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RELATIONSHIP BETWEEN LEAF MINERAL COMPOSITION OF WASHINGTON NAVEL ORANGE AND BOTH PRODUCTIVITY AND STORABILITY UNDER APPLIED SOME MATERIALS

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Abstract

This current investigation proposed to determine the effect of spray some natural extracts (Grapefruit seed, propolis, seaweed and fenugreek seed sprout) at 2% mM/L and aminoethoxy vinyl glycine 300 mg/L^{-1} on Washington Navel orange trees. Fruit samples were collected at maturity stage and stored under cold condition at 5°C and RH at 85% ± 2 for 100 days. Results indicated that, leaf mineral content, number of fruits/tree, yield (kg)/tree, average fruit weight(g), TSS%, TSS/Acid ratio, vitamin C (mg/ 100ml/ juice), total sugar% were increased by increasing the storage period. Whereas fruit drop %, fruit weight loss %, fruit disorders (%), firmness (Ib/$inch^2$) and total acidity (%) decreased. AVG + S.E. was the best treatment for improving fruit quality under cold storage conditions. Correlation coefficients between leaf mineral content and each of yield, yield component and fruit quality during storage were determined.

Key words: Navel orange, some natural extracts, AVG, mineral composition and storage period

Introduction

Citrus is one of the most important fruit in the world that is rich in numerous vitamins, mainly vitamin C, and minerals (Lacirignola and D'Onghia, 2009). In Egypt, about 80% of the total orange production is produced by large orchards and 20% by small orchards (FAO, 2012). The three major orange varieties produced in Egypt are Navel, Valencia and Baladi. Navel orange [*Citrus sinensis,* L. (Osbeck)] is the most popular orange fruit that compose about 39.4 % of the total area of citrus in Egypt (Shalhevet and Levy, 1990). Egypt currently exports citrus fruit to the European Union and the Gulf States. A small annual quota of 8,000 MT limits the exportation of the Egyptian orange to the European Union under the free trade agreement (Spreen, 2010). Grapefruit seed extract (GSE) is a commercial product derived from the seeds of grapefruit. Tirillini (2000) showed that, GSE is an effective broad-spectrum bactericide and is also environmentally safe without toxicity to humans or animals at effective concentrations. Xu *et al.,* (2007) demonstrated that, GSE has also been used for preservation of fruit, such as grapes. Propolis extracts possess antimicrobial activity and contain some hydrophobic compounds able to improve a few properties of biodegradable coatings on fruits (Ali *et al.,* 2015). Moreover, (Ali *et al.,* 2014) observed that, propolis extract, when combined with cinnamon oil, acts as an efficient bio-fungicide and slowing changes in weight, flesh firmness, peel color and concentration of soluble solids in peppers.

Algae extract (AE) has been widely used in horticultural fruit production, contains essential nutrients, trace of metal mixtures (Cu, Co, Zn, Mn, Mo etc.) (Verkeij, 1992). Ibrahim *et al.,* (2014) found that, AE can enhance the tolerance of crops to a wide range of abiotic and biotic stresses and extend the post-harvest shelf life of fruit. Al- Shereif *et al.,* (2013) stated that, crop seed sprout extract was very effective in enhancing growth, nutritional status, yield, and fruit quality of different horticultural crops. Cairney (2005) showed that, sprouting of seeds may alter the content and composition of proteins, fats and amino acids and enhance the biosynthesis of essential amino acids like glutamic acid, tryptophan and arginine, vitamins B, C and most essential macro- and micro- nutrients and makes them high available to fruit

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crops. Aminoethoxy vinyl glycine (AVG) discovered in the early 1970s as naturally occurring compound. Asrey *et al.,* (2012) divulged that its primary mode of action is to suppressed ethylene biosynthesis. AVG is commercially sold under the name of ReTain®. Rath and Prentice, (2004) indicated that, its environmentally friendly organic product registered to be used for plums, peaches, pears, apples, nectarines, and mandarins in many countries. Greene (2002) reported that, AVG applied before the ideal picking point prevents pre-harvest fruit drop and it delays fruit maturation in the apple tree. Cold storage besides its role in maintaining fruit quality is widely used as a strategy to reduce ethylene production and sensitivity during post-harvest storage of horticultural products (Thompson, 2004). Many studies showed the effect of some biological stimulants and different particles on fruit productivity and quality of Washington Navel Orange Trees such as El Zayat and Ali (2019); Bakr *et al.,* (2018) and El-Tanany *et al.,* (2019). Therefore, the aim of this investigation to study the relationship between leaf mineral composition of Washington Navel Orange and both productivity and storability under applied some natural extracts (Grapefruit seed, propolis, seaweed and fenugreek seed sprout) and AVG.

