 µg/g soil	
	9	Available phosphor (P)		32.56 µgg soil	
	10	Available potassium (K)		1.3 me/100 g soil	
	11	Available rron (Fe)		3.69 µg. Fe/g. soil	
	12	Available manganese (Mn)		2.31 µg. Mn /g. soil	
	13	Available zinc (Zn)		0.92 µg /g soil	
	14	Soluble C^{2+}		2.6 mmol$_c$.L^{-1}	
	15	Soluble Mg^{+2}		2.1mmol$_c$.L^{-1}	
	16	Soluble sodium Na^+		0.57mmol$_c$.L^{-1}	
	17	Soluble potassium K^+		0.41mmol$_c$.L^{-1}	
	18	Soluble chloride Cl^{-1}		0.21mmol$_c$.L^{-1}	
	19	Soluble HCO_3^{-1}		5.1mmol$_c$.L^{-1}	
	20	Soluble Sulfate $SO4^{-2}$		0.36mmol$_c$.L^{-1}	
	21	%$CaCO_3$		13.71	
	22	Cation exchange capacity (CEC)		30.00 g/100g soil	
	23	Organic matter		22.3 g/kg	

- Soil analysis was conducted in the Soil and Water Science laboratory, College of Agriculture, University of Duhok.

3.4. Weed Survey

The first survey was carried out to compute the effects of different mulches on weed growth in a vineyard site. Percentage weed cover with fresh and dry biomass assessment was computed during three months of peak emergence and growth (May, June, and July). For each plot, weed samples were collected randomly from 0.25 m^2 central area within vine rows (Figure 3.2). Weed species were identified; aboveground vegetation was harvested and separated, and dried in an oven at 75 ^{o}C for 72 hours. Dominant weed species were identified using the summed dominance ratio (SDR) according to Wibawa et al. (2007).

Figure 3.2. Vineyard floor management and weed cover shown in vines alley

3.5. Vine Growth and Activity

3.5.1. Dormant pruning weight:

Dormant canes were pruned in January 2018. Fresh and dry weights of pruning canes were recorded to measure grapevine vegetative growth. Whole vine dormant pruning weight was obtained for two vines per plot and individual cane weights were also determined (Fig. 3-right). Percentage increase in fresh or dry weight were also calculated which mean increasing proportion of the pruning cuts weight in each treatment compared to control according to the following equation:

Increase (%)= **(treatment – control) / treatment x 100**

Grapevines were balance pruned, leaving 7 fruiting canes. Winter frost dying of dormant canes was also weighted (Fig. 3-left).

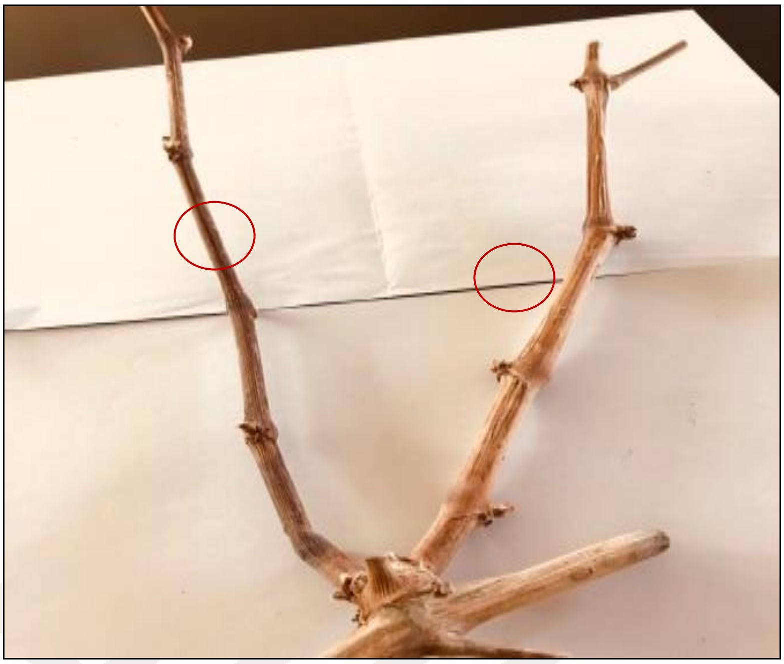


Figure 3.3. Pruning cut & cold dying of grapevine canes

3.5.2. Buds' viability:

Living buds were evaluated during March on two vines per plot, the number of viable primary buds was computed within 50 bud sample taken from 10 randomly canes and spurs after pruning.

According to Fennell (2004) and Goffinet (2004), the viable buds were determined as buds that remained green tissue in the primary bud, whereas brown buds were considered not viable.

3.5.3. Buds Phenology:

Buds phenology defined as the effects of winter cold on vegetative bud-break timing, this required monitoring the number of Julian days after pruning until the first unfurled leaf. According to Keenan (2007) phenology is defined as the science dealing with the influence of climate on the recurrence of plant life as the first of buds break; timing for the first emergence of leaves and flowers, buds viability and shoot growth.

Visual assessment was made depending on (Fig. 4.16). After pruning, buds on each plant were counted according to BBCH development scale (Fig. 4.17). Buds that reached BBCH 05 = wool stage or more were counted as viable. BBCH scale in biology for grapes describes the phonological growth stages (Lornez et al., 1994) as follows:

Code	**Growth stage and description**
0	Sprouting: bud development.
00	Dormancy: winter buds rounded, bud scales more or less closed.
01	Beginning of bud swelling: buds expand inside the scales.
03	End of bud swelling: buds swollen but not green.
05	Wool stage: brown wool clearly visible.
07	Beginning of bud burst: green shoot tips just visible.
09	Bud burst: green shoot tips clearly visible.

Figure 3.4. Example of swollen buds

Figure 3.5. BBCH identification key of grapevine, BBCH 05 = wool stage (brown wool clearly visible).

3.5.4. Plant growth:

Growth was estimated as shoot length for four vines per plot and four random mid cane shoots were chosen from each vine (Figure 3.6). Based on Curtis (2014), the length of these shoots was measured during optimum growing season in March, April, and May using a flexible measuring tape. These measurements were made three times starting one month post bud break and continued until bunch close.

Figure 3.6. Measurement of vines shoots length using a flexible tape.

3.5.5. **Single leaf area (cm^2):**

Twenty full expanded leaves at bloom were taken randomly from different positions of each vine to determinate leaf area using leaf area meter (AM 300, 2003 ADC Bio-scientific Limited, UK.) (Figure 3.7). Fresh and dry weights of leaves were also recorded; leaves were dried at 70 °C until the weight was stable.

Figure 3.7. Leaf area meter AM-300, 2003ADC, UK

3.5.6. Leaf chlorophyll content:

Chlorophyll was measured as an indicator of photosynthetic potential and overall vine health. Chlorophyll was estimated using a SPAD-502-meter (Konika Minolta Sensing, INC., Osaka, Japan) (Figure 3.8). Five leaves in opposite clusters were selected randomly from each plot at bloom (50% cap fall) and veraison (50% berry softening). Three measurements were taken on each leaf and averaged.

Figure 3.8. Estimation of leaves chlorophyll using SPAD-502-meter, Japan.

3.5.7. Vine nutrition:

The impact of vineyard floor management on the leaf petioles' contents of nitrogen (N), phosphorus (P), and potassium (K) were computed at bloom when leaves were fully expanded. Leaf petioles are considered the best vine parts to estimate the nutritive situation and petioles usually respond better to the various mineral nutrients (Winkler et al., 1974).

Twenty leaves per plot were selected randomly from opposite clusters. Leaf blades were separated from petioles and dried at 65 ^{o}C for 48 hours for measuring total N content using a Nitrogen Analyzer (2410 Series II; Perkin Elmer). Phosphorus was estimated using aluminum molybdiate. After color developing, the sample reading was recorded by Spectrophotometer at wavelength of 882 nm. Available potassium was estimated using Flame Photometer according to A.O.A.C. (1990).

3.5.8. Root measurements:

Root density was measured in both the vine row and the alley on 17 June 2018. Five cores (5.7 cm diameter) were collected from random locations in the vine row and the east-side alley at: 0-20 cm, 20-40 cm, and 40-60 cm depth. Cores collected from each depth in a given plot were combined and mixed.

The soil was wet sieved (Böhm, 1979) in 1000 g aliquots repeating the washing and decanting step three times. Soil was put in a container and covered with cold tap water. This mixture was stirred carefully and the suspension was filtered over a 500 mm sieve. Roots and organic debris from the sieve were placed in a white tray and the roots were removed using tweezers.

Fine roots were further separated from woody roots by hand under a stereomicroscope. All other grape roots were considered woody as defined by Mohr (1996). Lengths of woody roots with a ruler were measured (mm roots/g dry soil). Both fine and woody roots were quantified as a weight per weight (mg roots/g dry soil).

Additionally, total root density= (sum of fine and woody roots).

3.5.9. Grapevine Yield and Fruit Quality:

At harvest on 22 September 2018, all clusters per vine were counted, removed and weighted from three randomly vines per plot. A seven cluster sample was selected randomly from the harvested fruit for each plot (Fig.7-A), placed in a plastic bag in coolers, transported to the lab for computing average weight of a cluster and berry weight taking samples of 50 berries. The berries were then crushed and pressed through a double layer of cheesecloth; a juice was frozen for later chemical analysis according to published standards (AOAC 1990) including pH, and total soluble solids (TSS) (Brix) recorded with digital table refract-meter (Fig.7-B).

