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Effect of Fruit Preharvest Bagging and Some Botanical Extracts as Postharvest Treatments on Grapes (*Vitis vinifera L.*)

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A thesis

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DEDICATION

To My Parents

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I bow my head to ALMIGHTY ALLAH for the help guidance and blessing he has bestowed me. I am indebted to all who encouraged me to complete this research study.

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No.	Abbreviations	Item
1	*I. viscosa*	*Inula viscosa*
2	*M. syriaca*	*Majorana syriaca*
3	*T. vulgaris*	*Thymus vulgaris*
4	*S. officinalis*	*Salvia officinalis*
5	*V. iphionoides*	*Varthemia iphionoides*
6	*B. cinerea*	*Botrytis cinerea*
7	*P. expansum*	*Penicillium expansum*
8	*A. niger*	*Aspergillus niger*
9	*L. botrana*	*Lobesia botrana*
10	Kg	Kilo gram
11	Cm	Centimeter
12	O.D.	Optical Density

Abstract

A field experiment was carried out during the season 2011 in a private vineyard at Halhul-Hebron in order to study the effect of fruit preharvest bagging on grape (*Vitis vinifera* L.) cv. Halawani. The experiment was laid out in randomized complete block design with five replicates. Treatments were control (without bagging), paper bagging, brown cloth bagging, white cloth bagging, black cloth bagging, green cloth bagging, blue cloth bagging, red cloth bagging and yellow cloth bagging. For almost all parameters studied, the paper bagging and blue cloth bagging were the most effective treatments. The explanation may be due to reflected or absorbed rays from bags and their effects on grape cv. Halawani. The texture of paper bagging was smooth and reflect sunrays regularly, while blue cloth bag absorbed all spectrum colors and reflect blue wave.

A second experiment was conducted in the lab during the same season to study the effect of some botanical extracts as postharvest treatments on grape cv. Halawani. The experimental design was completely randomized design with five replicates. Treatments were control, chemical fungicide (Rovral), *Inula viscosa* (Clammy Inula), *Majorana syriaca* (Thyme), *Thymus vulgaris* (Thyme), *Salvia officinalis* (Sage) and *Varthemia iphionoides* (Varthemia). The most effective treatments on almost parameters studied in this experiment were *I. viscosa* and *V. iphionoides*. The explanation may be attributed to the presence of some active substances in these plant extracts and their mode of actions.

Introduction

Grape (*Vitis vinifera* L) is one of the most important commercially grown fruit crops in the world. It is cultivated under varied agro-ecological conditions, right from tropical to temperate and from cool-humid to hot-arid conditions (Anonymous, 2003).

In Palestine grapes come second in rank as the most delicious fruit, after olives (Issac and Hrimat, 1994; Tubaile and Alkowni, 2001).

Due to the unique geographical and ecological environment for growing high quality table grapes, its growing and production are still restricted to the southern part of West-Bank especially Hebron city, Halhoul, Beit Omar, Seir and Bethlehem areas. The area of land planted with grapes in the Hebron district was 44573 donums and the total production was estimated of 45,544 tons in 2010 season (MOA, 2010).

The most popular grape varieties planted in Palestine are: white varieties including Dabouki, Zainy, Salty, Hamdany, Jandaly, Bairoty and the other white varieties which were introduced to Palestine such as Sultanina, Perlette and Superior: Black varieties including Darawishi, Ballouty, Beitony and Shami; and red varieties including Halawani, Emperor, Cardinal and Fhaisy (Sultan, 2005).

Grape has a numerous uses of its fruit in producing juice, table grapes, dried fruit and organic compounds (Aigrain,1999). Grapes have a very special significance for the people of Hebron. Grapes are part of the cultural fabric and heritage of the population in Hebron and an indispensable food ingredient. In addition, grapes have a special economic and social significance for the Palestinian people, even though the yield of grapes in Hebron faces many difficulties, especially in marketing and promotion (Abu Alhalaweh, 2011).

The grape berry is a non-climacteric fruit with a relatively low rate of physiological activity (Millan *et al*., 2001). The grape clusters are subject to serious water loss following harvest, which can result in berry shatter, wilting and shriveling of berries and stem browning and drying (Crisosto *et al*., 2001). Further, stem stalk (rachis) respiration rate is approximately 15 times higher than berry respiration (Gardea *et al*., 1994; Mencarelli and Bellincontro, 2005).

The storage life of table grapes is influenced by ecological conditions at pre-harvest period and fruit maturity at harvest as well as post-harvest treatments. Grape deterioration can be due to physical, physiological, or pathological factors that may occur in the vineyard (preharvest) or after harvest (Crisosto *et al*., 2002; Zoffoli *et al*., 2009; Sen *et al*., 2012). Deterioration of grapes during storage is characterized by weight loss, stem browning, softening, shattering and decay (Crisosto *et al*., 2001).

As fresh fruit, grapes are delicate and the loss at harvest and during the distribution is high (Mencarelli and Bellincontro, 2005). The shelf life of grapes are short, especially of stem stalk, it is faster respiration. Pre/post harvest factors affects on post-harvest problems of grapes (physiological disorders and diseases). Although the use of synthetic pesticides and fungicides in plant protection had made a great contribution to plant protection, many are no longer used because of environmental or health concerns, or due to development of resistant strains (Pramila *et al*., 2008). The development of resistance to several pesticides, fungicides in moth and fungi were observed and several alternatives were suggested including preharvest bagging and botanical extracts.

Preharvest bagging has been shown to improve development and quality of fruits. Different light transmittance bags showed different effects on fruit quality (Chonhenchob *et al*., 2010). Biologically active

essential oils in some botanical extracts represent a rich potential source of an alternative and perhaps environmentally more acceptable disease management compounds (Meepagala *et al.*, 2002).

The objectives of this investigation were to:

1. Study the effect of different bagging color on grapes cv. Halawani.
2. Test some botanical extracts against storage diseases and physiological disorders of grapes.
3. Increase shelf life of grape clusters.

Chapter one

Literature Review

1.1 Description of Halawani grape

Halawani (*Vitis vinifera* L.) is a very popular grape variety in Palestine (Abu-Qaoud, 1999, Sultan, 2005), Jordan, Syria and Lebanon (Abu Ghyda, 2007). It is very attractive, red, seeded, late ripening variety (Issac *et al.*, 1995; Sultan, 2005) with excellent characteristics for consumption as table grape (Sama'neh, 2004).

Vines are vigorous, high productivity, required deep fertile soil and more water than other grape varieties (Isaac *et al*., 1994). Most of Halawani grapes are grown on arbors with long canes pruning (Zabadal and Brunke, 2001; Brown and Gao, 2004). Leaves of Halawani grapes are small in size (Isaac and Hrimat, 1994).

The clusters are large with fleshy, firm berries adhering to stem stalk at maturity (Mencarelli and Bellincontro, 2005).

The berries are round (spherical), large in size, red color, the skins of the berries are thin to medium in thickness (Sultan, 2005). Berries are very crisp, hard (firm pulp), low juice content (Smadi, 2011), high core present and sugars content are high after ripening (Sultan, 2005).

Halawani is similar to Red Globe variety, the reddish black color of red grapes is due to the flavonoids, a mixture of phytochemicals including flavonoids and antioxidant compound that it contains (Kobayashi *et al*., 2002). Furthermore, Isaac and Hrimat (1994) reported that Halawani grapes has long shelf life (good keeping and shipping qualities).

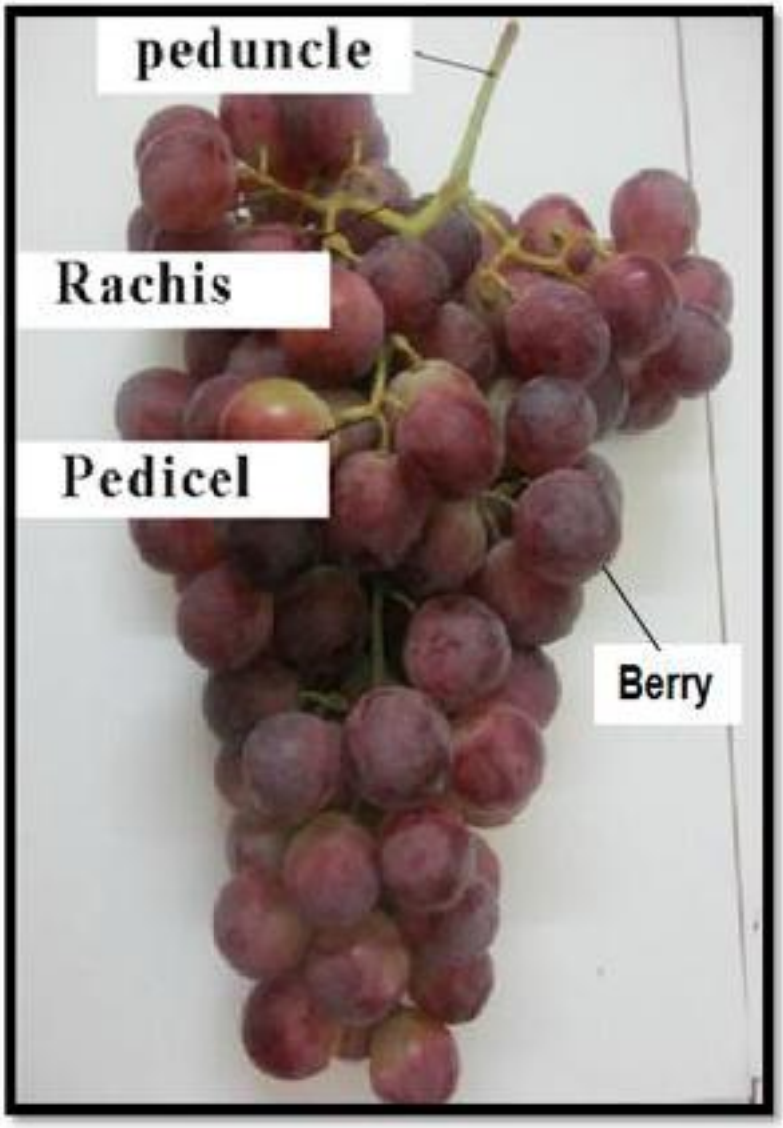

Fig. 1.1: Grape cluster (*Vitis vinifera* L.) cv. Halawani

1.2 Grape bagging

Preharvest fruit bagging had been a conventional practice in fruit cultivation to improve visual quality and promoting the commercial value of some fruits (Huang *et al*., 2009). Bagging may produce attractive and high quality fruits on ripening at harvest, leading to improve fruit marketing which resulted in better prices for fruit growers. Bagged fruit had a prolonged postharvest life and reduced weight loss and this may be of economic importance to the fruit retailers also (Mathooko *et al*., 2009). The effect of preharvest fruit bagging on fruit size among other postharvest parameters has been contradictory, which may reflect differences in the type of bag used, fruit age at bagging, fruit and cultivar response, prevailing climatic conditions, bag removal dates during maturation period and conditions of holding fruit after harvest (Johns and Scott, 1989a; Amarante *et al*., 2002; Weerasinghe and Ruwapathirana, 2002; Narayana *et al*., 2004).

Delay in the ripening process, which increases the time grapes may remain in the vine without any loss of sensory quality. Increase in the hygiene of the fruit (William, 1885), enhanced maturity slightly increased fruit size and yield per grapes and the skin of the berries will be preserved more perfectly than in those not bagged (William, 1885; Johns and Scott, 1989a; Amarante *et al*., 2002; Weerasinghe and Ruwapathirana, 2002; Narayana *et al*., 2004; Entity, 2012).

Preharvst fruit bagging resulted in better and uniform berry coloration of grape bunches, because the bags protected the grape bunches from the direct incidence of the sunlight (William, 1885). It is effective against sunburns and blemishes caused by wind-blown dust (Harhash and AL-Obeed, 2010; Muchui *et al*., 2010).

Chillet and Jannoyer (1996) and Harhash and AL-Obeed (2010) reported that bagging protectd fruit from high humidity, rain raised and temperature inside the bag.

Furthermore, fruit bagging provides physical protection from mechanical injuries (scars and scratches), physiological disorders, and fungal diseases on the fruits (Warren, 1999; Wang *et al*., 2011), reducing fruit splitting (Ding *et al*., 2003) and reduces pesticide residues in the fruits (Amarante *et al*., 2002) and protects from damage caused by insects. Fruit bagging was less bird damaged. As to flavor, opinions vary, some think it is better, others that it is not improved (Johns and Scott, 1989a; Amarante *et al*., 2002; Weerasinghe and Ruwapathirana, 2002; Narayana *et al*., 2004; Entity, 2012).

The fruit bagging technique is widely adopted in the production of grape (William, 1885; Signes *et al*., 2007), apple (Santos and Wamser, 2006; Hao *et al*., 2011), pear (Amarante *et al*., 2002; Feng *et al*., 2011; Hudina *et al*., 2012), peach (Jia *et al*., 2005; Wang *et al*., 2010), mango (Senghor *et al*., 2007; Wu *et al*., 2009), longan (Yang *et al*., 2009), grapefruit (Hwang *et al*., 2004), litchi (Tyas *et al*., 1998; Wang *et al*., 2003, Wang *et al*., 2005), melon, bitter gourd, guava and star fruit (Warren, 1999), banana (Warren, 1999; Muchui, 2010), date palm (Awad, 2007) and other fruits.

The benefits of bagging depend directly or indirectly on the color of the bag, that's where some colors perform many functions and several colors perform the same function. Depending on the degree of absorption and reflection of light and the sunshine through the bag and influence on the grape clusters. High light intensity can lead to several disorders in development and appearance of fruit that affect quality (Dorais *et al*.,

2001). In recent years, numerous crops and orchards have been found to improve their productivity and fruit quality when grown under colored bag (Shahak *et al*., 2004; Shahak *et al*., 2008). The colored bagging have been developed during the past decad to filter selected regions of the spectrum of sunlight, concomitantly with inducing light scattering. They are designed specification (spectrum, scattering and thermal components). These bag provide varying mixtures of natural, unmodified light, together with spectrally modified scattered light. They are aimed at optimizing desirable physiological responses (Shahak *et al*., 2008; Shahak *et al*., 2008b).

Black bags reduce the amount of light reaching the underneath plants, but do not affect light quality, as they neither modify its spectral composition, nor its relative content of scattered/diffused light (Healey *et al*., 1998). Bagging with blue and black bags possibly accumulates higher heat units than other bags and control, in this respect, blue and black bags were the most effective followed by paper bags (Awad, 2007). The yellow bag increased all leaf dimensions as well as harvest yield, compared with the common-practice black bag (Shahak *et al*., 2008). The advantage of the yellow and red bags in stimulating the vegetative growth (Oren-Shamir *et al*., 2001) might be related to the stimulatory effect of artificial green light supplementation (Kim *et al*., 2004). The yellow bags differs from the red net by additionally transmitting the green-yellow spectral range (Shahak *et al*., 2008).

Fruit developed longer and wider stems under the red and even more so under the yellow net, while shorter under the blue, compared with the equivalent black bagging net (Bastias *et al.,* 2012). Black, blue, green and red bag were associated with lower levels of diseases in the field experiments. The red bag was also superior in the mini-plots (Elad *et al*.,

2007). The effects of the blue and red bags might be attributed to their relative enriching/reducing of the blue vs. red and far-red spectral bands in the filtered light, and might further be related to similar effects reported for photo-selective films and artificial illumination (Rajapakse and Shahak, 2007; Whitelam and Halliday, 2007; Ilica *et al.,* 2012).

Different light transmittance bags showed different effects on fruit quality (Xu *et al*., 2010). Bagging of Kyoho grape with 560～580 nm wave length of color, 40% transparency, 38g raw paper filmed with wax significantly improved the fruit coloration and sugar content (Xiaohai *et al.,* 2006).

One study showed that bunch bagging with different materials such as black or blue polyethylene bags, white 'agrlsafe' (polypropylene fleece) and paper bags during the growing season significantly increased the rate of fruit ripening. In this respect, black and blue polyethylene bags were the most effective followed by 'agrlsafe' and paper bags (Awad, 2007).

1.2.1 Effect of fruit preharvest bagging on berry weight and size

Fruit weight and size are critical quality parameters that affect fruit marketing because larger size is generally preferred over small ones (Botes and Zaid, 1999; Al-Qurashi and Awad, 2011). Several techniques have been tested to increase weight and improve fruit quality such as fruit bagging (Galeb *et al*., 1988; Harhash, 2000; Al-Obeed *et al*., 2005 a,b).