Materials and Methods

Experiment and design

The present study was carried out in the two successive seasons of 2018/2019 and 2019/2020 on trees of Washington Navel orange [*Citrus sinensis* L. (*Osbeck*)], (20-years-old) budded on sour orange (*Citrus aurantium* L.) rootstock, grown in sandy soil table 1. Trees received normal horticultural practices including drip irrigation, fertilization, pruning, as well as pest and disease control. The trees were planted at (4.0 × 4.5) meters apart in a private orchard located at El-Nubaria region, EL-Behira governorate, Egypt, to study the effect of some natural extracts and aminoethoxy vinyl glycine on leaf mineral content, fruit drop, yield and yield component and the correlation among them. Also, the effect of the application on some parameters in quality during the storage period of Washington Navel orange fruits and the correlation between the mineral content and these parameters. Thirty trees nearly similar in growth, health and subjected to the same cultural practices were selected for the pre harvest treatments. In April of the two growing seasons, twenty shoots from all over the outer circumference of each tree were tagged in order to secure leaf samples of the same age. Leaf samples were collected at two weeks intervals from each of the selected trees during August 15 to August 31 in both seasons. A randomized complete block design (RCBD) was followed in analyzing the samples with three replications. Each treatment was represented in three trees.

Grapefruit seed extract (GSE) (Preparing Extract)

Self-made ethanolic extract of *Citrus paradisi* Mecf. was prepared from commercially available grapefruits. Air dried powdered plant material (juiceless pulp and seeds, in quantitative ratio 4:1) was extracted with 70% ethanol in a Soxhlet apparatus for 6 h. After cooling, the solvent was removed using rotary evaporator and dry residue was chemically analysed. For microbiological test, 33% (*m/V*) extract was prepared using 70% ethanol (Cvetniæ and Vladimir-Kneževiæ, 2004).

Preparation of water extract of propolis

Water extract of propolis was obtained as described by (Suzuki *et al*., 1990; de Lima *et al*., 2005; Yýlmaz, 2006) with slight modification. In brief, 50.0 g of propolis were suspended and extracted with 5 volumes of distilled water with shaking at 2^0C for 1day. The extracts were centrifuged at 28,000×g for 30 min, and the supernatants were pooled. The residue as re-extracted under the same conditions. The extracts were centrifuged under the same conditions and the supernatants were pooled. Supernatants obtained were combined and dialyzed

Table 1: Soil chemical characteristics of the experimental soil in El-Nubaria.

Parameters	Value	Unit
Particle size distribution		
Sand	76.22	%
Silt	9.30	%
Clay	14.48	%
Soil texture	Loamy sand	
Organic matter content	0.38	%
Soil pH	8.18	-
Electric conductivity		
(EC) 1:1$CaCO_3^-$	5.3038.9	dS/m %
Soluble Cations		
Ca^{++}	16.4	meq/L
Mg^{++}	9.84	meq/L
Na^+	22.76	meq/L
K^+	3.10	meq/L
Soluble Anions		
HCo_3^-	1.20	meq/L
Cl	10.20	meq/L
SO_4^{--}	52.80	meq/L
Available NPK		
N	11.34	mg/kg
P	22.00	mg/kg
K	250.00	mg/kg

against distilled water. Seaweed extract (REG NO. 1857 Agrochemical- made in Spain)

Elements	%	Elements	%
Seaweed	15%	Potassium	4%
Cytokines	1%	Boron	0.05%
Auxins	1%	Iron	0.45%
Nitrogen	6%	Zinc	0.10%
Phosphorus	1%	Manganese	0.10%

Preparation of water extract of Fenugreek seeds sprouts

Fenugreek seeds were sown in dark using glass jar method as described by Abdallah (2008), sprouts were harvested after three days from seed soaking and c) wheat seeds were sown in open trays and left under shade conditions till ten days then the sprouts were picked, Generally sprouts of wheat fenugreek were homogenized with distilled water at 1 : 10 using an electric blender for five minutes , then filtrated and kept under 4°C in the refrigerator till use. For preparing 0.4% concentrations (4 g/L) may take 40 ml of such extract/ water.

AVG: ReTain™ plant growth regulator- soluble powder

Active ingredient: Contains 150 g/kg Aviglycine Hydrochloride (AVG) in the form of a water-soluble powder. The following treatments were carried out for pre-harvest: Control (Spraying with water); Grapefruit Seed Extract at 2% mM/L; Propolis Extract at 2% mM/L; Algae (seaweed) extract at 2% mM/L; Fenugreek Seed Sprout Extract at 2% mM/L; AVG at 300 mg/L^{-1}; AVG at 300 mg/L^{-1} + Grapefruit Seed Extract at 2% mM/L; AVG at 300 mg/L^{-1} + Propolis Extract at 2% mM/L; AVG at 300 mg/L^{-1} + Algae (Seaweed) extract at 2% mM/L and AVG at 300 mg/l + Fenugreek Seed Sprout Extract at 2%. The surfactant 0.1% Tween-20 at the rate of 2.5 cm^3/5 liters water was added to all sprayed treatments to obtain best results. Four foliar spraying were carried out to trees from each treatment as follows: The first application was just at full bloom for Washington Navel orange trees. The second application was after 30 days from the first one, the third application was after 30 days from the second and the fourth application was before 45 days from the harvest date. At harvest on ripening stage (late November), under the experimental conditions, the yield per tree was determined.