Figure 3.9. **A.** Ripening cluster of grapevine, cv. Kamali during September, 2018. **B.** Estimation of TSS (Brix) using digital refract-meter.

3.6. Soil Quality

Soil Sampling and Analysis: Soil physiochemical analysis was performed for each treatment following procedures described by Sparks et al. (1996). Soil samples from five cores (6 cm) were taken from the middle of vines at 0-40 cm on 20 June 2018. The soil cores in each plot were mixed and gently crushed. Plant residual materials, stones and gravels were removed accurately, the soil was passed through 8 mm sieve, and stored at 4 ± 1 ºC for subsequent analysis.

Chemical properties measured were pH (mol/L), soil electrical conductivity (EC; ds/m), percentage of each organic matter, organic carbon (C), and total nitrogen (N), available phosphorus (P) (ppm), and C/N ratio. Percentage of organic matter, organic (C) and N were determined by combustion analysis (Combs and Nathan 1998). Phosphorus was extracted according to the procedure outlined by (Frank et al., 1998).

Soil pH was measured using HANNA H19813 meter (HANNA Instruments®, Woonsocket, RI, USA). The soil salinity was assessed by determination of the electrical conductivity (EC) at 25 °C on an aqueous soil extract (ratio 1:2 w/v) with a conduct meter (XS cond 510; Eutech Instruments, Singapore).

Measured physical soil properties included bulk density (g/cm^3), percentage of total porosity, and percent soil moisture (by drying 60 cm^3 of field moist soil for 24 hrs at 105 ºC) (USDA,1999).

3.7. Incidence of Powdery Mildew on the Vine Leaves and Fruits

Disease incidence and severity were estimated depending upon diagnostic initial symptoms on the leaves and fruits. These were assessed visually for the managed plots immediately before harvest according to (Gadoury et al., 2001) (Fig. 3.10-A, B).

Diseased foliage was recorded as the number of infected leaves per five shoots on each of four vines per plot. Disease severity on leaves was computed as percentage of the leaf surface colonized by *Erysiphe necator* pathogen on each infected leaf. The percent of the cluster surface colonized was also recorded on 10 fruit clusters on each four vines per plot.

Figure 3.10. Symptoms of powdery mildew on grapevine leaves and fruits.

3.8. Statistics

Data were analyzed using SAS software (ver. 9.1; SAS Institute Inc., Cary, NC). Values expressed as percentages were arcsine transformed and then analyzed. Analysis of variance (ANOVA) was performed at $p \leq 0.05$ and the mean values obtained for different treatments were statistically separated using Duncan's Multiple Range Test (DMRT).

CHAPTER 4

RESULTS

4.1. The effect of floor management practices in grape orchards on weeds

During the survey of weed cover (May and July 2018) after six months of mulching, seven weed species were identified viz., *Amaranthus retroflexus* L., *Chenopodium album* L., *Chondrilla juncea* L., *Cynanchum acutum* L., *Lamium amplexicaule* L., *Portulaca oleracea* L., Cronq., and *Sonchus oleraceus* L. The total infestation was 0% in the GEO, BP, and CC plots (Table 4.1). Organic mulching including WS, CM, LL & PB, and WCH showed weed cover lower than CP and HH. During May, the most abundant species were *Lamium amplexicaule* L., *A. retroflexus*, *C. album*, *C. acutum*, and *P. oleracea.* In organic practices of CM, LL & PB, and WCH, and synthetic mulches, the weeds covers were less than the HH treatment and there was no weed growth in CC, BP and GEO. Weed cover of *C. canadensis* was less in CR than WS; weed growth was 18.1% and 33.1% for both treatments, respectively. The later gave similar weed cover with other organic treatments of CM, LL &PB, and WCH. In July, 2018, weeds were killed completely in the CC, BP and GEO plots, *A. retroflexus* and *S. oleraceus* were found only in HH, CP, and organic plots. In July, the highest weed infestation of *C. acutum* was in the HH plot (45.8%) followed by (37.5%) in the CP. The literatures demonstrated that organic mulches of WS, LL, and WCH were less effective than synthetic mulches though reducing weed abundance to 5 cm thick when applied tree bark mulch (Hostetler et al., 2007a) or compost mulch (Pinamonti, 1998).

Table 4.1. Percent weed cover in the grapevine rows subjected to floor-management systems during 2018

Treatment	Weeds in May 2018						
	Total weeds	*Amaranthus retroflexus*	*Cynanchum acutum*	*Lamiumamplexicaule*	*Chenopodim Album*	*Portulaca oleracea*	Other species
W. Straw	36.4c*	0.1a	24.2c	1.7a	5.0b	0.1a	5.3b
Cover Crop	22.9b	0.0a	17.5b	0.1a	5.0b	0.0a	0.3a
C. Manure	41.7c	4.7a	26.4b	2.3a	5.5	2.3a	0.5a
Woodchips	36.1c	2.5a	22.8b	3.9a	3.7a	2.5a	0.7a
LL&PB	39.5c	1.6a	25.3b	4.7a	4,5a	1.8a	1.6a
Geotextile	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a
B Polyethyl	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a
Hand Held	148.4d	13.3b	24.0c	62.5b	13.3c	20.0b	15.3c
Chemical Control	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a
Weedy Control	213.5e	18.3c	36.1d	88.9c	19.4d	28.3c	22.5d

Weeds in July 2018								
Treatment	Total weeds	*A. retroflexus*	*C. acutum*	*L. plexicaule*	*C. album*	*P. oleracea*	*Sonchus oleraceus*	*Chondrilla juncea*
W. Straw	58.4c	7.5b	30.8b	1.7a	0.1a	0.0a	13.3b	5.0b
Cover Crop	47.2b	0.0a	37.5b	0.1a	1.7a	0.4a	0.0a	7.5b
C. Manure	38.6C	3.5a	10.7d	11.8c	2.5a	5.7b	0.7a	3.7b
Woodchips	41.0C	2.8a	12.6d	7.9c	3.2a	6.5b	i.4a	6.6b
LL&PB	42.4C	1.9a	15.5d	9.6c	1.5a	5.5b	0.9a	7.5b
Geotextile	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a
B Polyethyl	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a
Hand Held	159.2d	9.2b	45.8c	62.5b	20.0b	7.5b	9.2b	5.0b
Chemical Control	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a
Weedy Control	231.8e	13.4e	61.7e	93.1d	24.3e	10.8c	17.2c	11.3c

* Means followed by the same letter in each column are not significantly different based on Duncan's Multiple Range test (p=0.05).
** % Weed cover = No. of a weed species / Total number of all weed species x 100 ***Control treatment surely infested with high density of weeds, accordingly computing its coverage become undue and no found.

Data of weed cover composition presented in the (Table 4.2) clarified that vineyard plots were dominated by seven broadleaf species. The broadleaf species covering the area had a total relative density of 33.49% in May and 43.09% in July with relative dominance of 31.58 % and 44.83 % in May and July, respectively. About 23.94% of the weed composition was represented in May by two species of *C. acutum* and *L. plexicaule* in terms of their relative density. In July, 27.39% of the weed cover constituent by both of these species.

Table 4.2. Composition, relative density and SDR of broad leaf weed species

Scientific name	Family name	* RD (%)		**RDW (%)		***SDR (%)	
		May	July	May	July	May	July
A. retroflexus	Amaranthaceae	2.47	2.77	5.70	5.14	4.09	3.96
C. album	Amaranthaceae	4.11	3.22	3.27	4.12	3.69	2.45
C. acutum	Apocynaceae	15.58	16.99	8.47	10.16	12.03	13.58
C. juncea	Asteraceae	_	3.92	_	6.15	_	5.04
L. plexicaule	Lamiaceae	8.36	10.4	7.36	8.29	7.86	9.35
P. oleracea	Portulacaceae	2.97	2.85	4.84	6.54	3.91	4.70
S. oleraceus	Asteraceae	_	2.94	_	8.55	_	5.75
		33.49	43.09	29.64	48.95	31.58	44.83

*Relative density of a species □ Absolute density of a species / Total absolute density of all species x100
**Relative dry weight of a species = Absolute dry weight of a species/Total absolute dry weight of all species x 100
*** SDR (Summed Dominance Ratio) of a species=Relative density + Relative dry weight / 2

4.2. Influence of Floor Management on the Vine Growth and Activity

4.2.1. Dormant pruning canes

During dormant pruning after four months of application of floor treatments, plant growth was evaluated as biomass production through fresh and dry weight of pruning parts.

The results in (Table 4.3) showed that each of organic mulches CP, LL&TB, WCH, and WS were the most traditional practices that had enhanced vines growth remarkably and increased fresh shoot biomass to 950, 935, and 930 g i.e., fresh weight increased by more than 44%, 43% and 42% when applied aforementioned practices, respectively and it was similar with GEO that increased the shoot weight by 41.01%.