The response of fruit species for bagging was different, some were little effect (Awad, 2006; Marashi and Mousavi, 2007; Awad, 2010), while

another fruits were significantly increased in fruit weight and size (Mohammed and Shabana, 1980; Faust, 1989; Westwood, 1993; Davis, 2004) possibly by increasing cell size (Awad and Al-Qurashia, 2012).

Harhash and Al-Obeed (2010) reported that fruit bagging with different materials and colors increased fruit weight and improved quality of fruit. Also, Galeb *et al*., (1988) display fruit bagging with paper bags increased fruit size and yield of date palm.

1.2.2 Effect of fruit preharvest bagging on berry firmness

Fruit firmness is one of the most important factors which determine the quality of fruit (Mattoo *et al*., 1975) and is an important indicator for harvesting of fruit at appropriate maturity, which also determines the postharvest life of fruit (Sharma *et al*., 2013). Bagging treatment was used for keep the fruit firmness (Son and Lee, 2008). Only a few studies have been conducted on this aspect, which revealed that pre-harvest fruit bagging can influence the fruit firmness at harvest (Sharma *et al*., 2013). For example, Bentley and Viveros (1992) reported that fruit firmness of "Granny Smith" apples was improved by brown paper bags when done at golf-size of fruit development.

Sharma *et al*., (2013) observed that fruit bagging has affected the fruit firmness. At harvest, bagged fruits had higher firmness than non-bagged fruits, and higher firmness was also maintained during storage. However, Hofman *et al*., (1997) reported that fruit firmness was not affected by white paper bag in mango.

1.2.3 Effects of fruit preharvest bagging on berry ripening

Grapes don't require direct sunlight on the fruits to ripen and develop good color, the farmer can place bags over individual fruit clusters beginning when the berries are about half grown. Use a bag that will allow enough room for the bunch to develop and tie securely to the grape cane (Lerner, 1998). The bags should be applied soon after the fruit sets, or before it is half grown; otherwise the operation may be deferred till nearly the time for coloring (William, 1885).

Several researchers investigated the effect of bagging on fruit growth, maturation and ripening (Wad, 2007; Kassem *et al.*, 2011) and showed different effect according to bag color, materials and time of bagging (Awad, 2007; Kassem *et al.*, 2011). As the bags retard somewhat the ripening, which increases the time grapes may remain in the vine without any loss of sensory quality and may be supplied to purchasers for a-longer period (William, 1885; Signes *et al*., 2007). Further, the color of the bagging effected the intensity of ripening (Elad *et al*., 2007). High temperature in conjunction with high irradiance also contributed to blotchy or uneven ripening (Lipton, 1970).

1.2.4 Effects of fruit preharvest bagging on berry coloration

Color is the most important indicator of maturity and quality in many fruit species. Anthocyanins represent a group of natural flavonoid compounds in plants and are responsible for coloration (Lancaster and Dougall, 1992; Koes *et al*., 2005). Environmental factors like temperature

and light have also proven to be important factors stimulating anthocyanin biosynthesis (Iglesias *et al*., 2002; Wang *et al.*, 2011), but bagging does not change the effects of light and temperature on coloring of fruits (Arakawa, 1991). Bagging of fruit can improve anthocyanin synthesis. Nonbagged fruit is somewhat specific in its coloring behavior, red color development is slow and lacks a distinct anthocyanin production peak.

Antonio (2007) reported that preharvest technique bagging provided a more uniform color of grapes than non-bagged samples (lower values of the standard deviations of all color coordinates). This approach has been widely practiced in fruit cultivation to control fruit coloration in many countries. The practice of bagging brings about the same pattern of physiological change that is critical to color development in fruit. The peak anthocyanin production comes immediately before the onset of the ripening process (Arakawa, 1991). Thus, a delay in removing bags before harvest may result in a loss of good red color development (Liu *et al.*, 2013).

Use a bag that will allow uniform color of the whole bunch of grapes. A uniform color is reached because the grapes ripen protected against the direct incidence of the sunlight (Signes *et al*., 2007). The grapes keeps its color when bagged, as a general rule becomes deeper and lighter in color (William, 1885; Lerner, 1998). All bagging treatments increased the percentage of the skin area with development color to the harvest stage. The percentage of the skin with red color, and its intensity, increasing duration of bagging (Hofman *et al*., 1997). The cluster will average ripen later and color in general better (William, 1885).

1.2.5 Effects of fruit preharvest bagging on TSS and juice pH

Fruit bagging affects inner qualities (Bin *et al*., 2006; Zhou *et al*., 2012), such as fruit sweetness and acidity (Wang *et al*., 2002; 0Huang *et al*., 2009; Tuan and Yen, 2012). A delay in ripening (lower values of maturity index sugars, higher contents of organic acids) in bagging grapes compared to non-bagging grapes (Signes *et al*., 2007). Most of the studies indicated that fruit bagging decreased soluble solids contents (Hong *et al*., 1999; Huang *et al*., 2007; Slmanan *et al*., 2011).

Muchui *et al*., (2010) reported that total soluble solids (TSS) at harvest and during ripening was not influenced significantly by bagging. TSS increased as expected in ripening of banana (Stover and Simmonds, 1987). The starch formation during banana fruit ripening considerably degrade in this study (Muchui *et al.,* 2010). Bagging 'Harumanis' mango fruit during preharvest with different color of paper did not affect juice pH (Ding and Syakirah, 2009).

1.2.6 Effects of fruit preharvest bagging on sunburn injury

Sunburn and heat stress take a toll on vineyards which can ultimately impact both yield and quality of the grapes. Depending on the intensity and length of sunlight exposure and other factors, this damage can range from unseen impact on yield to faint browning of berries, scalding of berries and even complete berry collapse. Sunlight plays a role in cracks in the skin. Field-grown fruit exposed to sunlight were more than twice as likely to develop cracks as shaded fruit (Whaley-Emmons and Scott,

1997). The grape bagging keeps berries cooler, reducing damage by reflecting excessive infrared and ultraviolet radiation from the vine canopy. To prevent sunburn damage farmer using bagging. Grape bagging protectant reduces losses from sunburn and heat stress, resulting in increased fruit quality and higher yield potential (Xiaohai, 1999; Webb *et al*., 2009; Thomas, 2012).

1.2.7 Effect of fruit preharvest bagging on frost injury

Grapes bagged are protected from early frost, thus prolonging the season. Grapes that have been protected from the elements during the summer are more attractive than those exposed to the weather, since the fruits are free from weather marks and present a fresh, bright appearance, which puts them in a grade above unbagged grapes. Cold, frost, and winter winds injury their cell walls. If not taken care of, tearing of cell walls result in cancer in fruit skin (Priyanka, 2012). Plants can be prematurely killed or damaged by frost. Plant cover (or bagging) protects plants from frost and other damaging weather conditions during season.

Indeed bagging has been shown to reduce winter stress under supra-optimal condition which resulted in early fruit maturation (Jia *et al*., 2005). This is due to enhanced physiological and metabolic activities provided by the microclimate created by bagging (Johns and Scott, 1989a).

1.2.8 Effect of fruit preharvest bagging on physiological disorders (stem browning, berry shatter, shriveled berry and waterberry)

High light intensity can lead to several disorders in development and appearance of fruit that affect quality (Dorais *et al*., 2001; Sharma, 2009). Physiological disorders can be reduced by using cluster bagging, reduce sun light effect on berry and maintaining recommended temperature and relative humidity and delaying ripening due to limitation of photosynthesis and reduce sugar, this effect on physiological disorders such as stem browning, berry shatter, berry shrivel and waterberry (Crisosto *et al*., 2012; Sen *et al*., 2012).

Stem browning: Table grapes commonly suffer from variations of tissue browning including stem browning during harvest, packing and storage (Crisosto *et al*., 2001;Vial *et al*., 2005). During the storage period, the grape rachis loss quality because the shelf life is short (Ngcobo *et al*., 2011). Light influences the growth and composition of a stem stalk. Bagging applications affect stem browning period, as reduced light delay stem browning (Sen *et al*., 2012).

Berry shatter (loss of berries from the cap stem): In general, berry shatter increases in severity with increasing maturity, i.e., the longer the fruit remains on the vine. Berries of seedless cultivars are usually less well attached to the cap stem than seeded cultivars. Berry shatter varies considerably from season to season and there is a large difference among varieties. Berry shatter occurs mainly due to rough handling during field packing with additional shatter occurring all the way to the final retail sale (Crisosto *et al*., 2012; Sen *et al*., 2012). So, when the fruit bagging, it

will decrease the fruit ripening and decrease the fruit shatter rate (Signes *et al*., 2007).

Berry shriveled: A physiological disorder, adversely affects ripening of grape berries (Bondada and Keller, 2012). There are several causes of shriveled fruit in vineyards, including sunburn, dehydration, bunch stem necrosis and a recently described sugar accumulation disorder (Krasnow *et al*., 2010). After ripening begins, berries become flaccid and sunken. Some affected berries develop color; some remain white. The flaccid berries are usually interspersed with normal ones, but occasionally several berries at the tip of a lateral or at the cluster apex are affected. The clusters may be a slightly duller green but the berries must be touched to confirm the flaccid condition. The amount of fruit involved usually increases up to harvest (Crisosto, 2013). So when fruit bagging, it decrease the sunburn (Xiaohai, 1999; Webb *et al*., 2009; Thomas, 2012; Yan, 2012), dehydration, bunch stem (Sen *et al*., 2012) and sugar accumulation disorder (Hong *et al*., 1999). Consequently the amount of berry shriveled are decreases.

Waterberry: is associated with fruit ripening and most often begins to develop shortly after veraison (berry softening). The earliest symptom is the development of small (1-2 mm) dark spots on the cap stems (pedicles) and/or other parts of the cluster framework. These spots become necrotic, slightly sunken, and expand to affect more areas. The affected berries become watery, soft, and flabby when ripe. This disorder has been associated with a high nitrogen status vine, canopy shading, or cool weather during veraison and fruit ripening. Foliar nutrient sprays of nitrogen should be avoided in waterberry-prone vineyards. Trimming off affected berries during harvest and bagging is a common practice, although labor intensive (Crisosto *et al*., 2012).

1.2.9 Effects of fruit preharvest bagging on postharvest diseases (*Botrytis cinerea, Penicillium expansum* and *Aspergillus niger*)

Botrytis cinerea, *Penicillium expansum* and *Aspergillus niger* are common preharvest and post-harvest fungal decay pathogens of table grapes in most regions of the world (Bulit and Dubos, 1988a). Infections start from the inoculum present in the vineyard which can develop into latent infections with disease appearing later in packed table grapes during storage and transportation (Hewitt, 1988; Zahavi *et al.*, 2000; Latorre *et al.*, 2002b).

The fungus *B. cinerea* Pers.: Fr, the anamorph of *Botryotinia fuckeliana* (Schoonbeek *et al*., 2001) it is causes gray mold that affects nearly all species of dicotyledons, including most vegetable and fruit crops, flowers, woody ornamentals and greenhouse-grown crops. The fungus uses a wide range of infection strategies that allow it to directly penetrate tureto-senescent leaves and other tender tissues, such as seedlings, floral organs and mature fruits. The fungus generally infects host tissues in cool damp weather (10 to 25°C) in water droplets (Prins *et al.*, 2000a), but it also can germinate at high humidity in the absence of water droplets (Williamson *et al*., 1995). Gray mold is the most destructive of the postharvest diseases of table grapes, primarily because it develops at temperatures as low as 31°F (-0.5 °C) and spread from berry to berry.

The fungus *P. expansum* causes blue mould, is one of the most economically damaging postharvest diseases of pome fruits, although it may affect a wider host range, including sweet cherries and table grapes. *P. expansum* attacks a wide range of deciduous and tropical fruits. Several reports on the role of mycotoxins in plant pathogenesis have been published, but few focused on the influence of mycotoxins on the

variation in host preference amongst producing fungi (Sanzani *et al*., 2013).

The fungus *A. niger* causes a disease called black mold on certain fruits and vegetables such as grapes and is a common contaminant of food. It is ubiquitous in soil and is commonly reported from indoor environments (Sharma, 2012).

The bagging effects on action fruits were different (Chen *et al*., 2003). Some fungi were reduced by bagging (Hofman *et al*., 1997). The bagging changed the conditions of temperature and humidity, so this changed the diseases percent on fruits (Chen *et al*., 2003). Bagging as prevention of rot, if applied early enough; it is a prevention rot is found in some cases in the bags, but mostly takes place after the grapes are ripe (William, 1885).

Due to bad ventilation of fruit bag, air exchange between inside and outside of fruit bag is blocked after bagging, consequently inducing high temperature and high humidity in fruit bag. Fruits might not acclimatize to the micro-climate of fruit bags, or after removing the bag at unseemly time (Zhang *et al*., 2005), so the specification and holes in the bottom were should be used suitable for special fruit bag (Zhou *et al*., 2012).

The various bagging color suppressed the disease differently. The color of the bagging effected the intensity diseases lower in the field.

1.2.10 Effects of fruit preharvest bagging on fruit insects

The grapevine moth, *Lobesia botrana* (Lepidoptera: Tortricidae), is a major pest in a wide grape growing area (Gable and Roehrich, 1995; Moschos, 2006). Yield reduction caused by this insect results from

larvae feeding directly on grape and subsequent attack by pathogens. Additionally, feeding damage to berries after veraison exposes them to infection by *Botrytis* and other secondary fungi such as *Aspergillus*, and *Penicillium* (Moschos, 2006).

Bagging results in fruit that is 100 percent pest free. The bags act as a barrier to protect the fruit against attack by summer insect pests (Wu *et al.*, 1998). When the bags are used on disease resistant cultivars, no additional pesticide sprays are needed once the bags are placed on the fruits (Bessin and Hartman, 2010).

The bags had successfully deterred most insects by enclosing the fruit in brown paper bags and to keep insect pests from getting at them (Pleasant, 2012). Not only is this technique more environmentally friendly than spraying (even with an organic pesticides), but it also gives surer results (Swensen, 2000).

1.2.11 Effects of fruit preharvest bagging on bird injury

In fruits such as grape, banana, mango, apple and date, birds are major pests at the fruit ripening stage and cause considerable economic losses in agricultural areas world-wide (Sharma, 2009). Many authors reported that grapes bagging was the best method for prevent bird injury (William, 1885; Johns and Scott, 1989a; Amarante *et al.*, 2002; Weerasinghe and Ruwapathirana, 2002; Narayana *et al.*, 2004, Entity, 2012) and the preharvest bagging has been extensively used in grapes to control of bird damage (Kitagawa *et al.*, 1992; Hofman *et al.*, 1997; Joyce *et al.*, 1997; Amarante *et al.*, 2002; Harhash and Al-Obeed, 2010; Qin *et al.*, 2012).

1.3 Botanical extracts as postharvest treatments

The natural plant products derived from plants effectively meet ecofriendly pesticides and have enormous potential to influence modern agrochemical research. The use of botanical extracts is now emerging as one of the prime means to protect crops and their products and the environment from the chemical pesticides (Sanjay and Tikul, 2009). Botanical extracts degrade more rapidly than most chemical pesticides, and therefore, considered friendly to the environment and less likely to kill beneficial pests than synthetic chemical pesticides with longer environmental retention. Most of the botanical pesticides generally degrade within few days and sometimes within a few hours (Siddiqui and Gulzar, 2003).

Further, applied botanical pesticides is one of the means to reduce the loss of post-harvest diseases for being effective and fast (Singh *et al*., 2012).

1.3.1 Clammy Inula *(Inula viscosa)*

Inula viscosa (L.) Aiton (syn. *Cupularia viscosa* G. et G., *Dittrichia viscosa Greuter*) (Compositae) (common local name: Tayoon) is a perennial shrub distributed in different regions of the Mediterranean basin (Al-Eisawi, 1998; Al-Dissi *et al*., 2001), grows on hill slopes, damp habitats and roadsides (Smadi, 2011). *Inula* is an aromatic plant that disperses a strong smell of camphor (Hernandez *et al*., 2001).