Determinations parameters

Leaf mineral content: leaf samples were collected from each replicate. Leaf samples were carefully taken out washed with tap water followed by distilled water several times. The samples were oven dried at 70ºC until constant weight and grounded in stainless steel rotary mill, (0.3 g) of this dried samples was used for preparing the wet digestion procedure by using sulphoric acid and hydrogen peroxide (H_2O_2) as described by (Evenhuis and Dewaard, 1980). The digested solution was kept in brown bottle until the determination of minerals.

Nitrogen and Phosphorus were determined colorimetrically according to (Evenhuis, 1976) and (Murphy and Riley, 1962), respectively. Potassium was determined by flame photometer and calcium, magnesium, iron, manganese, zinc and copper by Perkin Elmer Atomic Absorption spectrophotometer model 305 B. The concentration of nitrogen, phosphorus, potassium, calcium and magnesium were expressed as percent, while those of iron, copper, zinc and manganese were expressed as parts per million on dry weight basis.

Fruit drop (%): to study the fruit drop percentages remainder fruits were calculated in June in both seasons through the following equation:

Fruit Drop % =

$$\frac{Number\ of\ developed\ fruitlets - Number\ of\ \text{Re}mained}{Number\ of\ developed\ Fruitlets} \times 100$$

Yield and the number of fruits/tree: number of fruits per tree was calculated and total yield was determined as follows: Total Yield (Kg/tree) = Number of Fruits × Average of Fruit Weight (kg)

Fruit quality parameters

Fruit samples were picked at mature and immediately transported to the laboratory of the Plant Production Department, Faculty of Agriculture, Saba Basha, Alexandria University.

(A) Physical properties: the following fruit parameters were measured directly after the harvest.

A.1. Fruit weight (g.): the average weight of five fruits of each replicate was determined.

Storage studies: for physical and chemical determinations during storage time, fruit samples as 60 fruits were taken randomly from each replicate in all treatments. The fruits uniformed in size and color were sampled randomly from each tree were packed in wooden tray and stored under cold condition (5ºC with 85-90% RH). Ten fruits from each wooden tray were used for weight loss determination every 20 days during the storage periods. Four fruits were also, taken from the wooden tray every 20 days for the determination of physical and chemical fruit properties.

A.2. Fruit weight loss percentage: weight loss was determined as follows:

$$\text{Weight loss (\%)} = [(W_0 - W_1)/W_0] \times 100$$

Where w_0 is the initial weight and w_1 is the weight measured at start of each storage period. The fruits were weight periodically during storage every 20 days and their weight loss was calculated.

A.3. Fruit disorders (%): decay % was determined by calculating the number of decayed fruits at harvesting date expressed as percentage of initial fruit number according to (El-Anany *et al.,* 2009).

A.4. Fruit firmness (Ib/inch^2): fruit firmness was measured in peel and pulp using pressure tester (Digital force- Gouge Model FGV-0.5A to FGV-100A. shimpo instruments) and expressed as (Ib/inch^2).

(B) Chemical properties:

B.1. Total soluble solids percentage: The percentage of total soluble solids (TSS %) was determined by using a digital refractometer (A.O.A.C, 1980).

B.2. Vitamin C (Ascorbic Acid): vitamin C content was determined in fruit juice using 2, 6- dichlorophenol-indo-phenol blue dye as mg ascorbic acid per 100 ml Juice (A.O.A.C, 1980).

B.3. Acidity percentage: fruit juice acidity was determined according to (A.O.A.C, 1980) by titration with 0.1 N sodium hydroxide using phenolphthalein as an indicator and expressed as citric acid percentage.

B.4. TSS/Acid ratio: The ratio was recorded by dividing TSS value by total acidity value.

B.5. Sugars determination: for sugars determination, the flesh of each fruit sample was cut into small pieces by a clean knife and mixed well. Five grams of the cut flesh were taken and extracted by distilled water according to (A.O.A.C, 1980). The total sugars were determined colorimetically using phenol and sulphuric acid according to (Malik and Singh, 1980).

Statistical analysis

CoStat, 6.311, copyright (c). (2005). Cohort software798 light house Ave. PMB320, Monterey, CA93940 and USA. Email: info@cohort.com and Website: http://www.cohort.com/DownloadCoStatPart 2.html.

Results and Discussion

Leaf mineral contents

Leaf macro elements

The effect of individual foliar application with some natural extracts [Grapefruit seed, propolis, algae (Seaweed) and fenugreek seed sprout] and aminoethoxy vinyl glycine on leaf nitrogen, phosphorus, potassium, calcium and magnesium content of Washington Navel orange trees in 2018/2019 and 2019/2020 seasons, are shown in Fig. 1, 2. Statistical analysis showed that, all treatments caused a significant increase in leaf macro content as compared with the control. Significant differences were found among the treatments that using individually for nitrogen, phosphorus, and potassium, except for G.S.E. compared to P.E. treatments in potassium. While no significant differences were found in calcium. Furthermore, significant increase was found in magnesium content between P.E. compared to F.S.S.E. treatments. Moreover, in the two seasons of the study in Fig. 1, 2, using AVG application with each natural extract caused a significant increase in leaf nitrogen, phosphorus, potassium, calcium and magnesium content in Washington Navel orange trees compared to control. In addition, there were significant differences were found among all treatments for nitrogen, calcium, and magnesium, except between AVG+ S.E. compared to AVG+ P.E. in phosphorus, and AVG+ G.S.E. compared to AVG+ P.E. treatments in potassium. Also, the AVG+ S.E. treatment caused the highest percentage of nitrogen, potassium,