The average of cane weight was 28.59, 28.10, and 27.56 g, respectively compared to 10.53 gm for control. In this aspect, Monterio et al (2008), Smith et al (2008), and

Fourie (2010) reported that using of cover plants regulated vine growth, improved soil fertility and WHC, and increased dynamics of the soil microorganisms though its need for maintenance, competition with vines (Celette et al., 2008, 2009). WS and GEO mulches were similar to aforementioned applications in their effect on the vegetative growth and accelerated the weight of pruning parts considerably compared to control plots, the average of cane weight were 22.32 and 23.97 g.

Practices of HH, CC, CM, were not varied significantly in their impacts on pruning parts, since weight of each was 745, 775 and 780 g, i.e., there was increase in percentage of fresh weight by more than 29, 32, and 32%, respectively. This reduction of pruning weight in cultivated plots may have been due to root damages from tillage which subsequent lead to reducing of shoot growth. Using glyphosate before vine bud break increased pruning weight particularly in new vineyards because of the decomposing cover crop biomass as illustrated by Steenwerth and Belina (2008b) and Celette et al. (2009). Hand hoeing and black plastic mulch had little impact on vine size (Wasko, 2010).

These results confirmed the effectiveness of most practices in increasing the dry weight of dormant cuts. Particularly important were WS, CP, CM, WCH, and LL & TP, which increased the dry weight by 306.84 to 332g that constitute 25.37-31.1% increase.

Table 4.3. Effect of floor treatments on the characters of grapevine pruning parts

Treatment	Fresh weight (g) of canes	Average of cane weight (g)	* * Increasing Fresh Weight for Pruned Canes (%)	Dry weight (g) of pruned canes	Increase in dry weight of pruned canes (%)
Control	525.00e *	10.53 d	0.00 e	228.74d	0.00d
Wheat Straw	916.67ab	22.32 ab	42.73a	317.41ab	27.94ab
Cover Crop	950.00a	28.59 a	44.74a	332.00a	31.10a
Composted Manure	780.00bcd	17.34 bc	32.69bc	325.56a	29.74a
Woodchips	930.00ab	28.10 a	43.55a	327.74a	30.21ab
Leaf Litter	935.00ab	27.56 a	43.85a	306.48abc	25.37abc
Geotextile	890.00abc	23.97 ab	41.01ab	294.84bc	22.42bc
Black Polyethylene.	651.67de	17.64 b	19.44cd	286.43.bc	20.14c
Hand Weight	745.00cd	17.56 b	29.53c	291.91bc	21.64bc
Chemical Control	775.00bcd	19.00 b	32.26bc	328.34a	30.33a

* Means followed by the same letter in each column are not significantly different based on Duncan's Multiple Range test (p=0.05).

** Percent increase in fresh and dry weight computed according to the equation=
(trt. – cont.) / trt. x 100.

1=Wheat straw (WS), 2=Cover crop of a rye *Secale cereal* (CP), 3=Composted manures, the most common mulches used by local growers (CM), 4=Wood chips (WCH), 5=Mixture of leaf litter and trees bark (LL & TB), 6=Inorganic mulches consisting of synthetic landscape fabric mulches including green non-woven geotextile as polypropylene (Non- woven Industries, Peschiera Boromeo, Italy) (GEO), 7=Black polyethylene (Polietilenenero; Si.Sac., Ragusa, Italy) (BP), 8=Weeds periodically cultivation 2-3 times per year (HH) during May, June, and July.9=Chemical control using glyphosate (Roundup Power Max™, Monsanto Company) at 1080 g/ha active ingredient applied two times, in autumn and spring (CC), 10=Control (Cont.).

4.2.2. Winter dieback of dormant canes:

The impact of cold winter on dying canes has been presented in the Table 4.3. The weight of damaged canes were 151.88 g in control and application of CP and BP decreased winter dieback considerably to 61.14 g and 44.88 g which constitute 6.44% and 6.89% for both treatments, respectively compared to 28.93% for control. Therefore, these practices led to reduction in the frost dying of canes by 59.74% and 70.45%. CM mulching also reduced injured canes substantially to 56.76 %. The effectiveness of other treatments in the reduction of dieback of canes was similar and ranged between 24.36 and 39.21%.

Table 4.4. Effect of floor treatments on the winter dying of grapevine canes

Treatment	Weight of winter dying canes/arms (g)	** Winter dying canes (%)	* * * Reduction of winter dying canes (%)
Control	151.88 a *	28.93 a	0.00e
Wheat Straw	101.27bc	11.04 c	33.32cd
Cover Crop	61.14de	6.44 e	59.74ab
Composted Manure	65.68 d	8.42 d	56.76b
Woodchips	114.88 b	12.35bc	24.36d
Leaf Litter	103.17 bc	11.03c	32.07cd
. Geotextile	103.17 bc	11.59 bc	32.07cd
Black Polyethylene	44.88 e	6.89 de	70.45a
Hand Weeding	95.64c	12.84bc	37.03c
Chemical Control	92.33c	11.91 bc	39.21c

* Means followed by the same letter in each column are not significantly different based on Duncan's Multiple Range test (p=0.05).
* * Percent winter dying canes computed as proportional weight of winter dying canes to fresh weight.
***% reduction of winter dying= **(cont. – trt.) / cont x 100**.

The correlation coefficients (r) among the major characters including pruning cuts and winter dieback of canes are given in (Table 4.5).

Results showed that fresh weight of pruning canes was non-significantly correlated with most of examined characters except for percentage of winter dying which was negatively correlated (-0.56) at p=0.01. This means that winter dieback of canes caused decrease in fresh weight of dormant prunings, because of privation and death of several parts under freezing conditions. Weight of winter dying canes was also found negatively correlated with dry weight of pruning cuts (-0.54). In contrast, positive correlation was noticed between reduction of winter dieback and dry weight of prunings and the values of these were 0.54 and 0.41 at p= 0.05 and 0.01, respectively.

Table 4.5. Correlation between examined vine characters

Characters	Fresh weight of pruned canes (g)	Weight of winter dying canes (g)	Winter dying canes (%)	Reduction of winter dying cane (%)	Dry weight of pruned canes (g)
Weight of winter dying canes (g)	-0.111				
Winter dying canes (%)	-0.559 **	0.845**			
Reduction of winter dying cane (%)	0.1212	-0.961 **	-0.839**		
Dry weight of pruned canes (g)	0.666	-0.536 **	-0.814**	0.535**	
Increasing of dry weight of pruned canes (%)	0.62	-0.483 **	-0.720**	0.409*	0.937**

* (p=0.05) **(p=0.01)

4.2.3. Timing of Buds Break after Pruning

The results shown in Table 4.6 illustrated that treatments significantly varied in their timing of bud break. Vines in plots with herbicide application required 75 days for buds opening compared to 80 days for mulched vines. It was anticipated that the organic mulches of WS, CM, WCH, and LL & TB would delay bud-break to approximately 70 days due to their moisture retaining and soil freezing effects (Stengar and Hatterman-Valenti, 2016). However, vines of different treatments consisted of delayed swollen buds at the same time of shoots growth to 15-18 cm.

4.2.4. Buds Viability

According to the results shown in Table 4.6, all of floor practices including organic and inorganic mulches and glyphosate application resulted in prerogative and substantial impacts on the percentage of buds viability with no differences detected among them which ranged between 79% and 83% compared to 50.33 in the control. There was a significant reduction (69.17%) in the viable buds for the vines applied with hand weeding.

Table 4.6. Influence of floor management on the buds viability

Treatment	No. of viable buds	Viable buds (%)	Bud break date (day)
Control	25.17	50.33c *	80.4a
Wheat Straw	38.83	79.33a	69.8c
Cover Crop	41.58	83.17a	71.5b
Composted Manure	41.33	82.67a	70.0bc
Woodchips	41.92	83.83a	70.6bc
Leaf Litter	39.92	79.83a	69.9c
. Geotextile	39.92	79.83a	71.7b
Black Polyethylene	40.42	80.83a	69.0c
Hand Held	34.58	69.17b	74.5b
Chemical Control	43.33	86.67a	75.4b

* Means followed by the same letter in each column are not significantly different based on Duncan's Multiple Range test (p=0.05).

4.2.5. Vine shoots growth

The calculation of increase in percentage for each positive character as we shown here and other tables are useful for comparing information where the sample sizes, length, totals etc. are different. Therefore, in the first reading during March 2018, percentage of shoot length was higher in both organic mulches viz. WS, CM, and synthetic mulched plots of GEO, BP, and HH and ranged between 15.97-19.89% (Table 4.7).

Table 4.7. Influence of floor management on the mid shoots growth

Treatment	Shoot length (cm) 30 March	* * Increase in shoot length (%)	Shoot length (cm) 21April	Increase in shoot length (%)	Shoot length (cm) 21 May	Increase in shoot length (%)
Control	22.83	0.00e*	88.48	0.00e	114.08	0.00
Wheat Straw	28.00	18.46 a	100.86	12.27c	174.73	34.71a
Cover Crop	26.67	14.39bc	110.15	19.67a	116.92	2.43d
Composted Manure	27.17	15.97ab	106.84	17.18a	144.75	21.19c
Woodchips	26.50	13.85bc	101.13	12.51c	173.50	34.25a
Leaf Litter	27.00	15.44b	95.09	6.95d	177.92	35.88a
. Geotextile	28.50	19.89a	105.42	16.07ab	161.00	29.14bc
Black Polyethylene	27.50	16.98ab	96.98	8.76cd	146.58	22.17b
Hand Weeding	28.50	19.89a	104.13	15.03b	151.75	24.82b
Chemical Control	26.17	12.76cd	102.38	13.58bc	121.25	5.91d

* Means followed by the same letter in each column are not significantly different based on Duncan's Multiple Range test (p=0.05).
* * % increasing of shoot length computed according to the equation= **(trt. – cont.) / trt. x 100**

These results are in agreement with previous studies which reported that black polyethylene mulch showed noticeable increases in mid shoot length for two years (Ferrara et al., 2012). The mulching materials probably retained and increased soil moisture close to the root system that increased shoot length.