The leaves and stems of the plant are coated with a sticky resin, from September through the winter months, the plant blooms with clusters of small yellow flowers, providing one of the few food sources available to honey bees during winter (Avisco Ltd. Israel, 2012).

The local Israeli (Palestine) phenotype of *I. viscosa* is considered the most potent in bio-active resin production, being located in the most southern latitude of its natural habitat range, it is believed to possess higher biological activity compared to its European relatives (Avisco Ltd. Israel, 2012).

Fourteen known and four new compounds were isolated from *I. viscosa* (Lauro and Rolih, 1990). In vitro antiproliferative and antimicrobial screening of plant products can provide valuable preliminary data for the potential uses of these products to treat cancer and/or microbial infections (Talib *et al*., 2012).

Crude extracts prepared from different parts of *I. viscosa* exhibit antifungal (Qasem *et al*., 1995), antioxidant (Schinella *et al*., 2002), antiulcerogenic (Alkofahi and Atta, 1999) and anthelmintic (Oka *et al*., 2001) properties and prevent zygote implantation (Al-Dissi *et al*., 2001). In previous studies we reported the potent antiproliferative and antimicrobial (Talib and Mahasneh, 2010) activities of an *I. viscosa* methanol extract.

Different chemical investigations have reported the presence of flavonoids (Grande *et al*., 1985), triterpenoids (Simoes and Nascimento, 1990; Grande *et al*., 1992), sesquiterpene lactones and acids (Grande and Bellido, 1992; Camacho *et al*., 2000).

A sesquiterpene lactone, tomentosin, has been isolated and identified from *I. viscosa* and it was shown to be active under in vitro conditions (Cafarchia *et al*., 2002). *Inula viscosa* extract causes a decline in chitin content, a very important constituent of fungal cell wall, which probably explains the antimycotic activity of the plant extract against dermatophytes. The extract caused dramatic changes in the hyphae and spore morphology due to severe damage in the fungal cell coat (Maoz and Neeman, 2000; Berdicevsky *et al*., 2001).

Abou-Jawdah *et al*., (2004) found out that *I. viscosa* has high activity against spore germination, but only moderate activity against mycelial growth of different fungi.

In traditional medicine, *I. viscosa* has many uses, including anti-inflammatory (Barbetti *et al*., 1985), anthelmintic, lung disorders (Al-Qura'n, 2009), antipyretic, antiseptic and antiphlogistic activities (Lauro and Rolih, 1990; Lev and Amar, 2000) in addition to treating gastroduodenal disorders (Lastra *et al*., 1993).

Inula viscosa were tested for their nematicidial activity in field trials, where only a slight effect was obtained, even though the formulated extract was effective in pot experiments (Oka *et al*., 2006).

Inula viscosa has also been subject of investigation against insects (Alexenizer and Dorn, 2007) and mites (Mansour *et al*., 2004). *Inula viscosa* in corporated as shoot dried material or crude water extract in a culture medium, showed antifungal effects on the mycelial growth of *Fusarium oxysporum* sp. *Lycopersici* (Qasem *et al*., 1995).

Under in vivo conditions preventive sprays of *I. viscosa* on squash and cucumber seedlings gave efficient protection against *Botrytis cinerea* and *Sphaerotheca cucurbitae*, but failed to control green mold of citrus fruits caused by *Penicillium* sp. (Abou-Jawdah *et al*., 2004).

Extracts of *I. viscosa* made with organic solvents were effective controlling late blight in potato and tomato, downy mildew in cucumber, powdery mildew in wheat and rust in sunflower, under controlled conditions (Wang *et al*., 2004).

Cohen *et al*., (2006) using an emulsified concentrate formulation of the oily paste extracts provided very good control against downy mildew of grapes caused by *Plasmopara viticola*. The major inhibitory compounds were identified as tomentosin and costic acid. Although the antifungal

activities of *I. viscosa* have been studied its possible application in postharvest fungi control remains unexplored (Mamoci *et al*., 2011).

1.3.2 Thyme *(Majorana syriaca)*

Majorana syriaca L. Rafin (equal to *Origanum syriacum* var. *Syriacum*, belonging to the mint family, Labiates) is one of the most popular herbs among Palestinian plants (Abu-Lafi *et al*., 2007). Both thyme-scented and oregano-scented forms are known. A shrubby mint with hairy stems which grows about 80 cm tall and bears dense spikes of small, pure white flowers on is upper branches. Close to the ground and shrubby, it is able to grow, even thrive, in a dry, stony, desert landscape, a phenomenon that gained it an ancient reputation as a symbol of modesty or humility. Its many stems are covered with small, nearly heart-shaped, downy leaves that give the whole plant a grayish appearance (the hairs help it with stand drought conditions). White flowers appear in dense terminal clusters in midsummer. If it harvested early, have excellent flavor when dried. The flowers are hermaphrodite and are pollinated by bees (Ann, 1997). Cultivation of *M. syriaca* was initiated by transferring wild population growing in the central and northern parts of the West Bank to experimental fields particularly at the Ketf Al-wad area at the city of Jericho (Werker *et al*., 1985). The production of cultivated thyme has increased dramatically in the recent years in response to the increasing local demands (Abu-Lafi *et al*., 2007).

The green leaves of *M. syriaca* are rich in essential oil, which is responsible for its characteristic flavor and fragrance (Dembitsky *et al*., 2002; Abu-Lafi *et al*., 2007). Antioxidant activity of common thyme and its extracts is dependent mainly on essential oil content and composition (Chizzola *et al*., 2008). The phenols, thymol and carvacrol are the

principal constituents of thyme oil. Thymol has been the most valuable compound for medicinal purposes, but carvacrol, its isomer, preponderate in oils that are extracted from wild origin. Oil of cultivated thyme is an important commercial product and is obtained mainly by steam distillation of the fresh leaves (Cosentino *et al*., 1999; Arnold *et al*., 2000; Abu-Lafi *et al*., 2007).

Shimoni *et al*., (1993) found that the whole essential oils from *M. syriaca*, exhibited in vitro activity against a number of phytopathogenic fungi.

Despite of the strong taste, thyme leaves are used mainly for food and medicine in some communities (Hinnawi, 2010). This plant, having a curative value in hypoglycaemic treatments (Yaniv *et al* ., 1987), was an important part of the purification rites and was used as a medicine and as a condiment (Fleisher and Fleisher, 1988). On the other hand, *Majorana syriaca* was used in traditional recipes, is used for preparing a traditional recipe that is very popular in all Palestinian communities (Hinnawi, 2010).

1.3.3 Thyme *(Thymus vulgaris)*

Thymus vulgaris L. or common thyme belongs to the family Labiatae (Jalas, 1972; Culiţa and Adrian, 2013). Thyme is an improved cultivated form of the wild thyme of the mountains of Spain and other European countries bordering on the Mediterranean, flourishing also in Asia Minor, Algeria and Tunis and is a near relation to our own wild thyme (*T. serpyllum*), which has broader leaves (the margins not reflexed as in the Garden Thyme) and a weaker odor. It is cultivated now in most countries with temperate climates (Grieve, 2013). Thyme is a perennial plant with a fibrous root (Copsey and Lerner, 2002). The stems are numerous, round,

hard, branched. The leaves are small, narrow and elliptical, greenish-grey in color, reflexed at the margins, and set in pairs upon very small foot-stalks. The flowers terminate the branches in whorls (Grieve, 2013).

Thyme essential oil is known to contain more than 40% of phenolic compositions (thymol and carvacrol), that have strong antiseptics effect. In addition to thymol, caffeic acid and thanin existing in essential oil can effectively prevent growth of bacteria, fungus and viruses. The highest value of thymol exists in *T. vulgaris*. According to GC analysis, *Thymus captatus* contains carvacrol that researchers pointed to its anti microbial property and inhibition activity of the existence of these two compounds (Karimi and Rahemi, 2009).

Researchers studied anti fungus activity of *T. vulgaris*, on green mould in laboratory conditions and the result showed that *T. vulgaris* essential oils had the most inhibitor effect and can generally replace other treatments for controlling green mould (Yahya-zadeh *et al*., 2008). In an extensive laboratory study, inhibition effects of *T. Vulgaris* and *S. officinalis* oils were evaluated on *Asperigillus parasiticus* growth and aflatoxin production was not observed by adding 1% thymus until 30 days (Muftah and Lloyd, 1982). In another research, *T. vulgaris* were investigated in different concentrations. Results showed that *T. vulgaris* oils had the most effect on growth inhibition with minimum inhibition concentration of 200 and 400 ppm. Due to these results, it can be said that *T. vulgaris* oils in the above concentration have the ability to inhibit fungi growth that contaminates food products (Maskoki *et al*., 2005). Application of *T. vulgaris* essential oil showed successful results both to control soft decay and gray mould agents in strawberry (Reddy *et al*., 1997). Effect of essential oils of *T. vulgaris* were investigated on citrus postharvest fungus diseases such as *Penicillium digitatum*, *Penicillium italicum* and *Alternaria citri*. Their results showed that *T. vulgaris*

essential oil in 500 ppm concentration inhibits the mycelium growth of 2 kinds of *Penicillium* (Azizi *et al*., 2007). According to other studies, *T. vulgaris* oils control green mould decay and postharvest quality of Valencia orange (Fatemi *et al*., 2011).

1.3.4 Sage *(Salvia officinalis)*

The sage (*Salvia officinalis*) belongs to the genus *Salvia* of the Labiaceae family comprising about 900 plant species, is a popular plant (Hedge, 1992) and it is one of the oldest medicinal plants (Stary and Jirasek, 1977; Pace and Piccaglia, 1995). Sage shows the appreciation since Roman times (Amr and Dordevic, 2000). It is an aromatic plant (Badiee *et al*., 2012), perennial (subshrub). The plant flourishes in well-drained alkaline soil under sunny conditions. It grows up to 75 cm height and feature woody, branching stems. Its aromatic leaves are grey-green, soft and pebble-like textured with fine hair-like filaments growing on either side. It bears violet-blue color bunches of flowers in summer (Rudrappa, 2009).

It is origin return to the Mediterranean region, especially in the area of the Adriatic sea and is cultivated to some extent in different European countries. The material of commerce originates from south eastern European countries (Blumenthal *et al*., 2000; Muhtasib *et al*., 2000).

Sage leaf consists of the whole or cut dried leaves of *S. officinalis* L. It contains not less than 15 ml/ kg of essential oil. Extract from sage leaf is rich in thujone (Menghini *et al.*, 2013) and phenolic acids such as rosmarinic acid, caffeic acid and ferulic acid (Kaledaite *et al*., 2011). Recent studies have identified diterpenoids, triterpenoids and flavonoids isolated from the plant *S. officinalis* (Badiee *et al*., 2012). The essential oil has a very variable composition depending on the source, time of

harvesting and other factors (Bradley, 2006). Principal components of the essential oil are thujone, cineol and camphor. In addition, the leaves contain tannins, diterpene bitter principles, triterpenes, steroids, flavones, and flavonoid glycosides (Blumenthal *et al*., 2000).

Sage leaves used as raw material in medicine, perfumery and food industry (Grieve, 1984; Muhtasib *et al*., 2000; Bhadoriya *et al*., 2011; Mohammad, 2011) and in perfumery and cosmetics (Piccaglia *et al*., 1993). Essential oil extracted from *S. officinalis* is used in the treatment of a large range of diseases such as respiratory and digestive syndromes, heart and blood circulation, metabolic and endocrine diseases, as well as for its many other therapeutic effects (Istudor, 2001; Lima *et al*., 2007).

The oil extract of *S. officinalis* showed good antifungal activity, and could serve as a natural alternative to synthetic fungicides for the control of some important fungal diseases (Miski *et al*., 1983; Krishnaiah *et al*., 2011; Badiee *et al*., 2012). Essential oil extracted is used in the treatment of a large range of diseases (Istudor, 2001; Lima *et al*., 2007). More recent studies on the biological activity of sage showed that the essential oil present some antimicrobial and antioxidant properties (Beir, 1990; Piccaglia *et al*., 1993; Tada *et al*., 1994; Wang *et al*., 1998; Geuenich *et al*., 2008). Concerning the antioxidants properties of sage the different studies developed in the literature conclude that the top of the aerial part contribute mainly to the antioxidant activity (Yinrong and Yeap, 2000; Bandoniene *et al*., 2002). Sage oil was effective against *Candida* spp. and inhibited the growth of all fungi tested in a dose-dependent manner, at a concentration comparable to that of some other antifungal agents (Badiee *et al*., 2012).

1.3.5 Varthemia (*Varthemia iphionoides*)

Varthemia (*Varthemia iphionoides*) belongs to the family Compositae (Al-Dabbas *et al*., 2006) is a perennial, bushy plant, 20-50 cm long, with a woody base and with many branched aromatic and sticky stems growing in rocky habitats. Leaves oblong, simple, entire, sub-sessile, densely hairy and grayish. Heads 2-5 mm in diameter, florets yellow-orange surrounded by oblong involucres (Afifi *et al*., 1991; Al-Dabbas *et al*., 2005). It is widely distributed in Palestine and Mediterranean region (Al-Dabbas *et al*., 2005). It is commonly used in medicine treatments (Afifi *et al*., 1991; Al-Dabbas *et al*., 2005).

The aqueous extract of *V. iphionoides* is commonly used in folk-medicine (Cowan, 1999; Zuo *et al*., 2008) for the treatment of gastrointestinal disorders, the treatment of patients with diabetes mellitus and healing eye inflammations. It has also been found to have an antispasmodic effect on the smooth muscles of rabbits, antiplatelet activity on human blood, antifungal and antibacterial activities (Afifi *et al*., 1991; Abu-Rabia, 2005; Al-Dabbas *et al*., 2005). Antibacterial, antifungal and antioxidative (Cowan, 1999; Abutbul *et al*., 2005; Zuo *et al*., 2008), ethyl acetate extracts of the aerial parts of *V. iphionoides* showed pronounced antibacterial activity (Al-Dabbas *et al*., 2005).

Antifungal flavonoids were also extracted from the aerial and subterranean parts of *V. iphionoides* and showing antifungal activity against *Fusarium solani, Candida tropicalis* and *Aspergillus parasiticus* (Afifi *et al*., 1991; Al-Dabbas *et al*., 2005).

Chapter Two

2. Material and Methods

This study was conducted at a private Halawani vineyard during the season of 2011 at Halhul town, five km away to the north of Hebron city. The location was in the related plain at an altitude of 1029 m above the sea level,^{o}31'34"43.99 N latitude and ^{o}35'5" 55.69 E longitude. The climatic conditions in Halhul are characterized by mild hot summer and cool winter with a rainfall of 500 mm annually.

Halawani grapevines (Fig. 2.1) were ten-years-old, spaced at 3×4 meter, T-training trellis system and the vine were grafted on P-1103 rootstock. All the grapevines in this experiment were selected for their uniformity in vigor and size and were subjected to the same usual horticultural practices.

Two separate experiments were designed in this study as follows:

2.1 First experiment: Effect of fruit preharvest bagging on grapes (*Vitis vinifera* L.) cv. Halawani

The experimental design was randomized complete block design (RCBD) and the plot size was one cluster. The number of replicates was five and the number of treatments was nine as follows: control (without bagging), paper bagging as standard check, brown cloth bagging, white cloth bagging, black cloth bagging, green cloth bagging, blue cloth bagging, red cloth bagging and yellow cloth bagging (Fig. 2.2).

Fig. 2.1: Vineyard of grape cv. Halawani

Fig. 2.2: Paper and cloths bagging

The paper bags were brown in color, 45×30 cm dimensions and 0.01 mm thickness. All the cloth bags were synthesised from cotton, 45×30 cm dimensions and 0.01 mm thickness.

Selection of grape clusters which used in this experiment was based on uniformity of cluster size. All bagging treatments were performed at verasion stage (beginning of berries coloration). Before bagging, the damaged fruits were removed. Then, the grape clusters were sprayed with Dorsban (chloropyrifos) insecticide.

Each fruit cluster was placed in the bag according to the treatments and firmly tied to the top ends to the bag with string (Fig. 2.3).

After 30, 60 and 90 days from bagging (01/10/2011), clusters were picked and sent to the lab for to ther analysis.