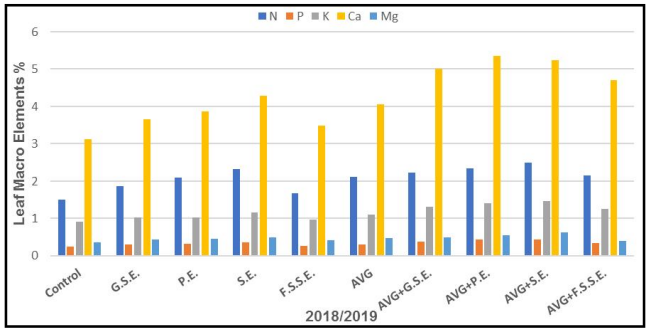

Fig. 1: Effect of preharvest foliar application with some natural extracts and AVG on leaf macro elements (%) (dry weight basis) of Washington Navel orange trees in 2018/2019 season.

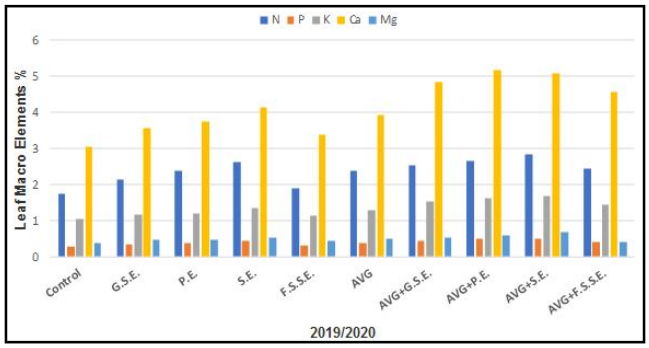

Fig. 2: Effect of preharvest foliar application with some natural extracts and AVG on leaf macro elements (%) (dry weight basis) of Washington Navel orange trees in 2019/2020 season.

and magnesium content. Furthermore, aminoethoxy vinyl glycine at 300 mg/l+ seaweed extract at 2% and aminoethoxy vinyl glycine at 300 mg/l+ propolis extract at 2% in phosphorus, and aminoethoxy vinyl glycine at 300 mg/l + propolis extract at 2% in calcium, had the best treatment.

Leaf micro elements

The effect of individual foliar application with some natural extracts [Grapefruit seed, propolis, algae (Seaweed) and fenugreek seed sprout] and aminoethoxy vinyl glycine on leaf iron, copper, zinc and manganese content of Washington Navel orange trees in 2018/2019 and 2019/2020 seasons, are shown in Fig. 3, 4. Statistical analysis showed that, all individual treatments caused a significant increase in leaf iron, copper and manganese content as compared with the control, except for F.S.S.E. treatment in zinc. Significant differences were found among all treatments in iron, copper and manganese leaf content, except between AVG compared to P.E. and S.E. treatments in zinc element. Moreover, AVG treatment caused the best effect on leaf iron and manganese content, while S.E. caused the highest value of copper and zinc content. Moreover, there were significant differences among the four treatments (Using AVG application with each natural extract) in leaf iron, copper and manganese content on Washington Navel orange trees as compared with the control, except for AVG+ F.S.S.E. treatment in zinc content. The highest value of iron, copper, zinc, and manganese content recorded by AVG+ S.E. treatment in both seasons of the study. Grapefruit seed extract is a natural product contains many active substances like alkaloids and glycosides, tocopherols, citric acid, and vitamin C, which are antioxidants compounds enhancing the metabolism and leaf mineral contents (Cho *et al.,* 1990). The hydrophobic compounds of propolis, as waxes and essential oils, acts as a barrier to water vapor and gas exchange (Zahid *et al.,* 2013) and possess broad spectrum of antimicrobial activity which reflect on enhancing element content in leaves. Bankova et al. (2000) found that, quite 300 biologically active constituents have been identified from propolis, mainly flavonoids and phenolic acids. Seaweed extract contains N, P, K, Ca, Mg, S, Zn, Fe, Mn, Cu, Mo and Co, some growth regulators, polyamines, and vitamins (Ibrahim, 2013). Commercial and academic reports make claims such as enhanced nutrient uptake, improved resistance to pests and disease (Ross *et al.,* 2011). In addition, Makai and Balatincz (1998) indicated that, extract of fenugreek seeds is rich in protein, fat and carbohydrates additionally to fluid materials, nutrients and vitamins, which reflect on enhancing leaf mineral content. These results are in agreement with (Bramlage *et al.,* 1980; Masia *et al.,* 1998), they worked on 'Golden Delicious' apples, and they reported that, spraying of AVG four weeks before harvest prevent ethylene production and delayed fruit maturation on the tree.