During April, the effectiveness of mulches such as CP, CM, and GEO were continued on the vines' shoot growth, since the percentage increase ranged between16 and more than 19% compared to 6.95% and 8.76% for plots of LL & PB and BP, respectively. This may be due to high soil fertility that stimulated plant vigor with higher root density and subsequently improved uptake potential with increased soil moisture (Schreiner et al., 2013). Using glyphosate before vine bud break increased shoot biomass by 13.58%.

After a month, a third reading in late May exhibited a peak shoot growth when transgressed one meter in length particularly in the organic mulch plots of WS, WCH and LL plus PB, which subsequently gave considerable increase in shoot growth that exceeded by n0062 34% compared to 2.43% and 5.91% for CP and CC plots.

4.4. Vine Leaf Area and Chlorophyll Content

Average leaf area and fresh weight was altered by treatments compared to control (Table 4.8). Leaf area at bloom increased remarkably to 177.45, 171.43, and 172.35 cm^2 in plots of synthetic mulches i.e., GEO, BP, and herbicide plots, respectively followed by 161.5, 163.08, 164.4, 159.15 cm^2 in plots of organic practices such as WS, CP, LL&PW, and WCH, respectively compared to 126.5 cm^2 in control. This increase in leaf area was due to an increased number of shoots which ranged between 19.89 and 27, pruning weight per vine were also affected by organic practices and synthetic mulches in 2018 with an average increase 56-96 % in proportion to non-mulched treatment (Table4.2). These justifications were consensuses with Curtis (2014). Subsequently, increasing differences of leaf fresh and dry weight in most treatments adopted on the leaf size though converging and non significant values between them. Chlorophyll not differed by treatments at bloom and at veraison in except of control that consist 27.15 and 37.42 SPAD, respectively.

Table 4.8. Leaf Area, Fresh & Dry Weight and Chlorophyll Content

Treatment	Shoot/vine	Leaf area(cm^2)	Fresh weight (g)	Dry weight (g)	Chlorophyll (SPAD)	
					Bloom	Veraison
Control	19.17	126.50c	2.26 e	0.79 c	27.15 c	37.42 b
Wheat Straw	25.77	161.50 ab	3.84 a	1.14 abc	38.09 a	40.52 a
Cover Crop	21.67	163.08 ab	3.54 ab	0.98 bc	33.14 ab	41.20 a
Composted Manure	21.00	141.43 bc	2.68 d	1.24 ab	34.44 ab	42.42 a
Woodchips	27.00	159.15 ab	3.32 abc	1.06 abc	32.45 ab	38.41 ab
Leaf Litter	25.83	164.40 ab	3.54 ab	1.42 a	32.31 ab	38.58 ab
.Geotextile	24.83	177.45 a	3.68 ab	0.92 bc	34.65 ab	41.92 a
Black Polyethylene	19.89	171.43 ab	3.57 ab	0.93 bc	31.18 b	41.76 a
Hand Weeding	23.67	149.70abc	2.99 cd	1.15 abc	36.09 ab	40.18 a
Chemical Control	24.33	172.35 a	3.34 abc	1.04 abc	35.31 ab	39.31 ab

* Means followed by the same letter in each column are not significantly different based on Duncan's Multiple Range test (p=0.05).

4.5. Vine nutrition

N and K in petiole tissue varied according to vine floor treatments (Table 4.10). There was a greater concentration of N in the mulched plots of BP and GEO (1.12 and 1.14%) compared to 0.83, 0.86 and 0.88 % in the control, HH and herbicide application, respectively. Increase in N concentration for mulched plots were more than 25% in comparison with the control. The most probable reason for this was that organic N provided by the residues was mineralized and became available as nitrate and ammonia leading to increased concentration of N available to vine compared to non-mulched treatments (Curtis, 2014). The other possible benefits of mulch include increase of root density which increase N uptake due to higher soil moisture (Becel et al., 2012; Curtis, 2014). The latter not only created favorable conditions for soil micro flora that mineralize N but can augment nitrate solubility and vine root uptake.

In contrast, P concentrations were non-significant in different plots though organic managements of CM, WCH and LL & PB resulted in increase in P by 24-29% compared to control. Potassium concentration was 2.63 and 2.78% for inorganic mulched plots that correspond to increase of 22.05 and 26.26%. Petioles from mulched and some organic treatments of LL & PB were also higher in K than HH and herbicide application. Worthily, potassium is needed for cellular solute movement, and clusters require high level of K for development. In this aspect, Pool et al. (1990) found 34% increase in grapes petiole K when oat mulch was used compared to sod, cultivation and herbicide treatments.

According to current nutrient recommendations recorded by Skinkis and Schreiner (2011), some treatments in this study were close to deficiency threshold though there were no visual symptoms of lack of minerals such as discoloration, necrosis or fruit set. In our study, the smaller vine size at bloom may have been more sensitive to differences in vine nutrition, thus; canopies with larger leaf areas showed reduced leaf N contents despite irrigation and crop load being held constant. On the other hand, lower petiole N, lower SPAD for CR plots may be referred to N use by cover crops growing in the alley which take up N and other nutrients from the soil; this uptake was reduced in legumes due to N fixation by rhizobium bacteria (Voisin et al., 2002). Residue nutrients were returned to mulched treated plots and moved into the vine row in these plots whereas in the CR, HH, and a cover crop that is mowed repeatedly and removed might had resulted in weaker vines.

Table 4.9. Nutrient concentration of vine leaf petioles collected at bloom.

Treatment	N %	Increase in N (%)	P (%)	Increase in P (%)	K (%)	Increase in K (%)
Control	0.83c*	0.00	0.22a	0.00e	2.05d	0.00
Wheat Straw	0.96b	13.54	0.26a	15.38	2.32b	11.64
Cover Crop	0.92b	9.78	0.28a	21.43	2.25b	8.89
Composted Manure	0.99b	16.16	0.31a	29.03	2.19b	6.39
Woodchips	1.06a	21.70	0.29a	24.14	2.17b	5.53
Leaf Litter	1,04ab	20.19	0.31a	29.03	2.38ab	13.87
.Geotextile	1.13a	26.55	0.27a	18.52	2.63a	22.05
Black Polyethylene	1.12a	25.89	0.24a	8.33	2.78a	26.26
Hand Weeding	0.86c	3.49	0.23a	4.17	2.13bc	3.76
Chemical Control	0.88bc	5.68	0.25a	12.00	2.15c	4.65

* Means followed by the same letter in each column are not significantly different based on Duncan's Multiple Range test (p=0.05).

4.6. Root Growth:

According to ANOVA, vine root growth; woody root length, woody and fine root density and subsequently total root density were affected greatly by its location, and developed substantially (P=0.05) within rows than alley regardless of ground cover type and soil depth.

Woody root length and root density of vines within rows developed to 0.260 mm/g soil and 0.369 mg/g soil compared to 0.161 mm/g soil and 0.263 mg/g soil in alley, respectively. Celette et al. (2005) and Morlat and Jacquet (2003) illustrated that there were differences in root development between vine row and alley due to competition with perennial grass roots. The total root density within rows was increased by 25%, and increase in woody roots was more than 28% compared to 12.09% for the fine roots. The length of fine roots within rows reached 0.091 compared to 0.080 mm/g soil in alley (Data not shown). The average of all treatments, location of vine row and alley, soil depth, and mulching are shown in the figures below.

Soil depth: Total root density was 0.498 mg/g soil at 20-40 cm soil depth. This significant increase in root growth depended greatly on woody roots with 0.421 mg/g soil though their length extended remarkably to 0.253 mm/g soil at 20 cm soil depth, in addition to considerable fine root density of 0.107 mg/g soil (Data not shown).

Mulching: Total root density of 0.462 mg/g soil in organic mulch LL &PB treatment was coincide with remarkable woody root density culminated 0.375 mg/g soil, followed by 0.345 and 0.347 mg/g soil in plots of CM and CP. In contrast, woody root length was 0.234 mm/g soil in CR plots followed by 0.22 5mm/g soil in HH practicing compared to 0.212 mm/g soil in the LL plots. Fine root growth was similar in the most practicing plots (Data not shown).

Analysis of Location x Depth clarified that the total woody root density of vines within rows was 0.557 mg/g soil at 40 cm (Fig. 189-A), and much of woody roots 0.475mg/g soil were reproduced at the same location (Fig.18-B). In contrary, the apparent woody root length extended considerably to 0.302 mm/g soil at 20 cm depth with noticeable density of fine roots 0.112 mg/g soil (Fig.18-C&D).