2.2 Second experiment: Effect of some botanical extracts as postharvest treatments on grapes (*Vitis vinifera* L.) cv. Halawani

The experimental design was complete randomized design (CRD) and the plot size was one cluster. The number of replicates was five and the number of treatments was seven as follows: control (untreated) as absolute check, chemical fungicides (Rovral) as standard check, *Inula viscosa* (clammy Inula), *Majorana syriaca* (thyme), *Thymus vulgaris* (thyme), *Salvia officinalis* (sage) and *Varthem iaiphionoides* (varthemia).

Fresh leaves of *I. viscosa*, *M. syriaca*, *T. vulgaris*, *S. officinalis* and *V. iphionoides* were collected from different areas in the Hebron district between May and August, 2011 (Table 2.1 and Fig. 2.4).

Table 2.1: Common, scientific and Arabic names of the botanical extracts used in the experiment.

No.	Common name	Scientific name	Arabic name	Place of collection
1.	Clammy Inula	*Inula viscosa*	طيون	Halhul
2.	Thyme	*Majorana syriaca*	زعتر	Baninaim
3.	Thyme	*Thymus vulgaris*	زعترغزال	Sourif
4.	Sage	*Salvia officinalis*	مريمية	Khalet Al-dar
5.	Varthemia	*Varthemia iphionoides*	اكتيلا	Khalet Al-dar

Fig. 2.3: Medical plants used in the experiment

All of the botanical plants were air dried. Dried leaves were grinder to powder and stored in dark colored jars at room temperature.

The powder were soaked in a solution of 80% hot water and 20% ethanol at room temperature for 48 h with occasional shaking. After filtering each solvent through a single layer of muslin cloth and filter paper. Then the final filtrates were collected.

A uniform size, shape and well developed color of Halawani grape clusters were collected from vineyard and sent to the lab. Before applied the treatments to the grape clusters the damage berries were removed.

A small plastic sprayers were filled with botanical extracts at 40 % concentration (Sharawi, 2009), then sprayed on grape clusters according to the treatments. Rovral was used at 4% concentration.

All treatments were applied according to experimental design at 1/10/2011. The treated clusters were put in plastic baskets as a plots and kept in the refrigerator at $0\ ^{0}C$ (Candir *et al*., 2011).

During storage period the clusters for all plots were checked periodically.

Observations were recorded monthly for three time, after 30 days of storage, the first set of observations was recorded. After 60 days of the storage, the second set of observations was recorded, while the third set was recorded after 90 days from the treatments.

For the two experiments and all sets the following observations were recorded:

1. **Berry size:** The size of grapes berries was measured by water displacement method (Ravindran and Kallupurackal, 2001). Twenty grapes berries were placed into a 1000 ml beaker filled with 500 ml of water. Water level that displaced was recorded and

the volume of 20 berries was measured. The value obtained for 20 berries was divided by 20 to obtain average volume of one berry.

2. **Berry firmness:** The berry firmness was measured by a digital hand–held penetrometer fitted with a 5mm probe (HPE-II). One berry was measured on two opposite sides then the average for one berry was taken.

3. **Berry ripening (only for the first experiment):**
   - Semi ripe = 61-70%
   - Ripe = 71-80%
   - Full ripe = 81-90%
   - Over ripe = 91-100%

4. **Color rating system of the berries by eyes:**

   • Green red (51-60%): there are many berries green or the most berries are green.

   • Red green (61-70%): there are some berries green or the most berries are red.

   • Light red (71-80%): the berries are light red and some berries are green.

   • Red (81-90%): all berries are red and some berries are light red.

   • Dark red (91-100%): all berries are dark red.

5. **Percentage of sunburn injured berries per cluster (only for first experiment):** Sunburn berries were computed by counting the number of sunburn berries from the total number of berries per cluster and expressed in percentage.

6. **Percentage of frost injured berries per cluster (only for first experiment):** Frost injury was computed by counting the number of berries injury by frost from the total number of berries per cluster and expressed in percentage.

7. **Stem browning:** It gave mark from (0-5) according cluster framework coloration
   - Green (0% brown) = 0-0.9
   - Semi-green (less than 40% brown) = 1-1.9
   - Green plus brown (41-60% brown) = 2-2.9
   - Semi–brown (61-80% brown) = 3-3.9
   - Brown (more than 81% brown) = 4-5

8. **Percentage of shatter berries per cluster:** Shatter berries refers to the loose berries, those that have detached from the stem. Shatter berries were computed by counting the number of shatter berries from the total number of berries per cluster and expressed in percentage.

9. **Percentage of shriveled berries per cluster:** Shriveled refers to the shrink fruits due to water loss. Shriveled berries were computed by counting the number of shriveled berries from the total number of berries per cluster and expressed in percentage.

10. **Percentage of waterberries per cluster:** Water berries refers to the fruits fail to ripen properly. Waterberries were computed by counting the number of water berries from the total number of berries per cluster and expressed in percentage.

11. **Percentage of infected berries with *Botrytis cinerea*:** Grape berries infected with *Botrytis cinerea* were computed by counting the number of berries infected with *B. cinerea* from the total number of berries per cluster and expressed in percentage.

12. **Percentage of infected berries with *Penicillium expansum***: Percentage of berry infection with *Penicillium expansum* was computed by counting the number of berries infected with *P. expansum* from the total number of berries per cluster and expressed in percentage.

13. **Percentage of infected berries with *Aspergillus niger*:** Percentage of berry infection with *Aspergillus niger* was computed by counting the number of berries infected with *A. niger* from the total number of berries per cluster and expressed in percentage.

14. **Percentage of damaged berries by *Lobesia botrana* (only for first experiment)**: The percentage of grape berries damaged by *L. botrana* was counting the number of berries infected with *L. botrana* from the total number of berries per cluster and expressed in percentage.

15. **Percentage of damaged grape berries by birds (only for first experiment)**: The percentage of grape berries damaged by birds was computed by counting the number of berries injured by bird from the total number of berries per cluster and expressed in percentage.

16. Odor (only for second experiment):

- No odor (0-0.9): There is no odor on grape berries.
- Very little odor (1-1.9): There is few odor on grape berries.
- Little odor (2-2.9): There is some odor on grape berries.
- Strong odor (3-3.9): There is high odor on grape berries.
- Very strong odor (4-5): There is very high odor on grape berries.

A sample of 50 berries were crushed by Moulinex blender, the juice was filtered by filter paper. Juice sample was taken and the follwing parameters were recorded:

17. **Percentage of total soluble solids (TSS):** was determined by using refractometer.

18. **pH of the grape juice:** was measured by pH meter.

19. **Color intensity:** was obtained by measuring the absorption of the filtrate at 520 nm wavelength, using spectrophotometer. The color intensity was expressed in Optical Density (OD) units.

All data were statistically analyzed (Little and Hills, 1978) and the significant different to the treatment means were separated according to LSD test at 5 % level for both experiments.

Chapter Three

Results

The present study on the effect of fruit preharvest bagging and some botanical extracts as postharvest treatments on grapes (*Vitis vinifera L.*) cv. Halawani was carried out during the season 2011 at Halhul town with an objectives to keep the grape fruit from damage by bagging the clusters in primary ripening stage and to test some botanical extracts against storage diseases of grapes and to extend the shelf life of grapes clusters.

Two independent experiments were carried out and the results obtained are presented in this chapter.

3.1 Experiment 1: Effect of fruit preharvest bagging on grapes (*Vitis vinifera* L.) cv. Halawani

The data pertaining to the effect of preharvest bagging on fruit quality, physiological disorders and postharvest diseases of Halawani grapes at 30, 60 and 90 days of bagging are presented under the following heads:

3.1.1 Effect of fruit preharvest bagging on berry size

At 30, 60 and 90 days of bagging, all the treatments had no significant effect on berry size as compared to the control (Table 3.1). However, at 60 days of bagging, although all treatments gave similar results as compared to the control, but the red (6.70 cm^3) cloth treatment was significantly superior over both paper (5.30 cm^3) bagging and black (5.30 cm^3) cloth treatments (Table 3.1). Furthermore, at 90 days of bagging,

blue (6.20 cm^3) cloth treatment was significantly superior in increasing berry size as compared to brown (5.20 cm^3) cloth (Table 3.1).

Table 3.1: Effect of fruit preharvest bagging on berry size (cm^3) of grapes cv. Halawani.

Treatments	Days of bagging		
	30	**60**	**90**
Control	7.00 a*	5.80 ab	5.70 ab
Paper bagging	6.00 a	5.30 b	6.10 ab
Brown cloth	7.00 a	5.70 ab	5.20 b
White cloth	6.65 a	6.30 ab	5.50 ab
Black cloth	5.80 a	5.30 b	5.40 ab
Green cloth	6.00 a	6.20 ab	5.50 ab
Blue cloth	6.80 a	6.20 ab	6.20 a
Red cloth	6.90 a	6.70 a	5.60 ab
Yellow cloth	6.80 a	5.60 ab	5.40 ab
LSD 0.05	**1.21**	**1.25**	**0.96**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.1.2 Effect of fruit preharvest bagging on berry firmness

At 30 days of bagging, all treatments except brown (45.21 kg/cm^2) and black (45.65 kg/cm^2) were significantly increased the berry firmness as compared to control (41.30 kg/cm^2). The most effective treatment was paper bagging (51.51 kg/cm^2) which was on par with white cloth bagging (49.10 kg/cm^2), green cloth bagging (49.96 kg/cm^2), blue cloth bagging

(50.05 kg/cm^2), red cloth bagging (49.87 kg/cm^2) and yellow cloth bagging (49.11 kg/cm^2).

At 60 days of bagging, paper bagging (40.44 kg/cm^2) was the best treatment in increasing berry firmness. The next best treatment was blue cloth (38.44 kg/cm^2) which was on par with green cloth (37.19 kg/cm^2), red cloth (36.41 kg/cm^2) and yellow cloth (35.56 kg/cm^2). The other treatments (black, white and brown) gave similar results to the control (Table 3.2).

At 90 days of bagging, the most effective treatment in increasing berry firmness was paper bagging (33.96 kg/cm^2) which was on par with blue (33.35 kg/cm^2) green (33.17 kg/cm^2) and red (32.00 kg/cm^2). The other treatments (brown, white, black and yellow) gave similar results to the control (Table 3.2).

Table 3.2: Effect of fruit preharvest bagging on berry firmness (kg/cm^2) of grapes cv. Halawani.

Treatments	Days of bagging		
	30	**60**	**90**
Control	41.30 c*	30.56 e	27.14 e
Paper bagging	51.51 a	40.44 a	33.96 a
Brown cloth	45.21 bc	32.24 e	28.22 e
White cloth	49.10 ab	33.44 cde	29.77 cde
Black cloth	45.65 bc	32.48 de	28.59 ed
Green cloth	49.96 ab	37.19 b	33.17 abc
Blue cloth	50.05 ab	38.44 ab	33.35 ab
Red cloth	49.87 ab	36.41 bc	32.00 abcd
Yellow cloth	49.11 ab	35.56 bcd	30.27 bcde
LSD 0.05	**5.32**	**3.20**	**3.47**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.1.3 Effect of fruit preharvest bagging on berry ripening

At 30 days of bagging, the treatment paper bagging (65%) was significantly superior in delay berry ripening as compared to control (80%). This treatment was on par with blue cloth bagging (67%), white (72%) and yellow (72%).

At 60 days of bagging, all treatments were significantly delayed berry ripening as compared to control (Table 3.3). However, paper (72%) bagging was the most effective treatment in delay berry ripening. This treatment was on par with blue (75%) cloth bagging and yellow (76%).

Finally, at 90 days of bagging, all treatments except blue (97%) cloth were significantly delayed berry ripening as compared to control (Table 3.3). The most effective treatments in delay berry ripening were paper (88%) bagging and blue (88%) which were on par with white (91%) and yellow (91%).

Table 3.3: Effect of fruit preharvest bagging on berry ripening (%)[z] of grapes cv. Halawani.

Treatments	Days of bagging		
	30	**60**	**90**
Control	80 a[*]	89 a	100 a
Paper bagging	65 c	72 d	88 c
Brown cloth	76 a	82 b	93 b
White cloth	72 abc	78 bc	91 bc
Black cloth	80 a	83 b	97 a
Green cloth	74 ab	80 bc	92 b
Blue cloth	67 bc	75 cd	88 c
Red cloth	75 ab	80 bc	92 b
Yellow cloth	72 abc	76 cd	91 bc
LSD 0.05	**8.72**	**5.55**	**3.91**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

[z]Semi ripe = 61-70%, Ripe = 71-80%, Full ripe 81-90%, Over ripe = 91-100%.

3.1.4 Effect of fruit preharvest bagging on berry coloration

Berry coloration was determined by two methods, the first was by eye (%) and the second was by spectrophotometer (optical density).

At 30 days of bagging, the best treatment in decreasing the percentage of berry coloration by eye was paper bagging (75%). The next best treatment was blue (77%). The other treatments (brown, white, black, green, red and yellow) gave similar results to the control (Table 3.4).

At 60 and 90 days of bagging, all treatments except black cloth were significantly effective in reducing berry coloration by eye as compared to control (Table 3.4). The most effective treatment in reducing berry

coloration was paper bagging which was on par with blue, yellow and white.

The data for color intensity measured by spectrophotometer and expressed in optical density (O. D.) was shown in Table 3.4.

At 30 days of bagging, the best treatment in reducing color intensity was paper bagging (0.60) followed by both white (0.67) and blue (0.67). The other treatments (brown, black, green, red and yellow) gave similar results to the control (Table 3.4).

At 60 days after bagging, all bagging treatments were not significantly reduced color intensity as compared to control (Table 3.4).

At 90 days of bagging, all treatments except brown and black cloth were significantly effective in reducing color intensity as compared to control (Table 3.4).

Table 3.4: Effect of fruit preharvest bagging on berry coloration of grapes cv. Halawani.

Treatments	Berry coloration by eye (%)[z]			Color intensity by spectrophotometer (Optical Density)		
	Days of bagging			Days of bagging		
	30	60	90	30	60	90
Control	90 a*	99 a	100 a	1.21 a*	1.61 a	2.11 a
Paper bagging	75 c	82 d	88 c	0.60 b	0.89 a	1.11 b
Brown cloth	86 ab	91 bc	93 b	0.92 ab	1.24 a	1.53 ab
White cloth	82 abc	88 bcd	91 bc	0.67 b	1.04 a	1.26 b
Black cloth	90 a	93 ab	97 a	1.11 ab	1.26 a	1.61 ab
Green cloth	84 abc	91 bc	92 b	0.98 ab	1.23 a	1.23 b
Blue cloth	77 bc	83 d	88 c	0.67 b	0.95 a	1.31 b
Red cloth	83 abc	90 bc	92 b	0.85 ab	1.03 a	1.23 b
Yellow cloth	82 abc	86 cd	91 bc	0.84 ab	1.04 a	1.04 b
LSD 0.05	**9.33**	**6.31**	**3.91**	**0.53**	**0.81**	**0.73**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

[z]Berry coloration by eye: Green red = (51-60%), Red green = (61-70%), Light red = (71-80%), Red = (81-90%) and Dark red =(91-100%).

3.1.5 Effect of fruit preharvest bagging on TSS

At 30 days of bagging, the treatments paper bagging (17.90%), brown bagging (17.84%), green bagging (18.02%) and yellow bagging (18.16%) were significantly reduced TSS content in the berries of Halawani grapes as compared to control treatment (19.06%). However, the other treatments (white, black, blue and red) gave similar results to the control (Table 3.5).

At 60 days of bagging, all treatments except black, blue and white were significantly decreased the percentage of TSS as compared to control

(Table 3.5). The most effective treatment in reducing TSS percentage was paper bagging (18.64%) which was on par with brown bagging (18.90%), green bagging (19.94%), red bagging (19.92%) and yellow bagging (20.04%).

At 90 days of bagging, all treatments were significantly decreased TSS as compared to control (Table 3.5). The most effective treatment in decreasing TSS was brown bagging (20.06%) which was on par with yellow (21.32%), red (21.38%) and green (21.44%).

Table 3.5: Effect of fruit preharvest bagging on TSS of grapes cv. Halawani.