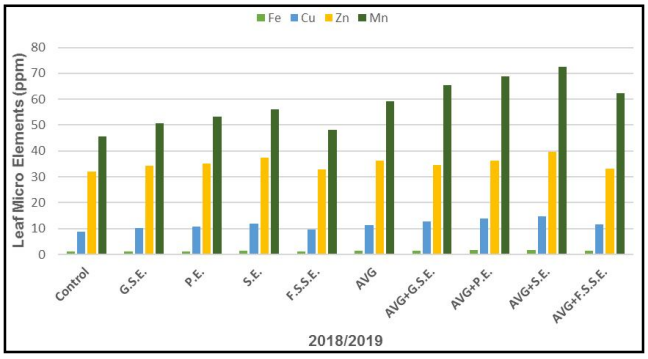

Fig. 3: Effect of preharvest foliar application with Aminoethoxy Vinyl Glycine and some natural extracts on leaf micro elements content (part per million) of Washington Navel orange trees in 2018/2019 season.

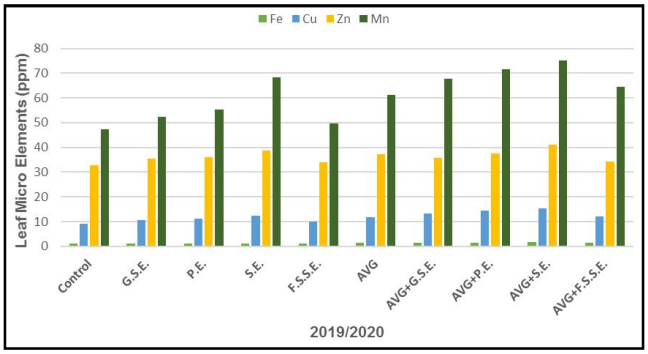

Fig. 4: Effect of preharvest foliar application with Aminoethoxy Vinyl Glycine and some natural extracts on leaf micro elements content (part per million) of Washington Navel orange trees in 2019/2020 season.

Yield Parameters

Fruit Drop (%)

Data, in Figure 5, showed that, all individual treatments

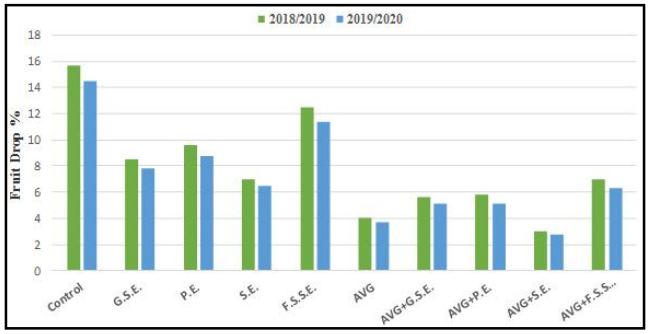

Fig. 5. Effect of preharvest foliar application with Aminoethoxy Vinyl Glycine and some natural extracts on fruit drop (%) of Washington Navel orange trees in 2018/2019 and 2019/2020 seasons.

decreased the fruit drop (%) of Washington Navel orange trees compared to the control, except for F.S.S.E. treatment in 2018/2019 and 2019/2020 seasons. While the lowest percentage value was obtained by the AVG treatment. No significant differences were found among the three treatments (G.S.E., P.E. and S.E.). On the meantime, using AVG application with each natural extract caused a significant decrease in fruit drop (%) compared to the control. Using AVG+ S. E. treatment caused a significant decrease in fruit drop (%) compared to AVG + F.S.S.E. treatment. No significant differences were also found among the rest treatments.

Yield (Kg/ tree)

Data presented in Fig. 6, showed that, in both seasons of the study, the five individual extracts caused a significant increase in the yield of Washington Navel orange trees as Kg/ tree compared with the control. Using S.E. and AVG treatment caused the highest amount of yield and there were significant differences between them. In the meantime, using AVG application with each natural extract caused a significant increase in the amount of yield compared to the control. There were significant differences were found among the treatments and AVG+ S.E. treatment caused the highest amount of yield compared to the three other treatments. While AVG+ S.E. was the most effective treatment in increasing yield as kilograms per tree compared with all other treatments.

Number of Fruits

Data, listed in Fig. 6, showed that, all individual treatments caused a significant increase in the number of fruits compared to the control, except for F.S.S.E treatment in the first season. AVG and S.E. treatments had the highest value compared with other treatments. In addition, in both seasons of the study 2018/2019 and 2019/2020, using AVG application with each natural extract caused a significant increase in the number of fruits compared to the control. In 2018/2019 season, significant differences were found between AVG+ S.E. and AVG+ P.E. compared to the two other treatments, except to AVG+G.S.E., in the first season. In general, AVG+ S.E. caused the best number of fruits.

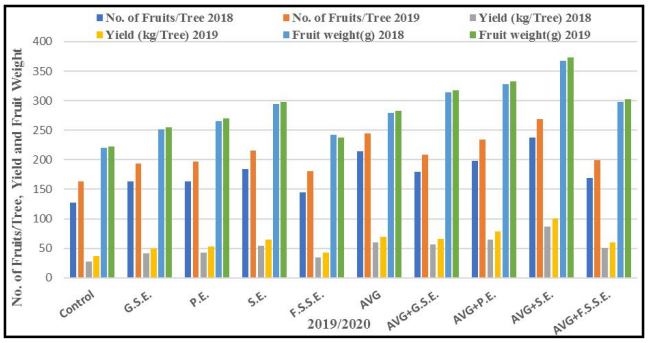

Fig. 6: Effect of preharvest foliar application with Aminoethoxy Vinyl Glycine and some natural extracts on Fruit weight(g) and yield as (No. of fruits per tree and kilograms per tree) of Washington Navel orange trees in 2018/2019 and 2019/2020 seasons.