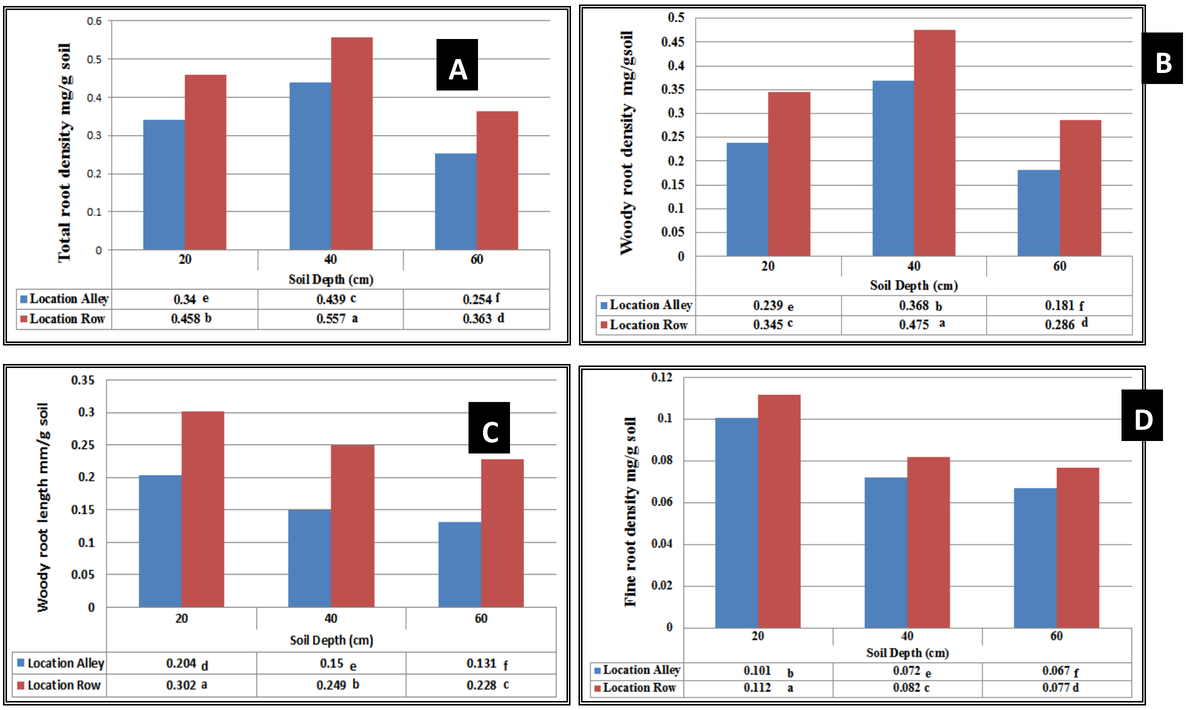
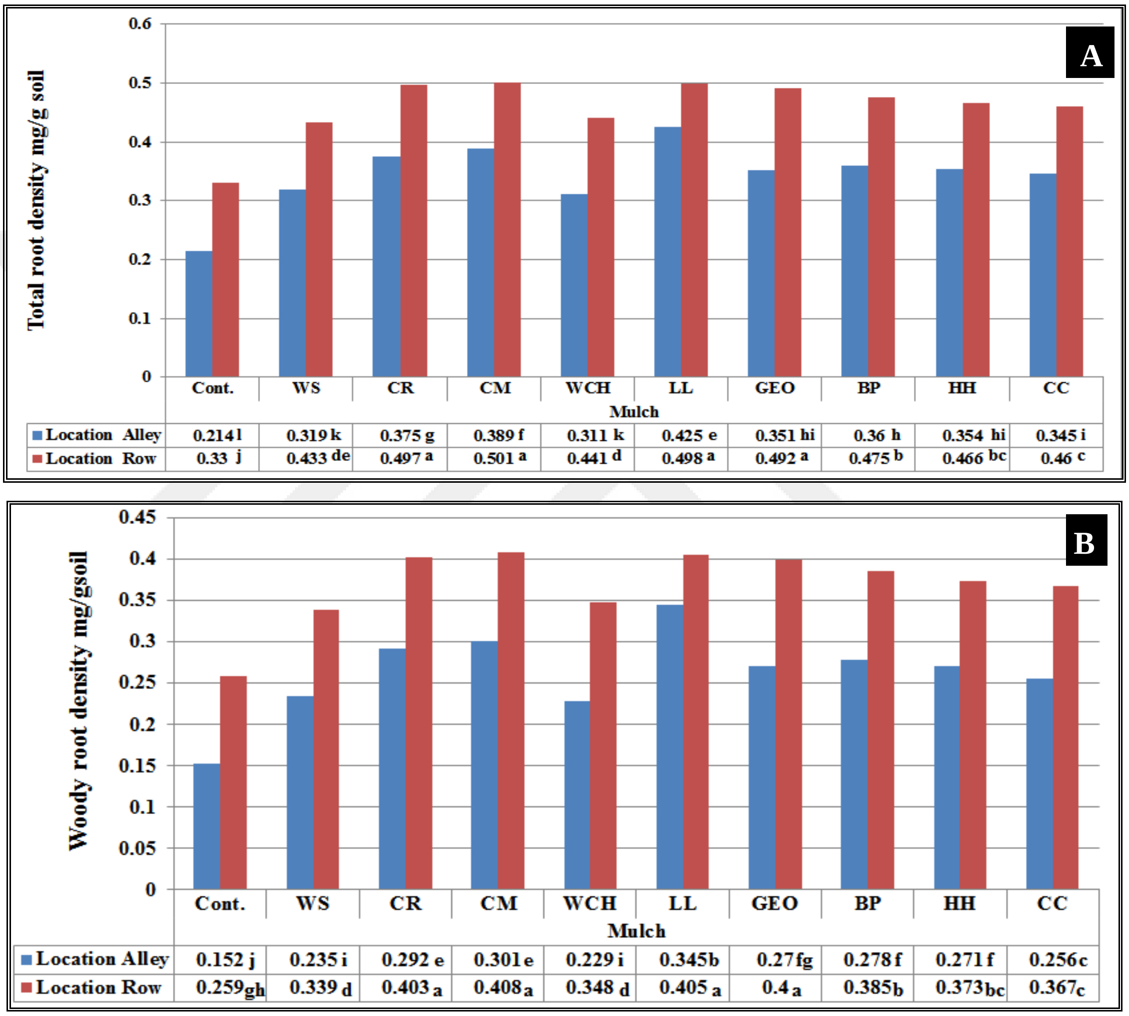
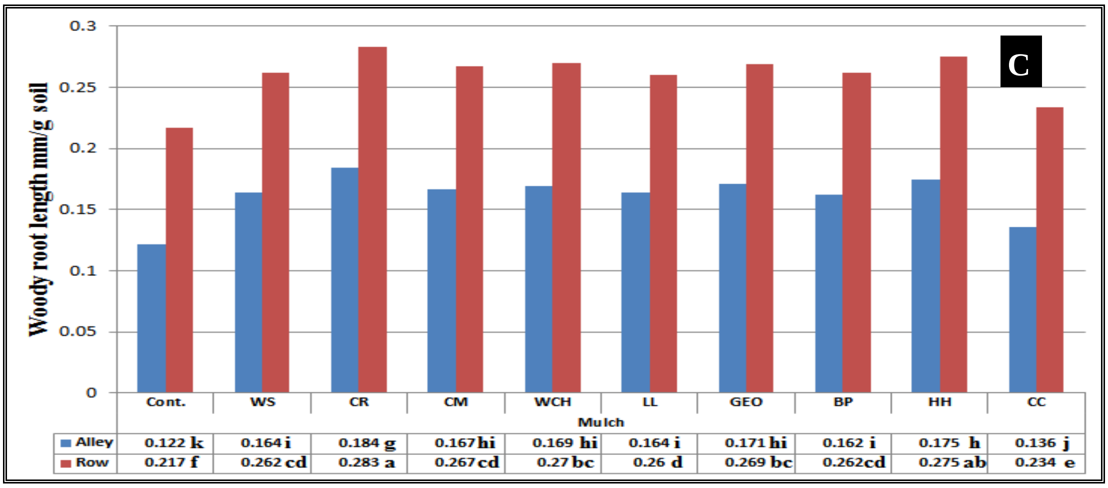


Figure 4.1. Effect of soil depth on the vine total root density with in row and alley (A), woody root density (B), woody root length (C), and fine root density (D).

Statistical analysis of Location x Mulch illustrated the similarity of organic mulches viz. CP, CM, LL&BP and GEO (a synthetic mulch) in their significance to increase each of total root growth and woody root density (Fig. 4.19-A &B). This shows that the mulch was providing beneficial conditions for root proliferation in the vine row, but it also may be due to increased soil nutrients from the mulch decomposition.



However, the distinguishable effect of woody root length was apparently in the vine rows particularly in the plots of CP (0.283), HH (0.275), and GEO (0.269) mm/g soil (Fig.4.19-C). The fine roots growth within vine rows was not affected by mulching, since most of these practices were incomparable (Fig.4.19-D).