Treatments	Days of bagging		
	30	**60**	**90**
Control	19.06 a*	21.76 a	25.32 a
Paper bagging	17.90 b	18.64 d	22.04bc
Brown cloth	17.84 b	18.90 cd	20.06 d
White cloth	18.48 ab	20.42 abc	22.06 bc
Black cloth	18.58 ab	20.50 ab	23.30 b
Green cloth	18.02 b	19.94 bcd	21.44 cd
Blue cloth	18.64 ab	20.54 ab	22.22 bc
Red cloth	18.54 ab	19.92 bcd	21.38 cd
Yellow cloth	18.16 b	20.04 bcd	21.32 cd
LSD 0.05	**0.86**	**1.53**	**1.50**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.1.6 Effect of fruit preharvest bagging on juice pH

At 30, 60 and 90 days of bagging, all treatments significantly decreased juice pH as compared to control (Table 3.6). The most effective treatment in decreasing juice pH was brown bagging (2.92, 3.45 and 3.99 at 30, 60 and 90 days respectively). Furthermore, at 90 days of bagging, red (4.07) and yellow (4.02) gave similar results as brown (3.99) in decreasing juice pH.

Table 3.6: Effect of fruit preharvest bagging on juice pH of grapes cv. Halawani.

Treatments	Days of bagging		
	30	**60**	**90**
Control	3.86 a*	3.95 a	4.64 a
Paper bagging	3.25 f	3.52 h	4.16 ed
Brown cloth	2.92 g	3.45 i	3.99 g
White cloth	3.44 d	3.79 d	4.21 cd
Black cloth	3.73 b	3.85 c	4.35 b
Green cloth	3.33 ef	3.68 f	4.11 ef
Blue cloth	3.62 c	3.91 b	4.26 c
Red cloth	3.55 c	3.59 g	4.07 fg
Yellow cloth	3.38 ed	3.76 e	4.02 g
LSD 0.05	**0.08**	**0.01**	**0.07**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.1.7 Effect of fruit preharvest bagging on sunburn injury

At 30 days of bagging, blue cloth bagging (0.34%), paper bagging (0.61%), red cloth bagging (0.92%) and white cloth bagging (1.30%) were significantly decreased the percentage of sunburn injury of the grape berries as compared to control (4.13%) treatment. The other treatments (brown, black, green, and yellow) gave similar results to the control (Table 3.7).

At 60 days of bagging, all treatments except brown cloth (9.08%) were significantly decreased the percentage of sunburn injury as compared to control (11.64%). The most effective treatment in decreasing the percentage of sunburn injury was blue bagging (4.09%) which was on par with yellow (5.76%), green (6.06%), red (6.12%) and white (6.64%).

At 90 days of bagging, all treatments were significantly decreased the percentage of sunburn injury as compared to control (Table 3.7). The best treatment in decreasing the percentage of sunburn injury was yellow bagging (5.86%). The next best treatment was blue (6.00%).

Table 3.7: Effect of fruit preharvest bagging on sunburn injury (%) of grapes cv. Halawani.

Treatments	Days of bagging		
	30	**60**	**90**
Control	4.13 a*	11.64 a	17.62 a
Paper bagging	0.61 b	7.87 bc	8.06 bc
Brown cloth	2.69 ab	9.08 ab	9.33 bc
White cloth	1.30 b	6.46 bcd	7.31 bc
Black cloth	2.69 ab	7.70 bc	10.35 b
Green cloth	2.34 ab	6.06 cd	7.68 bc
Blue cloth	0.34 b	4.09 d	6.00 c
Red cloth	0.92 b	6.12 cd	9.13 bc
Yellow cloth	1.45 ab	5.76 cd	5.86 c
LSD 0.05	**2.75**	**2.93**	**4.09**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.1.8 Effect of fruit preharvest bagging on frost injury

At 30 days of bagging, the results showed that frost injury was significantly decreased by paper bagging (0.00%), blue cloth (0.00%) and red cloth (0.00%) as compared to the control (0.87%). The other treatments (brown, white, black, green, and yellow) gave similar results to the control (Table 3.8).

At 60 days of bagging, all treatments were significantly decreased frost injury as compared to the control. The most effective treatment in decreasing the percentage of frost injury was blue bagging (1.05 %) while the less effective treatment was black bagging (4.06%).

Finally, at 90 days of bagging, all treatments resulted in a significant decreased in percentage of frost injury as compared to the control (Table 3.8).

Table 3.8: Effect of fruit preharvest bagging on frost injury (%) of grapes cv. Halawani.

Treatments	Days of bagging		
	30	**60**	**90**
Control	0.87 a*	10.54 a	18.80 a
Paper bagging	0.00 b	1.73 bc	6.91 b
Brown cloth	0.42 ab	4.04 bc	7.15 b
White cloth	0.23 ab	3.27 bc	7.28 b
Black cloth	0.29 ab	4.06 b	6.45 b
Green cloth	0.23 ab	3.02 bc	6.72 b
Blue cloth	0.00 b	1.05 c	6.12 b
Red cloth	0.00 b	2.06 bc	6.37 b
Yellow cloth	0.34 ab	3.02 bc	6.07 b
LSD 0.05	**0.75**	**3.00**	**5.87**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.1.9 Effect of fruit preharvest bagging on stem browning

At 30 days of bagging, all treatments except brown cloth (2.00) and black (1.80) were significantly decreased the percentage of stem browning as compared to control (2.20). The most effective treatments in decreasing the percentage of stem browning were paper (1.20) and blue (1.20) bagging which were on par with white (1.60), green (1.40), red (1.40) and yellow (1.50).

At 60 days of bagging, all treatments were significantly decreased the percentage of stem browning as compared to control (Table 3.9). The treatments namely paper bagging (1.40), blue cloth (1.40) and red cloth (1.40) bagging were the best treatments in maintaining the stem green. However, these treatments were on par with yellow bagging (2.00).

At 90 days of bagging, paper bagging (2.80) was significantly superior in decreasing the percentage of stem browning as compared to control (Table 3.9). The next best treatment was white cloth (3.20) bagging followed by red cloth (3.60), blue cloth (3.80) and green cloth (4.00). The other treatments (brown, black and yellow) gave similar results to the control.

Table 3.9: Effect of fruit preharvest bagging on stem browning[Z] of grapes cv. Halawani.

Treatments	Days of bagging		
	30	**60**	**90**
Control	2.20 a[*]	4.00 a	4.80 ab
Paper bagging	1.20 d	1.40 d	2.80 f
Brown cloth	2.00 ab	3.20 b	4.60 ab
White cloth	1.60 bcd	3.00 b	3.20 ef
Black cloth	1.80 abc	3.20 b	5.00 a
Green cloth	1.40 cd	2.60 bc	4.00 cd
Blue cloth	1.20 d	1.40 d	3.80 d
Red cloth	1.40 cd	1.40 d	3.60 de
Yellow cloth	1.50 bcd	2.00 cd	4.40 bc
LSD 0.05	**0.56**	**0.75**	**0.56**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

[z] Grape stem browning (%): Green (0% brown) = 0-0.9, Semi-green (less than 40% brown) = 1-1.9, Green plus brown (41-60% brown) = 2-2.9, Semi–brown (61-80% brown) = 3-3.9 and Brown (more than 81% brown) = 4-5.

3.1.10 Effect of fruit preharvest bagging on berry shatter

At 30 days of bagging, there were no significant differences among bagging treatments as compared to the control (Table 3.10).

At 60 and 90 days of bagging, all treatments were significantly decreased the percentage of berry shatter as compared to control (Table 3.10). At 60 days, the most effective treatment in decreasing the percentage of berry shatter was blue bagging (5.97%) which was on par with red (6.33%) and green (7.08%), yellow (7.63%), paper bagging (7.89%) and white (8.66%). Similarly, at 90 days, the most effective treatment was blue (6.83%) which was on par with yellow (8.62%), green (10.27%), paper bagging (11.87%), white (12.16%) and red (12.28%).

Table 3.10: Effect of fruit preharvest bagging on berry shatter (%) of grapes cv. Halawani.

Treatments	Days of bagging		
	30	**60**	**90**
Control	3.60 a*	13.77 a	27.37 a
Paper bagging	2.14 a	7.89 bcd	11.87 bc
Brown cloth	4.30 a	10.51 b	16.59 b
White cloth	2.75 a	8.66 bcd	12.16 bc
Black cloth	3.64 a	10.14 bc	17.72 b
Green cloth	2.93 a	7.08 cd	10.27 c
Blue cloth	2.20 a	5.97 d	6.83 c
Red cloth	2.44 a	6.33 d	12.28 bc
Yellow cloth	2.23 a	7.63 bcd	8.62 c
LSD 0.05	**2.27**	**3.13**	**6.28**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.1.11 Effect of fruit preharvest bagging on shriveled berry

At 30 days of bagging, although paper bagging (0.14%) was significantly superior in reducing the percentage of shriveled berries as compared to brown bagging (3.46 %), but there were no significant differences between all bagging treatments as compared to control (Table 3.11).

At 60 days of bagging, blue bagging (4.80%) was significantly superior in reducing the percentage of shriveled berries as compared to control (10.58 %), but the other treatments were not significantly difference as compared to the control (Table 3.11).

At 90 days of bagging, all treatments except black (21.29%) was significantly decreased the percentage of shriveled berries as compared to control (24.15%). The most effective treatment in reducing the percentage of shriveled berries was blue bagging (8.70%) which was on par with yellow bagging (13.07%), white bagging (13.94%), paper bagging (14.09%) and brown bagging (14.78%).

Table 3.11: Effect of fruit preharvest bagging on shriveled berry (%) of grapes cv. Halawani.

Treatments	Days of bagging		
	30	**60**	**90**
Control	1.78 ab*	10.85 a	24.15 a
Paper bagging	0.14 b	7.34 ab	14.09 bcd
Brown cloth	3.46 a	9.27 ab	14.78 bcd
White cloth	1.18 ab	7.64 ab	13.94 cd
Black cloth	1.76 ab	10.16 ab	21.29 ab
Green cloth	1.27 ab	6.03 ab	16.43 bc
Blue cloth	0.40 ab	4.80 b	8.70 d
Red cloth	0.65 ab	5.88 ab	16.37 bc
Yellow cloth	1.32 ab	8.17 ab	13.07 cd
LSD 0.05	**3.31**	**5.78**	**7.25**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.1.12 Effect of fruit preharvest bagging on waterberry

At 30 and 90 days of bagging, results showed no significant effect of bagging on the percentage of water berry as compared to control (Table 3.12).

At 60 days of bagging, paper bagging (0.00%) was significantly decreased the percentage of water berry as compared to control (3.80%). This treatment was on par with green cloth (1.00%), blue cloth (0.80%), red cloth (1.00%) and yellow cloth (2.40%).

Table 3.12: Effect of fruit preharvest bagging on waterberry (%) of grapes cv. Halawani.

Treatments	Days of bagging		
	30	**60**	**90**
Control	1.00 a*	3.80 a	6.60 a
Paper bagging	0.00 a	0.00 b	4.20 a
Brown cloth	1.40 a	3.40 a	6.20 a
White cloth	0.80 a	3.20 a	4.20 a
Black cloth	1.00 a	3.40 a	5.40 a
Green cloth	0.00 a	1.00 ab	4.80 a
Blue cloth	0.00 a	0.80 ab	4.40 a
Red cloth	0.00 a	1.00 ab	4.20 a
Yellow cloth	0.20 a	2.40 ab	6.40 a
LSD 0.05	**1.59**	**3.16**	**3.88**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.1.13 Effect of fruit preharvest bagging on *Botrytis cinerea*

At 30 days of bagging, all treatments were significantly decreased the percentage of infection with *Botrytis cinerea* as compared to control (Table 3.13).

At 60 days of bagging, all treatments except green (5.57%) was significantly decreased the percentage of infection with *B. cinerea* as

compared to control (9.12%). The most effective treatments in reducing the percentage of *B. cinerea* were paper bagging (0.00%) and blue bagging (0.00%) which were on par with white bagging (1.47%), black bagging (3.83 %) and red bagging (1.78%).

At 90 days of bagging, all treatments were significantly decreased the percentage of *B. cinerea* as compared to control (Table 3.13). The most effective treatments in decreasing the percentage of *Botrytis cinerea* were paper bagging (0.00%) blue bagging (0.00%) and red bagging (0.00%) which was on par with green (2.59%) and yellow (1.30%).

Table 3.13: Effect of fruit preharvest bagging on the percentage of infection with *Botrytis cinerea* of grapes cv. Halawani.

Treatments	Days of bagging		
	30	**60**	**90**
Control	1.63 a*	9.12 a	13.57 a
Paper bagging	0.00 b	0.00 d	0.00 d
Brown cloth	0.00 b	4.60 bc	6.76 b
White cloth	0.00 b	1.47 cd	3.17 c
Black cloth	0.00 b	3.83 bcd	7.00 b
Green cloth	0.00 b	5.57 ab	2.59 cd
Blue cloth	0.00 b	0.00 d	0.00 d
Red cloth	0.00 b	1.78 bcd	0.00 d
Yellow cloth	0.00 b	4.48 bc	1.30 cd
LSD 0.05	**0.43**	**3.87**	**3.12**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.1.14 Effect of fruit preharvest bagging on *Penicillium expansum*

At 30 days of bagging, there were no significant differences among bagging treatments as compared to the control (Table 3.14).

At 60 days of bagging, all treatments except brown (2.89%) and white (3.14%) were significantly decreased the percentage of *Penicillium expansum* as compared to control (3.90%). The most effective treatments in decreasing the percentage of *P. expansum* were red (1.01%) and yellow (1.01%) which was on par with green (1.07%), blue (0.88%), black (1.41%) and paper bagging (1.64%).

At 90 days of bagging, the best treatment in decreasing the percentage of *P. expansum* was green (1.13%) which was on par with blue (1.40%), paper (1.60%), white (2.38%), yellow (2.50%) and black (2.95%).

Table 3.14: Effect of fruit preharvest bagging on the percentage of berry infection with *Penicillium expansum* of grapes cv. Halawani.

Treatments	Days of bagging		
	30	**60**	**90**
Control	1.24 a*	3.90 a	4.85 a
Paper bagging	0.61 a	1.64 bcd	1.60 bcd
Brown cloth	2.66 a	2.89 abc	3.43 ab
White cloth	1.80 a	3.14 ab	2.38 bcd
Black cloth	1.92 a	1.41 cd	2.95 abcd
Green cloth	1.43 a	1.07 d	1.13 d
Blue cloth	0.60 a	0.88 d	1.40 cd
Red cloth	2.90 a	1.01 d	3.20 abc
Yellow cloth	1.21 a	1.01 d	2.50 bcd
LSD 0.05	**2.35**	**1.54**	**1.98**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.1.15 Effect of fruit preharvest bagging on *Aspergillus niger*

At 30 days of bagging, there were no significant differences among bagging treatments as compared to the control (Table 3.15). However, it can be seen that the treatments paper bagging (0.20%), green (0.17%), yellow (0.37%) and blue (0.40%) were significantly superior in reducing the percentage of berry infection with *Aspergillus niger* as compared to brown bagging (1.87%).

At 60 days of bagging, all treatments were significantly decreased the percentage of *A. niger* as compared to control (Table 3.15). The most effective treatments in decreasing the percentage of *A. niger* were black bagging (0.30%) and blue bagging (0.39%) which were on par with paper

bagging (0.85%) and white (0.78%), green (1.15%), red (1.01%) and yellow (0.90%) .

At 90 days of bagging, all treatments except brown (3.62%) was significantly decreased the percentage of *A. niger* as compared to control (Table 3.15). The most effective treatment in decreasing the percentage of *A. niger* was white bagging (0.41%) which was on par with paper bagging (0.56%), black (2.06%), green (0.44%), blue (0.68%), red (1.16%) and yellow (1.32%).

Table 3.15: Effect of fruit preharvest bagging on the percentage of berry infection with *Aspergillus niger* of grapes cv. Halawani.

Treatments	Days of bagging		
	30	**60**	**90**
Control	0.79 ab*	3.87 a	5.41 a
Paper bagging	0.20 b	0.85 bc	0.56 c
Brown cloth	1.87 a	2.11 b	3.62 ab
White cloth	1.00 ab	0.78 bc	0.41 c
Black cloth	0.80 ab	0.30 c	2.06 bc
Green cloth	0.17 b	1.15 bc	0.44 c
Blue cloth	0.40 b	0.39 c	0.68 c
Red cloth	1.16 ab	1.01bc	1.16 c
Yellow cloth	0.37 b	0.90 bc	1.32 bc
LSD 0.05	**1.19**	**1.42**	**2.30**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.1.16 Effect of fruit preharvest bagging on grape berry moth (*Lobesia botrana*)

At 30 days of bagging, results showed no significant effect of bagging on the percentage of infection with grape berry moth (*L. botrana*) as compared to control treatment (Table 3.16). However, there was significant differences between brown cloth bag (3.15%) and red cloth bag (0.37%).