Average fruit weight (g)

Data, in Fig. 6, showed that, all treatments that used individually increased the fruit weight of Washington Navel orange trees compared with the control. There were significant differences were found among all treatments. Moreover, the highest value was obtained by the S.E. treatment. Using AVG application with each natural extract caused a significant increase in fruit weight compared with the control. Significant differences were found among all treatments. Using AVG+ S.E. was the most effective treatment on increasing fruit weight.

Propolis has antibacterial activity, mainly attributed to the flavonoids and the phenolic acids, which can be explained by the several mechanisms such as alteration of membrane permeability and inhibition of protein synthesis, due to complex composition of propolis and synergistic activity between phenolic and other compounds (Kujumgiev *et al.,* 1999), which may have role in reduce fruit drop and maintain the fruit which enhance the yield. The enhanced effect of algae extract treatment on tree yield may be due to algae extract contents of minerals, vitamins and growth regulators especially, IAA and cytokinins which induced a positive effect on reducing fruit drop and increase number of fruits per tree and yield kg/tree (Abd El-Motty *et al.,* 2010). On the other hand, (Abdallah *et al.,* 2000; Crews and Peoples, 2004) found that, foliar application of fenugreek seed sprouts had an obvious promotion on the yield through supplying the plants with their requirements from organic and mineral nutrients, natural hormones and antioxidants. Moreover, Ahmed *et al.,* (2015) studied the influence of spraying fenugreek at 0.1% to 0.4% on stimulating yield of Washington Navel orange trees. Ahmed (2015) sprayed fenugreek seed sprout extract on "Keitte" mango trees and they found that fenugreek seed sprout extract at 0.5 to 2% caused enhancement in the yield. Using crop seed sprout extracts were very effective in enhancing growth and yield of different horticultural crops (Anderson and Cedergreen, 2010; Al-Shereif *et al.,* 2013). AVG applications significantly reduced accumulative drop rates compared to control, yield increment refers to reducing fruit drop and increasing fruit weight and the number by AVG treatments (Rath and Prentice, 2004). Also, (Batjer *et al.,* 1957) concluded

that, AVG does not increase fruit size but larger fruit may be harvested on AVG treated trees because harvest will be delayed longer than on non-treated trees, as fruit size increase 1% per day. In addition, (Greene and Schupp, 2004) illustrated that, in most instance delaying harvest 2 to 3 weeks resulted in an increase in fruit size 15%-20%.

Fruit Quality during Storage

Fruit Weight Loss (%)

In Fig. 7, 8, all five individual treatments decreased the weight loss of Washington Navel orange fruits compared to control. Significant differences were found among the five treatments, except between P.E. and AVG treatments. Using S.E. treatment caused the highest decrease in weight loss (%) compared to the other treatments. On the meantime, using AVG application with each natural extract caused a significant decrease in weight loss (%) of Washington navel orange fruits compared to the control, significant differences were also found among the four treatments. Furthermore, the usage of AVG+ P.E. gave the highest decrease in weight loss (%). Regarding the effect of storage periods on the changes in fruit weight loss (%), the weight loss percentage significantly increased by increasing the storage period. The tissues weakened as they are unable to carry on normal metabolic processes, fruit shrinkage as a result of moisture loss and fruit senescence by so rapid deterioration of the fruit, these results are on the contrary with Hidalgo *et al.,* (1996). The main effect of weight loss during storage of Washington Navel orange fruits could be explained as the physiological weight loss of fresh fruit is mainly due to the water loss during the whole period of cold storage and also to the loss of carbon dioxide in respiration processes.

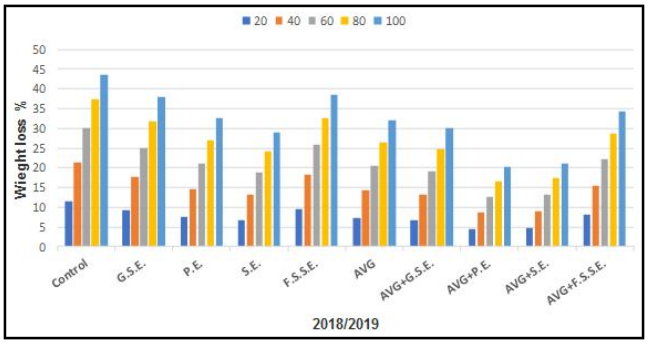

Fig. 7: Effect of preharvest foliar application with Aminoethoxy Vinyl Glycine and some natural extracts on weight loss percentage of Washington Navel orange fruits at harvest and during cold storage in 2018/2019 season.