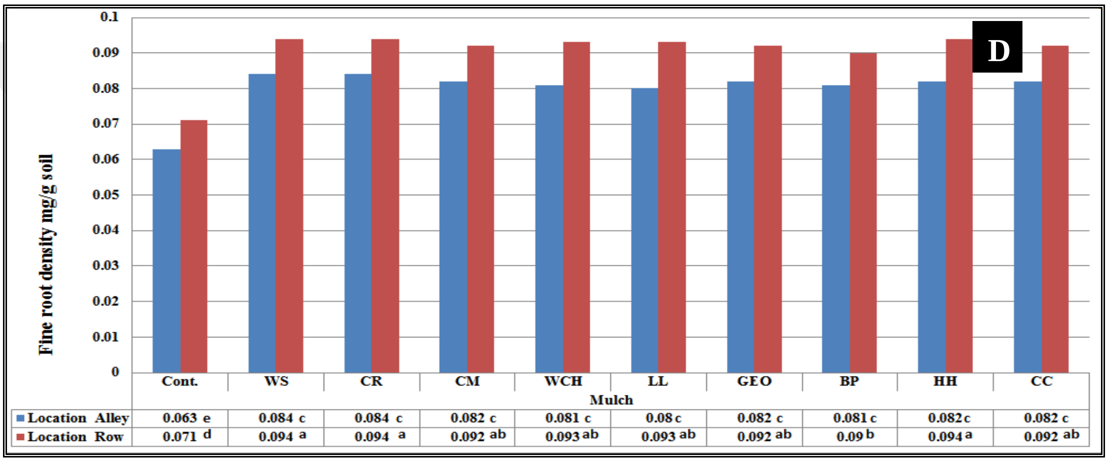


Figure 4.2. Effect of mulching on the vine total root growth within row and alley (A), woody root density (B), woody root length (C), and fine root density(D).

Analyzed data of Depth x Mulch explained the development total root density evident at 40 cm with a significant growth in plots of BP (0.561 mg/g soil) and CR (0.552 mg/g soil) (Fig.4.20-A). There was considerable accumulation of woody roots at the same soil depth, especially when BP, CP, and CM were practiced, woody roots were 0.482, 0.473, and 0.467 mg/g soil, respectively followed by other organic and synthetic treatment of GEO (Fig. 4.20-B). The root length exceeded at soil depth of 20 cm with remarkable growth reached to 0.292 mm/g soil in plots of LL&PB (Fig. 4.20-C). No differences were found between mulch plots in their fine roots density at the soil depth of 20 cm (Fig.4.20-D). However, vines in non-mulched treatments had roots more evenly distributed across both the vine row and the alley soil. This is despite the effect of root damage by tillage in the alley which was not quantified and may have caused root mortality in the 0 to 20 cm profile as was found by Van Huysteen and Weber (1980 b).

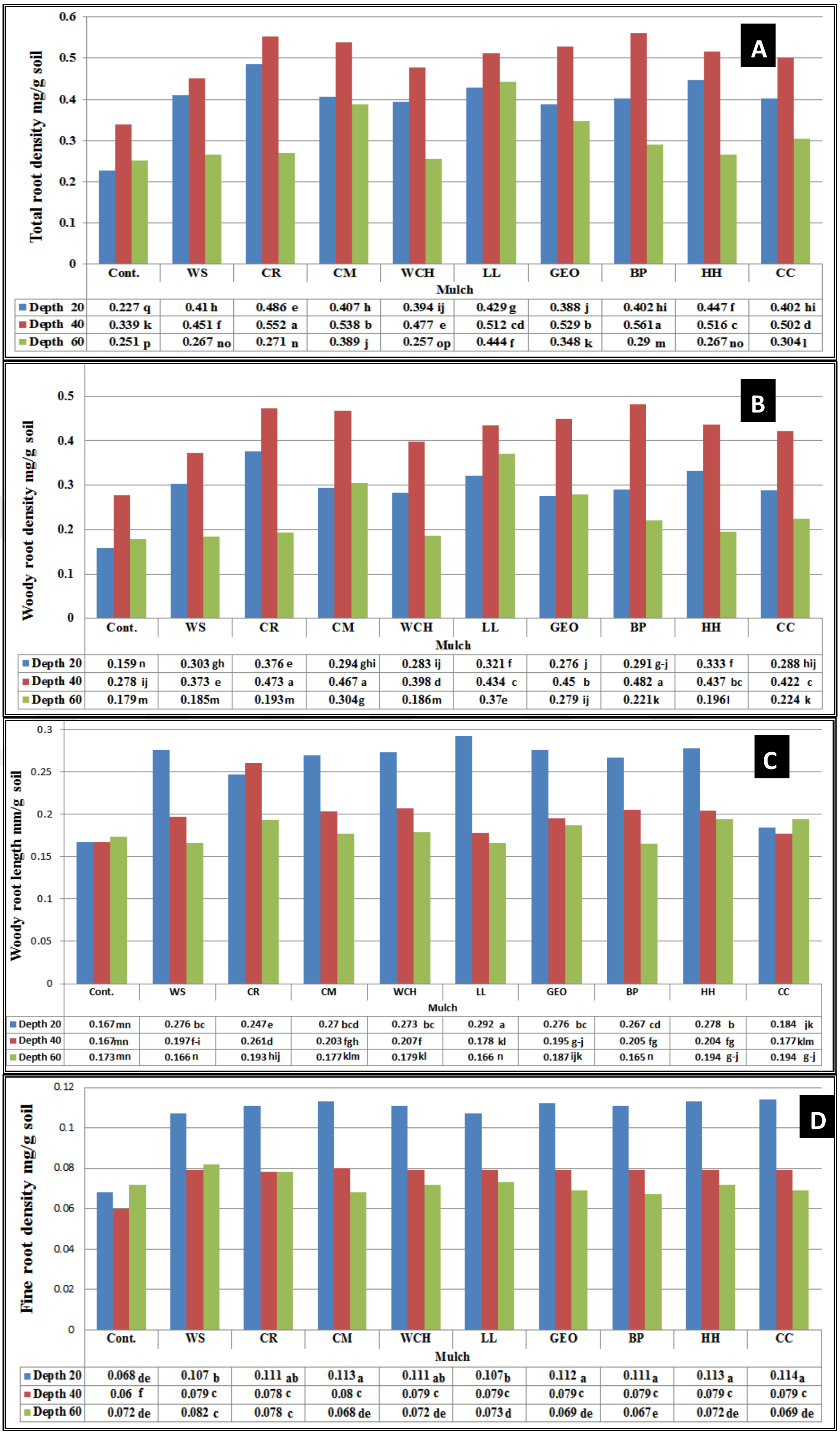


Figure 4.3. Effect of mulching on the vine total root growth at different soil depth (A), woody root density (B), woody root length (C), and fine root density(D).

4.7. Grapevine Yield and Fruits Quality

The **g**rapevine characters were influenced by mulching practices. Organic materials of WCH and CM were the best mulching, since yields were increased to 5.15 and 5.88 kg per vine and average cluster weights were 271 and 346 g. In contrast, other practices resembled in their yields except the herbicide application which reduced vine production to 4.22 kg.

Berry weight was also affected by ground management particularly when applied with CP, CM, WCH, and LL (Table 4.10). Grapes juice pH and percentage of TSS were not greatly varied in most plots. However, fruits derived from treatments of WS and CC were less preferred because of their low contents of soluble solids concentration and increase of pH.

Table 4.10. Influence of floor mulching on the grapevine yield and fruits quality

Treatment	Yield (kg/vine)	Vine cluster (no.)	Average cluster weight (g)	Berry weight (g)	TSS (%)	pH
Control	2.38 d *	12	198 d	2.29 d	16.9 c	3.15 a
Wheat Straw	4.39 bc	17	258 bc	3.92 a	17.0 c	3.10 b
Cover Crop	4.43 b	19	233 bc	3.34 b	18.9 a	3.11bc
Composted Manure	5.88 a	17	346 a	3.57 b	18.8 a	3.07 d
Woodchips	5.15 a	19	271 a	3.73 ab	19.2 a	3.12 bc
Leaf Litter	4.49 b	21	214 c	3.91 a	18.7 ab	3.07 b
.Geotextile	4.77 ab	18	265 b	3.87 a	18.2 b	3.10 c
Black Polyethylene	4.38 bc	20	219 c	3.03 bc	18.0 bc	3.09 c
Hand Weeding	4.49 b	17	264 b	3.05 bc	17.3 c	3.13 b
Chemical Control	4.22 c	18	222 c	2.98 c	17.9 bc	3.12 bc

* Means followed by the same letter in each column are not significantly different based on Duncan's Multiple Range test (p=0.05).

4.8. Soil Quality

Firstly, summer months of 2018 were the hottest in Iraq compared to previous three years and had no rainfall from mid-July until harvesting time in September. Soil moisture was influenced by mulching treatments and was consistently higher under both of the organic and non-organic mulch practices when compared to non-mulched treatments. According to the results shown in Table 4.11, the thicker mulch layer provided by the organic ground cover of CM was the best mulch in preserving soil moisture (14.32%) and thereafter it increased soil bulk density significantly to 1.72 g/cm^3, followed CP and WS with more than 13% moisture compared to 7.31% in control.