At 60 and 90 days of bagging, all treatments were significantly effective in reducing the percentage of infection with grape berry moth (*L. botrana*) as compared to control (Table 3.16). Furthermore, at 90 days of bagging, the most effective treatment in reducing the percentage of infection with grape berry moth was paper bagging (1.97%) which was on par with white bagging (5.58%), blue bagging (2.75%), red bagging (4.83%) and yellow bagging (4.21%).

Table 3.16: Effect of fruit preharvest bagging on the percentage of infection with grape berry moth of grapes cv. Halawani.

Treatments	Days of bagging		
	30	**60**	**90**
Control	1.71 ab*	8.70 a	14.02 a
Paper bagging	1.22 ab	1.47 b	1.97 d
Brown cloth	3.15 a	3.75 b	7.03 bc
White cloth	1.67 ab	4.32 b	5.58 bcd
Black cloth	1.77 ab	2.66 b	7.82 b
Green cloth	1.85 ab	3.23 b	8.62 b
Blue cloth	0.95 ab	1.64 b	2.75 cd
Red cloth	0.37 b	2.47 b	4.83 bcd
Yellow cloth	1.17 ab	2.51 b	4.21 bcd
LSD 0.05	**2.55**	**3.51**	**4.57**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.1.17 Effect of fruit preharvest bagging on bird injury

At 30, 60 and 90 days of bagging, results showed a significant effect for all bagging treatments in reducing the percentage of bird injury as compared to the control (Table 3.17).

Table 3.17: Effect of fruit preharvest bagging on bird injury (%) of grapes cv. Halawani.

Treatments	Days of bagging		
	30	**60**	**90**
Control	7.70 a*	13.60 a	14.50 a
Paper bagging	0.00 b	0.00 b	0.00 b
Brown cloth	0.00 b	0.00 b	0.00 b
White cloth	0.00 b	0.00 b	0.00 b
Black cloth	0.00 b	0.00 b	0.00 b
Green cloth	0.00 b	0.00 b	0.00 b
Blue cloth	0.00 b	0.00 b	0.00 b
Red cloth	0.00 b	0.00 b	0.00 b
Yellow cloth	0.00 b	0.00 b	0.00 b
LSD 0.05	**1.30**	**1.77**	**1.58**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.2 Effect of some botanical extracts as postharvest treatments on grapes cv. Halawani

The data pertaining to the effect of some botanical extracts (*Inula viscosa*, *Majorana syriaca*, *Thymus vulgaris*, *Salvia officinalis* and *Varthemia iphionoides*) as postharvest treatments on the fruit quality, physiological disorders and storage diseases of Halawani grapes at 30, 60 and 90 days of storage are presented under the following heads (Fig. 3.1):

3.2.1 Fruit quality

The data related to fruit quality parameters (berry size, firmness, berry color, TSS, juice pH and odor) as influenced by some botanical extracts as postharvest treatments on Halawani grapes are presented under the following titles**:**

3.2.1.1 Effect of botanical extracts as postharvest treatments on berry size

At 30, 60 and 90 days of storage in refrigerator, all botanical extracts treatments were not significant difference compared to control treatment (Table 3.18).

Fig. 3.1: Effect of some botanical extracts on grapes cv. Halawani at 90 days after storage

Table 3.18: Effect of botanical extracts as postharvest treatments on berry size (cm^3) of grapes cv. Halawani.

Treatments	Days of storage		
	30	**60**	**90**
Control	6.72 a*	6.18 a	6.06 a
Rovral	6.62 a	6.23 a	6.06 a
Inula viscosa	6.21 a	6.23 a	6.12 a
Majorana syriaca	6.68 a	6.32 a	5.76 a
Thymus vulgaris	6.69 a	6.17 a	6.05 a
Salvia officinalis	6.70 a	6.08 a	5.94 a
Varthemia iphionoides	6.51 a	6.27 a	6.11 a
LSD 0.05	**1.13**	**0.83**	**0.78**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.2.1.2 Effect of botanical extracts as postharvest treatments berry firmness

At 30 days of storage, *Inula viscosa* (50.68 kg/cm^2) treatment was significantly superior in increasing berry firmness as compared to control or to other treatments. On the other hand, *Majorana syriaca* (35.41 kg/cm^2) was significantly superior in decreasing berry firmness as compared to control or to other treatments. The other treatments (Rovral, *Thymus vulgaris*, *Salvia officinalis* and *Varthemia iphionoides*) gave similar results to the control (Table 3.19).

At 60 days of storage, there were no significant differences among the treatments as compared to the control (Table 3.19). However, *Majorana syriaca* (31.14 kg/cm^2) was significantly superior in decreasing berry firmness as compared to Rovral (41.42 kg/cm^2), *Inula viscosa* (42.53 kg/cm^2) and *Varthemia iphionoides* (40.83 kg/cm^2).

At 90 days of storage, there were no significant differences among the treatments (Table 3.19).

Table 3.19: Effect of botanical extracts as postharvest treatments on berry firmness (kg/cm^2) of grapes cv. Halawani.

Treatments	Days of storage		
	30	**60**	**90**
Control	43.51 bc*	36.39 ab	6.06 a
Rovral	42.19 bc	41.42 a	6.06 a
Inula viscosa	50.68 a	42.53 a	6.12 a
Majorana syriaca	35.41 d	31.14 b	5.76 a
Thymus vulgaris	41.25 c	36.11 ab	6.05 a
Salvia officinalis	42.91 bc	38.09 ab	5.94 a
Varthemia iphionoides	44.99 b	40.83 a	6.11 a
LSD 0.05	**3.50**	**7.06**	**0.78**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.2.1.3 Effect of botanical extracts as postharvest treatments berry coloration

At 30, 60 and 90 days storage, all treatments did not affect berry coloration measured by eye (%) or spectrophotometer (O.D.) in a significant manner as compared to the control (Table 3.20).

Table 3.20: Effect of botanical extracts as postharvest treatments on berry color of grapes cv. Halawani.

Treatments	Days of storage					
	Berry coloration by eye (%)[z]			Color intensity by spectrophotometer (O.D)		
	30	60	90	30	60	90
Control	88.00 a[*]	86.00 a	88.00 a	0.95 a	0.75 a	0.98 a
Rovral	90.00 a	91.00 a	88.00 a	1.11 a	1.18 a	1.65 a
Inula viscosa	87.00 a	89.00 a	87.00 a	1.11 a	0.92 a	0.93 a
Majorana syriaca	88.00 a	89.00 a	89.00 a	1.04 a	1.03 a	1.12 a
Thymus vulgaris	85.00 a	87.00 a	87.00 a	1.04 a	1.11 a	1.04 a
Salvia officinalis	90.00 a	88.00 a	88.00 a	1.13 a	1.29 a	1.23 a
Varthemia iphionoides	84.00 a	85.00 a	84.00 a	0.99 a	0.95 a	0.96 a
LSD 0.05	**6.75**	**6.19**	**4.84**	**0.78**	**0.81**	**0.78**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

[z] Berry coloration by eye %: Green red = (51-60%), Red green = (61-70%), Light red = (71-80%), Red = (81-90%) and Dark red = (91-100%).

3.2.1.4 Effect of botanical extracts as postharvest treatments TSS

At 30 days of storage, the treatment *Salvia officinalis* (17.06%), was significantly reduced TSS content in the berries of Halawani grapes as compared to control treatment (18.94%). Moreover, this treatment was on par with *Inula viscosa* (17.96%). The other treatments (Rovral, *Majorana syriaca*, *Thymus vulgaris* and *Varthemia iphionoides*) gave similar results to the control (Table 3.21).

At 60 days of storage, all treatments were not significantly influenced the percentage of TSS as compared to control. But Rovral (18.62%) was

significantly superior in increasing TSS as compared with *Inula viscosa* (17.22%) and *Salvia officinalis* (16.78%).

At 90 days of bagging, the best treatment in increasing TSS was Rovral (18.58%) followed by *Majorana syriaca* (17.58%). The other treatments (*Inula viscosa, Thymus vulgaris, Salvia officinalis* and *Varthemia iphionoides*) gave similar results to the control (Table 3.21).

Table 3.21: Effect of botanical extracts as postharvest treatments on TSS of grapes cv. Halawani.

Treatments	Days of storage		
	30	**60**	**90**
Control	18.94 a*	17.52 abc	16.38 c
Rovral	18.94 a	18.62 a	18.58 a
Inula viscosa	17.96 ab	17.22 bc	16.52 bc
Majorana syriaca	18.38 a	17.74 abc	17.58 ab
Thymus vulgaris	18.00 a	17.80 abc	17.06 bc
Salvia officinalis	17.06 b	16.78 c	16.56 bc
Varthemia iphionoides	18.66 a	18.26 ab	17.18 bc
LSD 0.05	**1.19**	**1.12**	**1.18**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.2.1.5 Effect of botanical extracts as postharvest treatments on juice pH

At 30, 60 and 90 days of storage, all treatments not significantly affect the juice pH as compared to control (Table 3.22). However, at 30 days, *Inula viscosa* (3.71) and *Thymus vulgaris* (3.77) were significantly superior in increasing juice pH as compared to Rovral (3.17) and

Majorana syriaca (3.22). Further, at 60 days, *Inula viscosa* (4.12) was significantly superior in increasing juice pH as compared to *Majorana syriaca* (3.65).

Similarly, at 90 days, *Inula viscosa* (4.17) was significantly superior in increasing juice pH as compared to Rovral (3.84) and *Majorana syriaca* (3.82).

Table 3.22: Effect of botanical extracts as postharvest treatments on juice pH of grapes cv. Halawani.

Treatments	Days of storage		
	30	**60**	**90**
Control	3.47 ab*	3.97 ab	4.05 ab
Rovral	3.17 b	3.78 ab	3.84 b
Inula viscosa	3.71 a	4.12 a	4.17 a
Majorana syriaca	3.22 b	3.65 b	3.82 b
Thymus vulgaris	3.77 a	3.89 ab	4.08 ab
Salvia officinalis	3.50 ab	3.87 ab	3.92 ab
Varthemia iphionoides	3.50 ab	3.78 ab	4.03 ab
LSD 0.05	**0.48**	**0.34**	**0.29**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.2.1.6 Effect of botanical extracts as postharvest treatments on odor

After 30, 60 and 90 days of storage, there were significantly differences between control and the other treatments (Table 3.23). The highest odor was found on Rovral treatment.

Table 3.23: Effect of botanical extracts as postharvest treatments on odor[z] of grapes cv. Halawani.

Treatments	Days of storage		
	30	**60**	**90**
Control	0.00 d[*]	0.00 d	0.00 c
Rovral	5.00 a	4.00 a	2.60 a
Inula viscosa	3.20 b	2.00 b	1.40 b
Majorana syriaca	2.80 b	1.00 c	1.00 b
Thymus vulgaris	2.00 c	1.00 c	1.00 b
Salvia officinalis	3.00 b	1.40 c	1.00 b
Varthemia iphionoides	1.80 c	1.00 c	1.00 b
LSD 0.05	**0.79**	**0.44**	**0.51**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

[z]Odor: No odor = (0-0.9), Very little odor = (1-1.9), Little odor = (2-2.9), Strong odor = (3-3.9) and Very strong odor = (4-5).

3.2.2 Physiological disorders

The data pertaining to physiological disorders (stem browning, berry shatter, shriveled berries and water berry) as influenced by some botanical extracts as postharvest treatments on Halawani grapes are presented under the following heads:

3.2.2.1 Effect of botanical extracts as postharvest treatments on stem browning

At 30 days of storage, all treatments except *Majorana syriaca* were not significantly affect stem browning as compared to control. It can be noticed from Table (3.24) that *Majorana syriaca* (3.40) was significantly

increased the percentage of stem browning as compared to control (1.80) and to *Inula viscosa* (1.80).

At 60 days of storage, all treatments except Rovral were not significantly affect stem browning as compared to control. It can be noticed from (Table 3.24) that Rovral (5.00) was significantly increased the percentage of stem browning as compared to control (3.80).

At 90 days of storage, *I. viscosa* (4.60) and *S. officinalis* (4.60) were significantly superior in decreasing the percentage of stem browning as compared to control (5.00) and to the other treatments.

Table 3.24: Effect of botanical extracts as postharvest treatments on stem browning[z] of grapes cv. Halawani.

Treatments	Days of storage		
	30	**60**	**90**
Control	1.80 b*	3.80 b	5.00 a
Rovral	2.00 ab	5.00 a	5.00 a
Inula viscosa	1.80 b	4.2 ab	4.60 b
Majorana syriaca	3.40 a	4.40 ab	5.00 a
Thymus vulgaris	2.20 ab	4.8 ab	5.00 a
Salvia officinalis	2.40 ab	4.00 ab	4.60 b
Varthemia iphionoides	2.20 ab	4.40 ab	5.00 a
LSD 0.05	**1.50**	**1.12**	**0.38**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

[z] Grape stem browning (%): Green (0% brown) = 0-0.9, Semi-green (less than 40% brown) = 1-1.9, Green plus brown (41-60% brown) = 2-2.9, Semi–brown (61-80% brown) = 3-3.9 and Brown (more than 80% brown) = 4-5.

3.2.2.2 Effect of botanical extracts as postharvest treatments on berry shatter

At 30 days of storage, *Majorana syriaca* (11.81%) and *Thymus vulgaris* (13.74%) were significantly increased the percentage of berry shatter as compared to the control (2.37%). The other treatments gave similar results to the control (Table 3.25).

At 60 days of storage, there were no significant differences among the treatments as compared to the control (Table 3.25).

At 90 days of storage, all treatments except *M. syriaca* (22.07%) and *T. vulgaris* (19.74%) were significantly decreased the percentage of berry shatter as compared to control (28.19%). The best treatments for decreasing the percentage of berry shatter were *I. viscosa* (5.46%) and *V. iphionoides* (7.86%) which were on par with *S. officinalis* (11.43%) and Rovral (11.46%).

Table 3.25: **Effect of botanical extracts as postharvest treatments on berry shatter (%) of grapes cv. Halawani.**

Treatments	Days of storage		
	30	**60**	**90**
Control	2.37 c*	10.16 a	28.19 a
Rovral	2.81 bc	13.00 a	11.46 bc
Inula viscosa	0.40 c	4.03 a	5.46 c
Majorana syriaca	11.81 ab	13.24 a	22.07 a
Thymus vulgaris	13.74 a	10.26 a	19.74 ab
Salvia officinalis	5.61 abc	9.40 a	11.43 bc
Varthemia iphionoides	2.43 c	3.52 a	7.86 c
LSD 0.05	**9.05**	**11.10**	**9.73**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.2.2.3 Effect of botanical extracts as postharvest treatments on shriveled berries

At 30 days of storage, all treatments except *Majorana syriaca* were not significantly affect shriveled berries as compared to control (Table 3.26). *Majorana syriaca* (8.43%) was significantly superior in increasing the percentage of shriveled berries which was on par with *Thymus vulgaris* (3.18%) and Rovral (3.00%).

At 60 days of storage, there were no significant differences among the treatments as compared to the control (Table 3.26).

At 90 days of storage, the most effective treatment in decreasing the percentage of shriveled berries as compared to control (23.34%) was *Inula viscosa* (5.34%) followed *Thymus vulgaris* (10.12%) and Rovral (10.30%).

Table 3.26: Effect of botanical extracts as postharvest treatments on shriveled berries (%) of grapes cv. Halawani.

Treatments	Days of storage		
	30	**60**	**90**
Control	0.49 b*	9.76 ab	23.34 a
Rovral	3.00 ab	9.43 ab	10.30 bc
Inula viscosa	0.45 b	5.36 ab	5.34 c
Majorana syriaca	8.43 a	11.59 a	18.26 ab
Thymus vulgaris	3.18 ab	3.81 ab	10.12 bc
Salvia officinalis	1.97 b	5.41 ab	13.33 abc
Varthemia iphionoides	1.64 b	7.93 ab	15.12 abc
LSD 0.05	**5.56**	**7.40**	**10.90**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.2.2.4 Effect of botanical extracts as postharvest treatments on waterberry

At 30 days of storage, there were no significant differences among the treatments as compared to the control (Table 3.27).