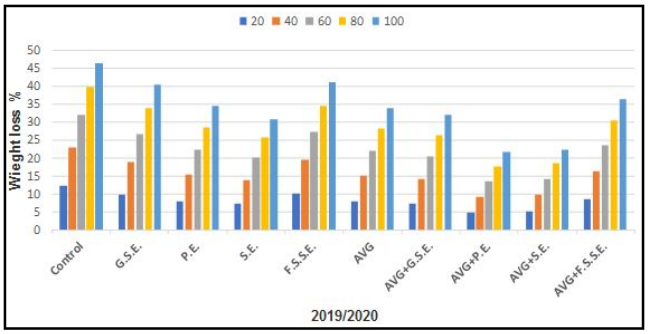

Fig. 8: Effect of preharvest foliar application with Aminoethoxy Vinyl Glycine and some natural extracts on weight loss percentage of Washington Navel orange fruits at harvest and during cold storage in 2019/2020 season.

Fruit Disorders (%)

Data, in Fig. 9, 10, showed that, in both seasons of the study, the five individual treatments caused a significant reduce in fruit disorders (%) compared with control. The lowest percentage of fruit disorders was obtained by the P.E treatment. As the effect of AVG application with each natural extract, all treatments caused a significant reduce in fruit disorders (%) of Washington Navel orange fruits and the lowest value of fruit disorders was obtained by the AVG+ G.S.E. and AVG+ P.E. treatment compared to AVG+ S.E. and AVG+ F.S.S.E. treatment in both seasons. In general, in both seasons, P.E. was the most effective on decreasing fruit disorders (%). In the same

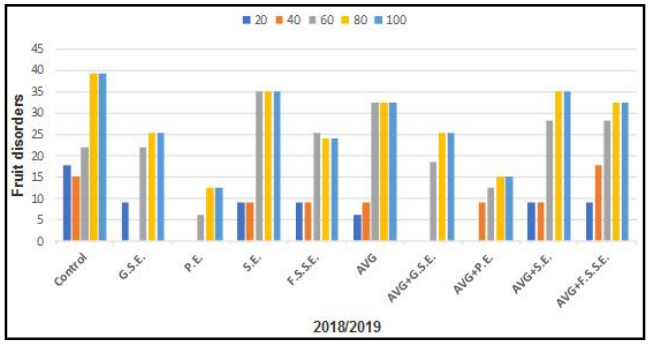

Fig. 9: Effect of preharvest foliar application with Aminoethoxy Vinyl Glycine and some natural extracts on disorders percentage of Washington Navel orange fruits at harvest and during cold storage in 2018/2019 season.

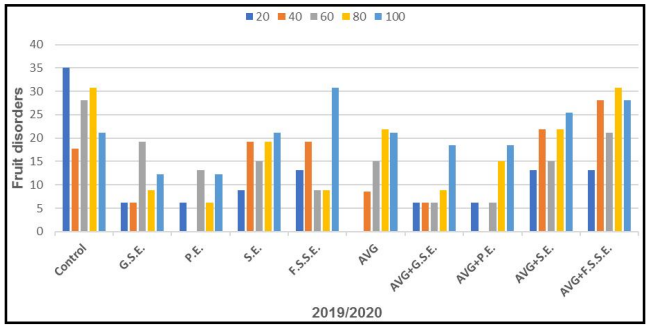

Fig. 10: Effect of preharvest foliar application with Aminoethoxy Vinyl Glycine and some natural extracts on disorders percentage of Washington Navel orange fruits at harvest and during cold storage in 2019/2020 season.

study, data, in Fig.. 9, 10, revealed that, fruit disorders (%) in general, were significantly decreased with prolonging the storage periods, in both seasons and the differences were significant among the storage periods. The increase in fruit disorder percentage during storage could be due to 1- Fruit chilling injury as the orange fruits were susceptible to cold storage which cause membrane stain so flavedo and albedo becomes brown and pitted. The tissues weakened as they are unable to carry on normal metabolic processes. 2- Fruit shrinkage because of moisture loss. 3- Fruit senescence by so rapid deterioration of the fruit. These results are on the contrary with (Hidalgo et al., 1996), who stored unripe "Manila" mangoes at 6°, 12°, 16° and 25°C and 85-90% RH for up to 15 days and then fruits were removed every three days for ripening at 25°C. They observed that, visual symptoms of chilling injury were not evident during refrigerated storage but appeared during ripening.

Firmness (Ib/inch²)

Data, in Fig. 11, 12, in both seasons, showed that, the five individual treatments significantly increased fruit firmness compared with the control, using S.E. treatment caused the highest increase in firmness compared to the four other treatments. In the meantime, using AVG combined with each natural extracts, AVG+ G.S.E. treatment caused a significant increase in firmness of Washington Navel orange fruits compared to the control and the rest treatments, except to AVG+ S.E. treatment. In addition, S.E., AVG, AVG + S.E. and AVG + G.S.E. were more effective in increasing fruit firmness. The changes of fruit firmness are shown in Fig. 11, 12. In both seasons, results showed that, the firmness was significantly decreased by increasing the storage periods, and the differences among all tested storage periods were statistically significant. Yashoda *et al.,* (2006) observed that softening in fruit texture from unripening to ripening stage of mango was a result of a reduction in starch content, pectin, cellulose, and hemicellulose.