Drip irrigation systems in most of the vineyards are only used during establishment and during drought events. The results of this study show that mulch can be used to preserve soil moisture in the vine row through dry hottest summer months, and may be an appropriate substitute for irrigation systems and would be sufficient to avoid drought conditions.

The soil porosity is considered crucial factor for moisture preserving, hence the different synthetic and organic mulching practices improved soil porosity within a range of 0.40 to 0.53%. Particularly important mulches in this regard were LL & PB, WCH, and GEO compared to in control (0.37% porosity). In this aspect, Dry and Loveys (1998) suggests that vines can have growth benefits from additional soil water availability without differences in vine water status. This is due to regulation by abscisic acid (ABA) that is produced in the roots during dry soil conditions independent of vine water status (Stoll et al. 2000). Thus, mulching was effective in altering water status in vines grown in arid regions, and vines mulched with olive pomace and black geotextile had higher stomata absorption rate when compared to vines with mowed native vegetation or black polyethylene covered vine rows (Ferrara et al., 2012).

Table 4.11. Physical soil properties of mulching treatments

Treatments	Soil Moisture (%)	Bulk Density (%)	Soil Porosity (%)
Control	7.31 f *	1.22 f	0.37 c
Wheat Straw	13.22 b	1.56 bc	0.43 b
Cover Crop	13.52 b	1.54 bc	0.44 b
Composted Manure	14.32 a	1.72 a	0.40 b
Woodchips	8.87 d	1.58 b	0.48 ab
Leaf Litter	8.45 de	1.43 de	0.53 a
.Geotextile	11.12 c	1.39 e	0.48 ab
Black Polyethylene	8.93 d	1.50 cd	0.45 b
Hand Weeding	8.39 ef	1.44 de	0.42 b
Chemical Control	7.99 ef	1.42 de	0.42 b

* Means followed by the same letter in each column are not significantly different based on Duncan's Multiple Range test (p=0.05).

The chemical soil properties were also positively changed in the mulched plots (Table 4.13). Organic mulched treatments of CM gave elevated soil carbon (2.29%) which resulted in an optimum C/N (27.26). WCH and WS treatments had 1.84 % and 1.88% organic matter, respectively and this may due to the decomposition process of manures particularly in the upper soil surface, which is typical for most soils (Peregrina et al. 2010). These results suggest that soil organic matter increased enough to 3.92% and 3.25% in the plots of CM and both of WS and WCH, respectively and was reduced considerably to 1.64% in control. The indirect effects of application of glyphosate are the partial loss of soil fertility due to poor soil content of organic matter that reached to 2.18% that not varied with HH and CP. These results were in agreement with Steenwerth and Belina (2010).

Table 4.12. Effect of mulching practices on the soil chemical properties in the vineyard

Treatments	pH	E.C. (ds/m)	OM (%)	Organic C (%)	Total N (%)	P (ppm)	C/N
Control	7.85 a *	0.25 d	1.64 e	0.95 g	0.112 d	11.88 e	8.48 c
Wheat Straw	7.74 ab	0.30 bc	3.25 b	1.88 b	0.140 b	14.41 d	13.42 b
Cover Crop	7.46 c	0.25 d	2.21 d	1.74 c	0.122 c	14.72 d	14.26 b
Composted Manure	7.81 a	0.37 a	3.92 a	2.29 a	0.084 d	34.12 b	27.26 a
Woodchips	7.74 ab	0.23 d	3.25 b	1.84 b	0.168 a	21 .00c d	10.95 bc
Leaf Litter	7.59 bc	0.23 d	2.22 e	1.30 ef	0.154 ab	13. 38 de	8.44 c
.Geotextile	7.77 a	0.25 d	2.78 c	1.60 d	0.140 b	23 .78 c	11.43 b
Black Polyethylene	7.77 a	0.30 bc	2.72c	1.60 d	0.140 b	37.16 a	11.43 b
Hand Weeding	7.72 ab	0.26 cd	2.23 d	1.36 e	0.115 c	17.06 d	11.83 b
Chemical Control	7.85 a	0.34 ab	2.18 d	1.29 f	0.113 cd	13.57 de	11.42 b

* Means followed by the same letter in each column are not significantly different based on Duncan's Multiple Range test (p=0.05). OM: Organic matter.

4.9. Effect of Vineyard Practices on the Incidence of Powdery Mildew

Initial disease symptoms caused by *Erysiphe necator* (Schw.) Burr., was observed on the grapevines canopy at full bloom. Apparently, incidence of powdery mildew on the vines canopy and clusters increased significantly in the control i.e., the non-mulched treatment; the leaves in this treatment had infection of 39.2% and clusters had 0.3 %

infection (Table 4.14). Most of mulching practices demonstrated inhibitory effects on disease incidence and severity particularly the organic mulches of WS, CM and inorganic mulches of BP and GEO in addition to HH and CC. No variance was found between WCH, LL and control. It is widely presumed that pathogen's conidia originating from fungal colonies are primary source of infection for fruits infection (Gadoury et al., 2001); the occurrence of disease continued from bloom to late period of harvesting.

Table 4.13.Effect of grapevine floor mulching on the occurrence of powdery mildew

Treatment	No. of infected leaves/shoot	Leaf infection (%)	Cluster infection (%)
Control	7.8	39.2 a *	0.3 a
Wheat Straw	2.8	11.3 c	0.0 b
Cover Crop	2.5	8.9 c	0.0 b
Composted Manure	3.3	25.7 b	0.1 b
Woodchips	4.8	30.7 ab	0.1 b
Leaf Litter	6.2	35.4 a	0.1 b
Geotextile	2.0	9.7 c	0.3 a
Black Polyethylene	1.9	6.9 cd	0.0 b
Hand Weeding	1.7	8.4 c	0.1 b
Chemical Control	0.2	10.2 c	0.0 b

* Means followed by the same letter in each column are not significantly different based on Duncan's Multiple Range test (p=0.05).

CHAPTER 5

DISCUSSION

5.1. The effect of Applications on Weeds

Until mid-2018, all of organic and synthetic mulch materials were in good conditions. After this duration, the GEO and black polyethylene had been destroyed by storms, warm sunlight, and precipitation (Table 4.7). These results are in agreement with Ingels et al. (2005) and Wasco (2010). However, efficacies of mentioned practices in controlling weeds may extend for two years suggesting its possible agronomic utility.

Weed covers were lower in the most organic mulches having 10 cm thickness because of maintaining a permanent groundcover which resulted in weed seed decay, and inhibition of pre and post seedlings emergence and growth. In June, favorable conditions for seed germination and growth were observed clearly in herbicide and compost manure treated plots.

5.2. Dormant Pruning Wood

The most common weeds in the in the experimental site were large crabgrass (*Digitaria terrestris*) 16.63%, witchgrass *Panicum capillare* 17.06%, barnyard grass (*Echinochloa crus-galli*) 17.48%, and canary grass *Phalaris minor* 18.55% (Table 4.1). Therefore, the damage of cyclic infested weeds reverberated on the weaken vines, since visually the vigorous one produced a large amount of the pruning cuttings.

More variation was found in the managed vines' floor, and though most studies confirmed that cover crops had inefficient impacts; lower pruning weight, lower lateral shoots, increased openness canopy particularly in a dry warm sites i.e. 300 mm annual precipitation (Tesic et al. 2007). However, a high pruning in the plots cultivated with cover crop of rye constituted 44.74% (Table4.2). Another trial revealed that composted plots for two seasons increased pruning weights from 8 to 18% over control non treated plots. In our study, composts treated vines had pruning weights 32.69% higher than un-treated vines. However, no differences has been reported in pruning weights caused by types of compost (Biala, 2000). Literature confirmed that organic mulch of wheat straw and composted manures increased shoot length, encourage roots growth that stimulated vine growth and increased pruning weight. However, straw mulch resulted in a lower soil temperature than bare soil. Therefore, bud numbers were reduced in mid-spring and bud break delayed presumably by the lower soil temperature. Worthily, composted wheat straw may take three years of mulching before vine vigor was observed (Porter, 1999).

Inorganic mulches of colored plastic film increased vine vigor and pruning canes. Brown and blue film particularly prevented weeds for emerging Furthermore, polyethylene and geotextile mulches were useful under fluctuating climatic conditions i.e., a cool short season during winter and a very hot season during summer (Hegazi, 2000). For our knowledge, the damage of cold to vulnerable species of grapevines (winter dying) was 151.88 g; 30% in control, and the highest winter dying found in plots of WCH 114.88 g; 12.93 % (Table 4.3). Thus, winter dying was reduced by 24.36%.

The cold dying tissue characterized by explosive ice formation inside the cells, ruptures plasma membrane and kills the cells content for the entire plant. Therefore, the fertility and subsequently potential productivity of the primordial buds decreases. The shoots and expanded leaves, depends entirely on stored food within the vine, frosts of early spring can deplete stored reserves within the vine tissues, and subsequently affecting development of shoots, flowering, and fruiting. Indeed, floor cover, grass cover, or different mulches in Europe may have a major influence and may reduce temperatures by 4-6 ºF.