At 60 days of storage, all treatments except Rovral (0.00%) and *V. iphionoides* (0.37%) were significantly affected the percentage of waterberry as compared to control treatment (0.00%). The most effective treatment in increasing the percentage of waterberry was *M. syriaca* (3.96%) which was on par with *T. vulgaris* (3.63%), *I. viscosa* (2.89%) and *S. officinalis* (2.87%).

At 90 days of storage, *V. iphionoides* (0.00%) was significantly superior in decreasing the percentage of water berry as compared to control treatment (9.08%). This treatment was on par with Rovral (0.75%) and

I. viscosa (2.82%). Other treatments gave similar results to the control (Table 3.27).

Table 3.27: Effect of botanical extracts as postharvest treatments on waterberry (%) of grapes cv. Halawani.

Treatments	Days of storage		
	30	**60**	**90**
Control	0.00 a*	0.00 b	9.08 a
Rovral	0.00 a	0.00 b	0.75 bc
Inula viscosa	0.00 a	2.89 a	2.82 bc
Majorana syriaca	0.00 a	3.96 a	5.52 ab
Thymus vulgaris	0.70 a	3.63 a	4.84 ab
Salvia officinalis	0.00 a	2.87 a	4.93 ab
Varthemia iphionoides	0.00 a	0.37 b	0.00 c
LSD 0.05	**0.76**	**2.02**	**4.82**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.2.3 Storage diseases

The data pertaining to storage diseases (*Botrytis cinerea*, *Penicillium expansum* and *Aspergillus niger*) as influenced by some botanical extracts as postharvest treatments on Halawani grapes are presented under the following heads:

3.2.3.1 Effect of botanical extracts as postharvest treatments on *Botrytis cinerea*

At 30 days of storage, there were no significant differences among the treatments as compared to the control (Table 3.28). Despite this, Rovral (2.70%) and *Inula viscosa* (2.12%) were the most effective treatments in reducing the percentage of berry infection with *Botrytis cinerea* as compared to *Majorana syriaca* (10.84%).

At 60 days of storage, Rovral (4.98%) and *I. viscosa* (2.41%) were significantly decreased the percentage of infection with *B. cinerea* as compared to control (10.35%). Other treatments gave similar results to the control (Table 3.28).

At 90 days of storage, *I. viscosa* (0.65%) was significantly decreased the percentage of *B. cinerea* as compared to control (14.36%). This treatment was on par with *V. iphionoides* (6.48%) and Rovral (8.91%). Other treatments gave similar results to the control (Table 3.28).

Table 3.28: Effect of botanical extracts as postharvest treatments on *Botrytis cinerea* (%) of grapes cv. Halawani.

Treatments	Days of storage		
	30	**60**	**90**
Control	5.35 abc*	10.35 ab	14.36 ab
Rovral	2.70 c	4.98 cd	8.91 abc
Inula viscosa	2.12 c	2.41 d	0.65 c
Majorana syriaca	10.84 a	14.43 a	14.25 ab
Thymus vulgaris	10.44 ab	8.84 bc	16.41 a
Salvia officinalis	3.79 abc	8.41 bc	10.07 ab
Varthemia iphionoides	3.26 bc	5.98 bcd	6.48 bc
LSD 0.05	**7.56**	**4.89**	**8.72**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.2.3.2 Effect of botanical extracts as postharvest treatments on *Penicillium expansum*

At 30 days of storage, , all treatments except *Thymus vulgaris* (3.04%) had no significant effect as compared to control (0.88%). However, Rovral (0.21%) and *Varthemia iphionoides* (0.72%) had an effect on decreasing the percentage of *P. expansum* but this effect did not reach level of significant (Table 3.29).

At 60 days storage, there were no significant differences among the treatments as compared to the control (Table 3.29). However, *I. viscosa* (1.42%) was significantly superior in decreasing the percentage of *P. expansum* as compared to *S. officinalis* (4.62%).

At 90 days storage, the best treatments in decreasing the percentage of *P. expansum* was *I. viscosa* (0.87%) which was on par with *V. iphionoides* (2.41%), Rovral (4.20%) and *S. officinalis* (4.44%).

Table 3.29: Effect of botanical extracts as postharvest treatments on *Penicillium expansum* of grapes cv. Halawani.

Treatments	Days of storage		
	30	**60**	**90**
Control	0.88 bc*	3.10 ab	7.91 ab
Rovral	0.21 c	1.76 ab	4.20 bcd
Inula viscosa	1.28 abc	1.42 b	0.87 d
Majorana syriaca	2.82 ab	2.74 ab	9.63 a
Thymus vulgaris	3.04 a	4.07 ab	6.21 abc
Salvia officinalis	1.88 abc	4.62 a	4.44 bcd
Varthemia iphionoides	0.72 c	1.70 ab	2.41 cd
LSD 0.05	**2.02**	**3.07**	**4.49**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

3.2.3.3 Effect of botanical extracts as postharvest treatments on *Aspergillus niger*

At 30 days of storage, there were no significant differences among the treatments as compared to the control (Table 3.30). Rovral (0.00%) and *Varthemia iphionoides* (0.38%) were significantly superior in decreasing the percentage of *Aspergillus niger* as compared to *Thymus vulgaris* (3.46%).

At 60 days storage, all treatments except *T. vulgaris* (5.07%) had no significant effect as compared to control (1.44%). However, it can be seen that Rovral (0.79%) had a slight but insignificant effect in decreasing the percentage of *A. niger* (Table 3.30).

At 90 days of storage, *I. viscosa* (2.28%) and *V. iphionoides* (2.00%) were significantly decreased the percentage of *A. niger* as compared to control (5.73%). Other treatments gave similar results to the control (Table 3.30).

Table 3.30: Effect of botanical extracts as postharvest treatments on *Aspergillus niger* (%) of grapes cv. Halawani.

Treatments	Days of storage		
	30	**60**	**90**
Control	1.09 ab*	1.44 b	5.73 a
Rovral	0.00 b	0.79 b	3.31 ab
Inula viscosa	1.25 ab	1.15 b	2.28 b
Majorana syriaca	2.14 ab	3.41 ab	5.41 a
Thymus vulgaris	3.46 a	5.07 a	4.88 ab
Salvia officinalis	0.78 ab	3.30 ab	3.71 ab
Varthemia iphionoides	0.38 b	1.29 b	2.00 b
LSD 0.05	**3.06**	**3.09**	**2.89**

*** Means within column followed by the same letter(s) are not significantly different at 5% level according to LSD test.**

Chapter Four

Discussion

The present study was under taken during the season 2011 at Halhul town to investigate the effect of fruit preharvest bagging on grapes (*Vitis vinifera* L.) cv. Halawani. Also, the effect of some botanical extracts as postharvest treatments was studied. The results obtained from the study are discussed in this chapter.

4.1 Experiment 1: Effect of fruit preharvest bagging on grapes (*Vitis vinifera* L.) cv. Halawani

At January month the grapes season in Hebron were over, there were not available commercial amount of grapes in the markets, here comes the role of bagging grapes in maintaining of grapes with high quality for long time in the season. Thus, gives grapes a high price compared with the price during the season.

In the present study, preharvest bagging at 30, 60 and 90 days had no significant effect on berry size (cm^3) of grapes cv. Halawani as compared to control (Table 3.1). Lack effect of bagging treatments on the berry size in a significant manner could be explained by the fact that bagging was applied to mature berries. Beyond this stage, no dramatical changes in berry size could be expected.

The effect of fruit preharvest bagging on berry size has been contradictory, some fruits had no or little effect (Awad, 2006; Marashi and Mousavi, 2007; Awad, 2010), while with other fruits bagging had significant effect by increasing fruit weight and size (Faust, 1989; Westwood, 1993; Davis, 2004). The reasons for that may be related to

differences in the type of bag used, fruit age at bagging, fruit and cultivar response and prevailing climatic conditions (Amarante *et al*., 2002; Weerasinghe and Ruwapathirana, 2002; Narayana *et al*., 2004)**.**

Through this study, all bagging treatments increased the berry firmness as compared to control. The grape berries in paper bagging and blue cloth bags had more berry firmness than other bagging treatments (Table 3.2). One of the suggested explanation of the more firmness in paper bagging and blue cloth treatments might be due to better microclimate conditions inside these bags which directly or in directly influence positively on the berry firmness. The other suggested explanation might be due to reflect ray from bag colors and decrease temperature inside the paper bagging and blue cloth bag. Also, the texture of paper bagging was smooth and reflect sunrays regularly, while blue cloth bag absorbed all spectrum colors and reflect blue wave.

Only a few previous studies have been conducted on this aspect, which revealed that pre-harvest fruit bagging can influence the fruit firmness at harvest. For example, Bentley and Viveros (1992) reported that fruit firmness of apples was improved by brown paper bags. Hofman *et al*., (1997) reported that fruit firmness was not affected by white paper bag in mango. Whilst Son and Lee (2008) reported that fruit firmness was lower in the no-bagging treatment group than in the bagging treatment groups. Bin *et al*., (2006) and Li *et al*., (2006) reported that flesh firmness of unbagged fruit was higher than that of bagged fruit.

In our study and in most cases, the effect of bagging was clear for delay the grape berry ripening as compared to control (Table 3.3). Paper bagging and blue cloth bagging were more significantly resulted in delay berry ripening. This may reflect differences in temperature, humidity,

lighting and sunray inside bags. Also, blue cloth is considered cold, since it reflect high energy wave (blue wave), so it delay berry ripening. This may reflect differences in the type of bag used, fruit stage when it was bagged, duration of fruit exposure to natural light after bag removal and / or fruit and cultivar specific responses.

These experimental data supported the fact that bagging grapes cv. Halawani delays the ripening process of grapes. This agrees with many of the previous studies (Signes *et al*., 2007). However, other studies gave contradictory results for the effects of preharvest bagging on maturity. For instance, Amarante *et al*., (2002) reported little or no effect on maturation of grapes from 40 varieties of *Vitis vinifera*.

In this study we observed that, black cloth bags was negative results compared to other bagging treatments, it increase berry coloration (%). The interpretation for these results may be due to the fact that black bag absorbs full spectrum of sun light falling on bags, which leads to a rise in the temperature inside the bag. In contrary, the paper and blue cloth bags were the most effective treatments in decreasing grape berry coloration as compared to control (Table 3.4). Paper reflects the falling light and blue bag reflects blue wave and absorbs other waves, so the temperature inside the bags are equal to the temperature outside the bag.

In general, it is fruit bagging inhibited anthocyanin synthesis entirely in fruit peel. This agrees with the result in apples (Li *et al*., 1998) and pear (Huang *et al*., 2009). Sharma *et al*., (2013) studies also revealed that bagged fruits have better color development than non-bagged fruits. Bagged apples with light-yellow bags resulted in the development of attractive red color over non-bagged apples. Conversely, the yellow/green

color development was suppressed by bagging. Fruit of black and red bag treatments had the highest lightness values (Huang *et al*., 2009).

Johns and scott (1989a) showed that, reduced color intensity in grapes bagged with non-perforated cellulose bags may be the result of modification of the internal atmosphere and/ or elevated temperature inside the bag.

The present results showed that the percentage of total soluble solids (TSS) in the berries of grapes cv. Halawani was decreased by bagging treatments as compared to control (Table 3.5). The synthesis of sugar were in leaves, but the change in TSS% between the treatments were dependent on the shading and temperature and their effect on enhance grape berry ripening. The bagging were effected on the berry, so grapes juice TSS and berry ripening related to each other. Brown cloth bag and paper bagging, have lowest TSS content, these result may be due to the fact that paper bags were dark in color and smooth in texture, so prevention of sunlight from entering the bags and reaching to grape berries.

Brown color is a mixing from red and green colors, these two colors have long wavelength and low energy. All these could be responsible for delay grape ripening and decreasing berry TSS. But black cloth treatment was high TSS content nearly like control treatment. Black cloth bags absorbed all sunray color (high energy) and reflect black wave, this increased bag temperature and enhancing grape berry ripening and increasing TSS content.

Similar results were observed by Signes *et al*., (2007) who reported that covering grapes with cellulose bags was shown to reduce sugar content in the berries compared to the uncovered control. Son and Lee (2008) demonstrated that, the TSS was high in order of white bagging > yellow

bagging > blue bagging > no-bagging group and lower transmittance of the bag resulted in lower TSS. Also, Watson *et al*., (2002) reported that pre-harvest covering of strawberry fruits caused a significant reduction in TSS contents compared to fruits from uncovered treatments. On the other hand, Sharma (2014) reported that, the percentage of TSS in apple fruits was better in bagged fruits and their quality in respect to TSS was better over non-bagged fruits. Bagging grape with light intensity of 40,000 luk after the veraison, and they reported that the TSS increased in the bagging treatment group with light transmittance of 50%. Son and Lee (2008) believed that the SSC in the no-bagging group decreased due to the leaf burning of berries not only after the veraison but also before the stage.

In our measurement of juice pH, grapes berry from the brown bagged treatment has high value of juice pH, whereas control treatments has low rate juice pH (Table 3.6). Juice pH were related to grape berry ripening. Fruit preharvest bagging delay berry ripening, decreasing TSS and increasing juice pH compared to nonbagging. Therefore, the possible reasons are the same as mentioned previously either to berry ripening or to TSS.

Similar results were observed by Antonio *et al*., (2007) who reported a slightly lower content of sugars with the same time higher content of organic acids in bagged grapes compared to non-bagged grapes. Son and Lee (2008) showed that, the pH was high in order of no-bagging group > blue bagging > yellow bagging > white bagging and lower transmittance of the bag resulted in high pH.

In the present study, all bagging treatments were significantly decreased the percentage of sunburn injury as compared to control, blue cloth bagging was more effective than other treatments (Table 3.7). The reason of decreasing sunburn injury by blue bagging may be attributed to the fact

that blue cloth bag was considered cold color, it reflect blue wave (short wavelength and high energy) and absorbed other sunlight (long wavelength and low energy), this causes decreased in the temperature inside the bag.

Pre-harvest bagging has been extensively used in several fruit crops to reduce sunburn of the skin (Muchui *et al*., 2010). Grape bagging protectant reduces losses from sunburn and heat stress, resulting in increased fruit quality and higher yield potential (Webb *et al*., 2009; Thomas, 2012; Yan, 2012). However, few berries of some clusters suffered sunburn. That is agree views of other studies such as Yazici and Kaynak (2009) who noted that sunburn damage on bagging fruits was reduce compared to control. In other study, Milenkovic *et al*., (2012) reported a positive results of the effect of photo selective shade nets (like bagging process effect) on reducing of tomato sunburn disorders.

As shown in (Table 3.8) all bagging treatments had significant effect on frost injury of grapes cv. Halawani. In the first month (01/10/2011), the frost was not strong, so had little effect on berry injury. But in the second and third months the frost was increased, from here the effect of bagging was clear to keep grapes berry from frost injury.

Similar results were observed by Taraporewala (2011) who showed covers are a great bargain for protecting your plants against frost. In addition, Priyanka (2012) reported that the protecting plants from cold weather is to use cloth bag for covering the plants.

Tables 3.9, 3.10, 3.11 and 3.12 showed the effect of fruit preharvest bagging on grape physiological disorders (stem browning, berry shatter, shrivel berry and waterberry). In general, except some cases like brown

and black cloth bags, all bagging treatments were effective in decreasing grape physiological disorders.

Several studies focused on the effects preharvest bagging on fruit physiological disorders (Li *et al*., 2005; Santos and Wamser, 2006; Li *et al*., 2011). Preharvest bagging of fruits has been conventionally practiced for fruit growing in Japan, Australia and China in peach, apple, pear, grape and loquat cultivation in order to optimize fruit quality through reduced physiological disorders (Joyce *et al*., 1997) leading to improved appearance (Amarante *et al*., 2002).

Stem browning was attributed to the environmental factors like temperature, light and wind, these factors increase water evaporation from stem stalk cells. Therefore, using bags protect grape stem stalk from this environment factors. Paper bagging was the best treatment because it smooth in texture and did not had pores like cloth bags, so it prevents any environmental factors affected on grape stem stalk. In brown and black cloths bagging may be light wave absorbed and high temperature were increased temperature inside the bag and gave hot air, this enhance stem browning. Snowden (1992) showed that vein track browning, is caused by exposure to sun or high temperature at harvest.