5.3. Growth of Mid Shoots

The higher rate of mulch did not perform better than the low rate in most vine growth measures. Cover crop residue produced 19.67% more shoots in April from a single adjacent alley which means mulch can enhance vine growth (Table 4.6). The effect of magnitude of the mulch on shoot length was similar to differences reported by Van Huyssteen and Weber (1980b) for effect of wheat straw mulch on vines. Locally, orchard men knowing that organic manure effects in previous years were significant enough to have a legacy effect on shoot growth. Legacy growth effects would be due to increased growth post-bud break through increasing carbohydrate or nutrient storage. This may be an important result when considering the transition to full production because increased vegetative growth is not the goal of most vineyards during production years (Table 4.6). This legacy effects indicate that cover crop residue mulch or cultivation or weed mowing can be used in young vineyards without having the potentially negative long term impact of creating excess vegetative vigor.

5.4. Leaf Area, Chlorophylls and Vine Nutrition:

Leaf greenness was tested at bloom and veraison using Soil Plant Analysis Device (SPAD); a value correlating to the amount of chlorophyll and N that the leaf contains (Table 4.9). Fanizza et al. (1991) reported that chlorophyll readings are closely related to total leaf content of vines and provide a non-destructive method for measuring this parameter. The method was chosen for use in this trial to make comparisons with the vines receptivity for photosynthesis.

Readings were taken from mature, non-damaged basal leaves and where possible leaves were selected one up from the very basal leaf on fruiting shoots of the same age.

A positive relationship was found between SPAD and petiole N at bloom, and an increase of soil nutrients due to breakdown and mineralization of organic mulches. Therefore, tissue N and SPAD results suggest that mulched vines benefited from increased N availability in the soil (Findeling et al., 2007). The variability was possibly due to the variation in photosynthesis that affected development of individual leaves and may lead to decline at the end of season. However, mulched practices had higher chlorophyll as estimated by SPAD, this may indicate usefulness from the breakdown of mulch N and subsequently chlorophyll requires a large N investment by plants (Niinemets,2007) and has been positively related to leaf nitrogen content (Percival et al., 2008).

At a veraison, leaf chlorophyll increased relatively compared to their contents at bloom, but differences were not found between managed plots beyond non practiced control treatment. The latter was also similar with organic mulches of LL & PB and WCH.

5.5. Root Growth

The vineyard was watered with drip irrigation that restricted more water within rows than alleys. There were root growth differences caused by mulching treatments. The increasing soil moisture resulted in decreased soil mechanical resistance which can lead to activated root elongation.

Soil moisture allows some nutrients, including N, to become more soluble and available for vine uptake. Neve and Hofman (2002) reported that N mineralization from both soil amended with plant residues and not amended soil increased with increasing soil moisture. This could lead to preferential growth with respect to nutrient concentration as was found by (Zhang and Forde, 2000).

5.6. Grapevine Yield and Fruits Quality

This project is the first academic study on weed management and grape performance for vineyards under local climates in Duhok, Iraq.

Mostly organic and synthetic mulches are important practices for weed control and improve soil health and fruit yield (Hartwig and Ammon, 2002). The continental climate of Iraq is cooler with moderate to high precipitation during winter. Moreover, the study was conducted during 2018 when the climate was unusually hot and dry, particularly in which the vineyard experienced drought stress.

In general, all fruit grades were within required description. However, fruit derived from most plots were contained less percentage of soluble solids with increasing in pH.

The study clarified that environmental conditions particularly of adequate soil moisture listed by Jones and Davis (2000) consider a crucial factor during the hottest months of June to September when vines reached fruit set, clusters bunch and ripening (Table 4.11).

Mulched plots had higher number of clusters, cluster weight and yield. The most important factor in determining cluster number is not well understood, but it is most likely based on available carbohydrates and N resources (Bennet et al., 2005). Other studies relate fruitfulness to N, hence both high and low levels of N have resulted in reduced fruitfulness (Keller and Koblet, 1995). Additionally, high N availability can cause dense canopies which can also reduce fruit set in buds. However, the crucial factors here are the late season leaf pulling and canopy manipulation that exposed the fruit near veraison, causing some sunburn, berry desiccation and cluster abscission. Berry weight was greater in fruits harvested from WS, LL, and GEO mulch plots (Table 4.11).

5.7. Soil Quality

Increased soil moisture in vineyard soil may be due to soil shading under both types of organic and inorganic mulches in addition to dense shade of grapevines. Although from visible observations inorganic layers lasted longer compared to organic residue layers which no longer apparent at fruit bunch and harvest due to the predominant highest air temperatures during fruiting (Table 4.12). This shows that the mulch layer had a direct effect on soil moisture retention through shading and insulation.

In vineyard production, maintaining soil moisture is critical for vine health and vigor. Therefore, absence of summer precipitation can lead to growth limitation for vineyards in non-irrigated or where there is inadequate water. In this work, there was evidence of water stress with symptoms of partial wilting and the foliage discoloration.

Studies of Stoll et al. (2000) and Yang et al. (2002) suggested that root drying triggers synthesis of ABA in roots, a plant hormone that signals stomata to close to reduce evaporative loss and slowing carbohydrate degradation. Root drying may not have occurred in most plots due to soil moisture available in drier years establishing while vines would be susceptible to this effect.

Though the mulched vines could gain from more available soil water for root elongation, larger vines, or vines with a higher growth rate, would utilize more soil water than smaller vines without showing stress symptoms. Subsequently, this is due to more leaf surface area for transpiration, and more water allocated to cellular growth.

The shading mulch layers were able to effectively buffer against high temperature, and the soil that remains cooler is less prone to evaporation; this is one of the factors possibly maintaining increased soil moisture under the mulch. Studies show that evaporation rate decreases with a reduction in soil surface temperature (Qiu et al. 1999).

5.8. Soil Carbon and Nitrogen

The organic C from mulch materials and crop residue may have been fully decomposed and lost as CO_2. It is possible that a temporary increase in soil C occurred attributed to the significant C content of the weed cover residues, and decomposition generally leads to an increase in the soil carbon, microbial dynamics and C-based organic matter temporarily increases (Wolf and Wagner, 1999).

The nutrient composition particularly soil (C/N) ratio determines the decomposability of soil organic matter and N availability to plant. The ratio in different treatments was not close to optimal balance levels 20-30:1, which is often considered a break-even point between soil nitrogen becoming more or less plant-available during decomposition (Myrold, 1999). Soil microbes will utilize available soil N during organic matter metabolism if there is not enough N content in the residue, initially reducing the amount available N in the soil for vine uptake. Over a longer time scale, the residue would have been a source of N to the soil and residue would have been mineralized.

Other nutrients were also available for plant use, especially the nutrients such as K and Fe were high in concentration in the residue. It is difficult to separate the tissue nutrient benefits of mulch decomposition from additional uptake from a more established root system. However, the high levels of organic matter typically found in the Duhok soils are a good source of plant available N without additional inputs, but the vine must have the root system to intercept these transient inorganic forms (Table 4.13).

Nitrogen dynamics can change rapidly over short periods of time (Steenwerth and Belina, 2008b), and differences in plant-available N may have occurred during the time of residue breakdown without lasting effect on total N. Nitrate, the principle form of N for vine uptake (Perez and Kliewer, 1982), is easily leached during precipitation events. It is likely that soil nitrate differences would not persist during the heavy rainfall winters. It is difficult to remove vine and weed roots from the soil sample prior to analysis, and these sources of organic N may have influenced our findings (Horneck et al., 2011). Increase in vine leaf and petiole N and leaf chlorophyll suggest that N from the decomposing mulch was used by the vine, despite the lack of response in total soil N.

The outbreak dispersal of powdery mildew on grapevines in the experimental site during 2018 in Duhok possibly attributed to that the weather conditions at late spring of rain fall favored the secondary infection by conidia (Table 4.14). The latter do not need free water for germination and dense formation of germ tube (Pearson and Gadoury, 1992). Thus, powdery mildew infection by direct infection of sexual ascospores may be unrecognized on the vines foliage, but intensive disease may be prevailed on fruits where ascospores are released during repeated rainfall (Gadoury et al., 1997). In the same time, Austin and Wilcox (2012) illustrated that UVB radiation of full sunlight inhibited conidial germination and mycelia growth of *E. necator* and suppressed the fungal colonization (latent period).

CHAPTER 6

CONCLUSIONS

This project provides information on weed management in vineyards using several types of organic and synthetic mulches compared to conventional practices of glyphosate application and tillage (hand hoeing), and their effects on the grapevine growth, and susceptibility to epidemic incidence of powdery mildew under continental climate viticulture in Duhok, Northern IRAQ.

This study illustrated that synthetic and organic mulches particularly wheat straw, wood chips, and leaf litter were maintained and accelerated foliage growth of grapevine and kept buds viability through delaying bud break to 70 days due to soil moisture conservation. In contrast, blue geotextile, black polyethylene, and glyphosate inhibited the weeds entirely during their apical growth in May and July, and increased leaf area that coincide with their contents of N and K. P concentration was increased in the organic mulched plots which led to demonstrated root density due to improvement in soil physical properties and elevated soil content of N and organic matter. However, WCH, and CM resulted in the best vine yield and fruit quality with a considerable inhibition of powdery mildew compared to control.

Continued monitoring and evolution of mulches within continental climate vineyards for several growing seasons will be essential for practical understanding the type of mulches that should be applied. Further research is needed to determinate the economic benefits and costs of various weed management practices in the vineyards.

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