In the first month of bagging (October), grape was not reached to the maturity stage sufficient to lead to shatter of berry so the berry shatter (%) was little. But in second month (November) and third month (December), bagging effect was clear for decrease berry shatter (%), but black bag result was the same as control, this may be due to high temperature inside the black bags and this causes increasing in berry shatter (%). Crisosto *et al*., (1998) showed berry shatter incidence can be reduced by using cluster bagging.

Shrivel berry and waterberry need more temperature and time to occur. So with time grape shrivel berry and waterberry were increased. Grape

preharvest bagging prevent shrivel berry and waterberry because bagging provides protection for grapes clusters from sun and adverse environmental condition. Clearwater *et al*., (2009) suggest that the shrivel disorder was a consequence of a high fruit transpiration rate, and that the perception of complete loss or reversal of inward xylem flows in ripening fruits. The current consensus for grapes appears to be that shrivel disorders, including late season dehydration, bunch stem necrosis, and berry shrivel, may often involve some degree of xylem backflow (Choat *et al*., 2009; Tilbrook and Tyerman, 2009; Hall *et al*., 2011). However, backflow from grapes has never been directly observed and few studies have convincingly partitioned berry water loss between evaporation and xylem flows (Greer and Rogiers, 2009).

Gray mold can grow under cold and wet condition, at second month the weather was good (not suitable for *B. cinerea* growth) so we don't observed *B. cinerea* infection. Paper bagging keep the grape cluster from *B. cinerea* infection because it do like block. Similarly, blue color bags reducing *B. cinerea* infection. Kitagawa *et al*., (1992) uses paper bagging on the fruit tree before the infection with *B. cinerea* occurs. Also, they strongly recommend using bagging for control diseases on tropical fruits such as mangoes. Kim *et al*., (2013) demonstrated that blue light inhibition of gray mold disease, which can be mechanistically explained by the enhanced proline accumulation and antioxidative processes at least in partial.

There were no difference effect on *P. expansum* infection on grapes cv. Halawani between the treatments in the first period of the experiment. The impact of bagging effect were noted in the second and third months of the experiment, green and blue cloth bagging were more effective in reducing *P. expansum* infection (Table 3.14). The infection percentage was low in all transactions at first time of study, so we don't noted the

fruit bagging effect. In second and third months of bagging *P. expansum* was more spread because rain fall provide suitable condition for *P. expansum* growth. Qin *et al*., (2012) experiment did not agree our results, they were separated *P. expansum* from pericarp of fruit with ‘‘Kobayashi apple’ bag and ‘Tongle’ bag.

The infection percentage with *A. niger* was low in bagging treatments (Table 3.15). The reason of *A. niger* spread at middle and last study was rain fall which provide suitable condition for *A. niger* growth. Our result are in agreement with Qin *et al*., (2012) who showed that bagging methods protect Kobayashi apple from *A. niger*.

In almost cases, all bagging treatments were effective in reducing the percentage of infection with grape berry moth *L. botrana* as compared to control (Table 3.16). The reason for reduction in the percentage of infection with grape berry was considered to the fact that bags act as a barrier to protect the grape berries against attack by summer insect pests such as *L. botrana*.

These results are in agreement with those obtained by Santos and Wamser (2006) and Sarker *et al*., (2009) who reported, a reduction in insect damage by preharvest bagging practices. Also bagging technique was reported as a successful control measure against the fruit fly in different types of cucurbits including bitter gourd, sponge gourd (Fang, 1982) and cucumber (Akhtaruzzaman *et al*., 1999).

All bagging treatments were prevent bird injury on grapes cv. Halawani (Table 3.17). The reason may be related to fact that fruit bag prevent birds to reach the grape clusters. Many study agree with this study, Muchui *et al*., (2010) and Sharma, (2014) showed that, fruit bagging has good methods for prevent birds injury.

4.2 Experiment 2: Effect of some botanical extracts as postharvest treatments on grapes (*Vitis vinifera* L.) cv. Halawani

In the present study, botanical extracts as postharvest treatments at 30, 60 and 90 days had no significant effect on berry size (cm^3) of grapes cv. Halawani as compared to control (Table 3.19). The non-significat effect of botanical extract treatments to affect the berry size could be explained by the fact that botanical extracts was applied after grapes harvesting. Grapes are non-climacteric fruit, it is ripen only on the grapevine and berries final size and maturation reach at this stage. Beyond this stage, no dramatical changes in berry size could be expected. Kromdijk *et al*., (2013) showed that grape berry take final size at maturation time.

In our study *I. viscosa* extracts was the most effective treatment in maintaing berry firmness of Halawani grapes, while *M. syriaca* was the less effective treatment on grape berry firmness (Table 3.19). The explanation for this result could be related to many reason such as mode of action for active substances which may had positive effect for *I. viscosa* and negative effect for *M. syriaca*.

Table grapes encounter server problems during postharvest storage. The loss of quality is based on softening, which leads to a reduction of shelf-life (Xu *et al*., 2007). The effect of humidity on grape berry firmness during postharvest storage have been reported in table grapes (Valverde *et al*., 2005), strawberry (Reddy *et al*., 2000; Mali and Grossmann, 2003) and apple (Moldao-Martins *et al*., 2003).

As shown in (Table 3.20) botanical extracts don't effect on grapes berry coloration because the grapes is non climacteric, it is color doesn't change during storage. These results are in line with those obtained by Ozgur *et*

al., (2004) who reported that grapes postharvest treatments don't effect on grapes berry color.

Grapes TSS and juice pH don't change during postharvest storage but in this study there were different significantly between treatments (Table 3.21 and Table 3.22). In general, storage grapes in refrigerator does not change the chemical characteristic (TSS and juice pH) because grapes non-climacteric fruit.

Al-Qurashi and Awad (2013) reported no significant effects were shown on grapes TSS and juice pH during grapes storage periods. While, Maedeh *et al.,* (2012) reference that, TSS started decreasing gradually in all storage treatments. In this regard, the view of (Rohani *et al*., 1997) is noteworthy that the slower respiration also slows down the synthesis and use of metabolites resulting in lower TSS due to the slower change from carbohydrates to sugars.

In our study *I. viscosa* extracts had strong odor and influential on grapes taste (Table 3.23). Grape clusters retained botanical extracts odor because it did not subjected for good ventilation after treatments, it was remained inside the refrigerator and keep the odor.

Our result is consistent with Sissay *et al.,* (2007) who reported that botanical extracts applied as postharvest treatments to *Citrus sinensis* resulted in more smell and flavor with overall acceptability when kept at 7 ºC for 50 days.

The effect of *M. syriaca* and *T. vulgaris* extracts were not enough effectiveness for reduce stem browning (Table 3.24). This might be due to stem stalk cells respiration and low rate of physiological activity and the active material and volatile oils were vanish with the time (from first month). Asghari *et al*., (2013) provide the application of botanical extracts is becoming restrictive in reducing physiological disorders like

stem browning. Also, Mohamadreza *et al*., (2013) confirmed uses of *Aloe vera* extract keep stem of sweet cherry fruit from browning.

In general the berry shatter increased with the advancement in storage period (Table 3.26), *M. syriaca* and *T. vulgaris* extracts increase grapes berry shatter more than other treatments. The increased in berry shattering in storage grapes (treatments and non-treatment) is probably due to fungal infection or humidity (may be from botanical extracts spray). Clusters with less berry shatter may be return to decrease diseases infection and stopping the aging which lead to persistence of green in the rachis and preventing enzymatic shattering.

Mahajan *et al.,* (2010) showed that berry shatter increased with the advancement in storage period. Morris *et al*., (1992) and Soylemezoglu and Agaaolu (1996) have reported that grapes wrapped and stored without SO_2 treatment had the greatest amount of berry shatter than those packed with SO_2 generators. Also, berry shattered because it associated with any stress to which the fruit is subjected such as cold (low temperature) and humidity (Crisosto *et al.,* 1998).

Our observation showed *M. syriaca* was the less effective treatment for prevent grape shriveled berries. Low rate of physiological activity of grapes causes water loss following harvest, which can resulted in shriveling of the berries and the volatile oils for *M. syriaca* were vanish, so it does not have good effect.

Similar result were observed by Nelson (1985) and Bondada *et al.*, (2005) who reported a reasonable reduction in the water supply (as concentrated sugar solution), this may be responsible for berry shriveled.

In this study waterberry percentage was low. Control and *M. syriaca* treatments had more waterberry percentage. Waterberry most often

begins to develop shortly after berry softening (Crisosto *et al*., 1994) or in the grapes ripening (Bettiga, 2013).

The objective of the current research was to study the effect of some plant extracts on *Botrytis cinerea*, *Penicillium expansum* and *Aspergillus niger* that are pathogens for the post-harvest diseases of the fruits.

As shown in (Table 3.28) *I. viscosa* was effective for control of gray mold caused by *B. cinerea* on table grapes. On the other hand, *M. syriaca* and *T. vulgaris* have no effect on decreasing the percentage of *B. cinerea*. Lowest *P. expansum* spread on grapes was recorded in *V. iphionoides* and *I. viscosa* treatments. While *T. vulgaris, S. officinalis* and *M. syriaca* were recorded high spread (Table 3.29). *Inula viscosa* and *Varthemia iphionoides* had a positive effect on *A. niger* inhibition. In contrast *T. vulgaris* and *M. syriaca* have a negative effect on *A. niger* inhibition (Table 3.30).

In this study, it is believed that *I. viscosa* and *V. Iphionoides* had more potential as antifungal compared to other botanical extracts tried in this experiment. This may be Due to the presence of some active compounds in plant extracts that showed antifungal activity against storage diseases of Halawani grapes.

Sharawi (2009) showed that extracts made from leaves of *I. viscosa* possess broad-spectrum activity against *B. cinerea* diseases on vegetables. In addition, Gamalat *et al.,* (2006) showed that the mycelium growth of *B. cinerea* decreased with increased plant extract concentration. While, Bhaskara *et al*., (1998) showed the essential oils of *T. vulgaris* at the highest concentration (200 ppm) inhibited the MGR of *B. cinerea* by 90.5%. Oil extracts from thyme (Arras *et al*., 1995) and sage (Carta *et al.,* 1996) inhibited in vitro mycelial growth of *B. cinerea*.

The plant extracts reported effective against the fungi *Penicillium digitatum* include garlic (Obagwa and Korsten, 2002), neem (Mossini *et al*., 2009), mustard and horseradish (Mconie, 1964). The antifungal effect of *S. aromaticum* and *C. zeylanicum* found on *Aspergillus* spp. and *Penicillium* spp. was reported earlier (Tewari and Dixit, 1994; Vazquez *et al*., 2001). Presence of ajoene and alliicin in *A. sativum* might be the reason for their complete inhibition of *A. niger* (Naganawa *et al*., 1996). A strong inhibition was observed in case of *T. ammi* and *C. zeylanicum* whereas a moderate inhibition was recorded in black pepper. This variability in antifungal potential in plant materials may be firstly due to the difference in the chemical compositions and secondly their solubility in water. This also in agreement with the reports of Qasem and Abu-Blan (1996) and Amadioha (2000).

The aqueous extracts of other spices like *Murraya koenigii*, *Zingibe rofficinale* and *Allium cepa* were not proved to be effective against the growth of *A. niger*. The ineffectiveness of these spices on *A. niger* might be due to insolubility of their active compounds in water (Qasem and Abu-Blan, 1996; Amadioha, 2000).

Summary

Two independent experiments were carried out on grapes (*Vitis vinifera* L.) cv. Halawani during the season 2011. The first one was on the effect of fruit preharvest bagging, while the second one was on the effect of some botanical extracts as postharvest treatments.

1. **Experiment 1:** The effect of fruit preharvest bagging on grapes (*Vitis vinifera* L.) cv. Halawani was studied at a private vineyard at Halhul town. The experimental design was randomized complete block design (RCBD) and the plot size was one cluster. The number of replicates was five and the number of treatments was nine as follows: control (without bagging) as absolute check, paper bagging as standard check, brown cloth bagging, white cloth bagging, black cloth bagging, green cloth bagging, blue cloth bagging, red cloth bagging and yellow cloth bagging. Berry size of Halawani grapes was not significantly affected by all bagging treatments. Paper bagging and blue cloth were significantly superior in increasing berry firmness. Also, paper bagging and blue cloth were significantly superior in decreasing the fruit ripening, berry coloration, sunburn injury, frost injury, physiological disorders, postharvest diseases, grape berry moth and bird injury.

   Brown cloth bagging was the most effective treatment in decreasing TSS and juice pH.

2. **Experiment 2:** The effect of some botanical extracts as postharvest treatments on grapes (*Vitis vinifera* L.) cv.

Halawani was studied in the lab at Hebron university. The experimental design was complete randomized design (CRD) and the plot size was one cluster. The number of replicates was five and the number of treatments was seven as follows: control (untreated) as absolute check, chemical fungicides (Rovral) as standard check, *Inula viscosa* (clammy Inula), *Majorana syriaca* (thyme), *Thymus vulgaris* (thyme), *Salvia officinalis* (sage) and *Varthemia iphionoides* (varthemia). Berry size, berry coloration and juice pH were not significantly affected by all botanical extracts used in this experiment.

Inula viscosa and *Varthemia iphionoides* were significantly superior in increasing berry firmness. Also, *I. viscosa* and *V. iphionoides* were the most effective botanical extract treatments in decreasing berry shatter and *P. expansum*.

Conclusions

It could be concluded from this study that:

1. Paper bagging and blue cloth bags are the most useful treatments for protection the grape clusters from physiological disorders, postharvest diseases, insects and birds damaged and for extended storage of grapes cv. Halawani.

2. *Inula viscosa* and *Varthemia iphionoides* extracts are the most effective treatments in decreasing physiological disorders and storage diseases of grapes.

Future research is required to test other bag colors and other synthetic material of bags as well as other times of bagging. Also, study the effect of bagging on other varieties of grape such as Shami. It is important to test other local botanical extracts and to use other methods of plant extraction as well as to test other treatment times such as preharvest or harvest application before reaching the stage of large-scale application of natural and alternatives methods.

Chapter Five

5. References

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تأثير تكييس الثمار في مرحلة ما قبل الحصاد وبعض مستخلصات الأعشاب كمعاملات ما بعد الحصاد على العنب (*Vitis vinifera* L)

أجريت تجربة حقلية خلال الموسم الزراعي٢٠١١ في بستان عنب في بلدة حلحول/ الخليل بهدف دراسة تأثير تكييس الثمار في مرحلة ما قبل الحصاد على العنب الحلواني. تم استخدام تصميم القطاعات العشوائية الكاملة (RCBD) بواقع خمس مكررات، وكانت المعاملات على النحو التالي: شاهد (بدون تكييس)، كيس ورق، كيس قماش بني، كيس قماش أبيض، كيس قماش أسود، كيس قماش اخضر، كيس قماش أزرق، كيس قماش أحمر، كيس قماش أصفر. وجد أن معاملات تكييس الثمار بكيس الورق وكيس القماش الأزرق هي أكثر المعاملات فعالية في معظم المعايير التي تم دراستها في هذه التجربة. قد يكون سبب ذلك إلى الأشعة المنعكسة أو الممتصة من الأكياس، فملمس كيس الورق ناعم ويعكس الأشعة بانتظام، بينما كيس القماش الأزرق يمتص جميع ألوان الطيف ويعكس الموجة الزرقاء.

أجريت تجربة ثانية في المختبر في نفس الموسم بهدف دراسة تأثير مستخلصات الأعشاب الطبية كمعاملات ما بعد الحصاد على العنب الحلواني. تم استخدام التصميم العشوائي الكامل (CRD) بواقع خمس مكررات، و كانت المعاملات على النحو التالي: شاهد، مبيد فطري (روفرال)، الطيون، الزعتر البري، المرمية، زعتر الغزال، الاكتيلا. أظهرت النتائج أن معاملة الطيون ومعاملة الاكتيلا هما الأكثر فعالية من باقي المعاملات على معظم المعايير التي تم دراستها في هذه التجربة. قد يعزى سبب ذلك إلى وجود بعض المواد الفعالة في هذه المستخلصات النباتية.