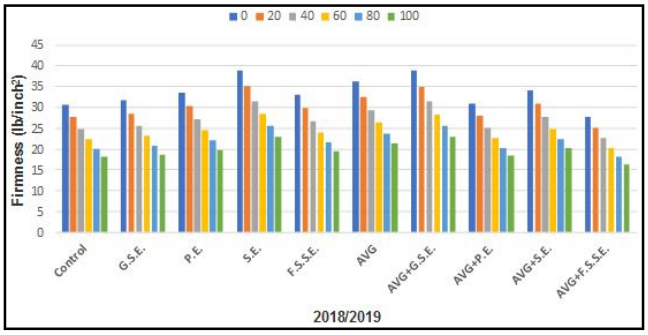

Fig. 11: Effect of preharvest foliar application with Aminoethoxy Vinyl Glycine and some natural extracts on firmness (Ib/inch²) of Washington Navel orange fruits at harvest and during cold storage in 2018/2019 season.

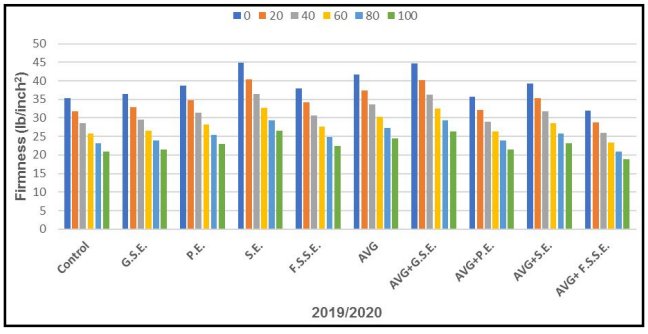

Fig. 12: Effect of preharvest foliar application with Aminoethoxy Vinyl Glycine and some natural extracts on firmness (Ib/inch²) of Washington Navel orange fruits at harvest and during cold storage in 2019/2020 season.

Total Soluble Solids (%)

In Fig. 13, 14, the five individual treatments caused a significant increase in TSS(%) of Washington Navel orange fruits compared to the control in 2018/2019 and 2019/2020 seasons, also significant differences were found among them. Using AVG application with each natural extract caused a significant increase in T.S.S.

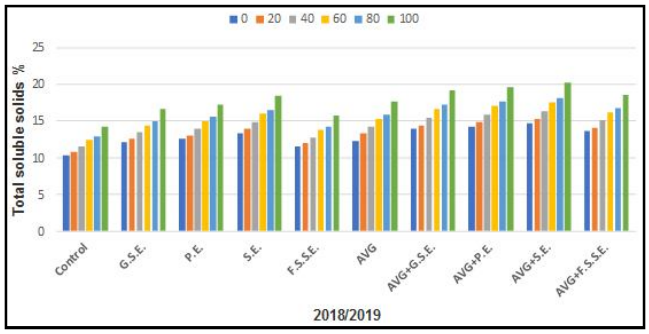

Fig. 13: Effect of preharvest foliar application with Aminoethoxy Vinyl Glycine and some natural extracts on total soluble solids percentage of Washington Navel orange fruits at harvest and during cold storage in 2018/2019 season.

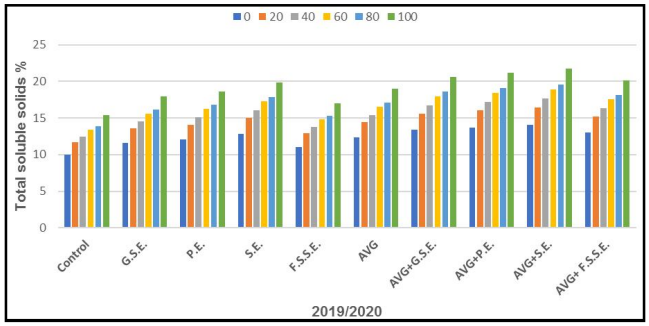

Fig. 14: Effect of preharvest foliar application with Aminoethoxy Vinyl Glycine and some natural extracts on total soluble solids percentage of Washington Navel orange fruits at harvest and during cold storage in 2019/2020 season.

compared to control, and significant differences were found among them. Using AVG+ S.E. treatment caused a significant increase in TSS % compared to the three other treatments. In addition, AVG+ S.E treatment was the most effective on increasing TSS (%).

As for the effect of storage periods data indicated that, fruit total soluble solids were significantly increased by prolonging the storage periods and the differences among all tested storage periods were statistically significant. Hifny *et al.,* (2012) worked on Washington navel orange and Abobatta (2015) worked on Valencia orange, they found that, TSS% was increased by increasing storage period. They added that, TSS% is a function of total dissolved solids and moisture content of fruit and the increase in TSS% may be due to loss of fruit moisture content during cold storage period.

Acidity (%)

Data, in Fig. 15, 16, showed that, in both seasons 2018/2019 and 2019/2020, the five individual treatments caused a significant decrease in percentage of acidity in fruits compared with control, except to G.S.E. treatment, which has a significant increase compared to control.

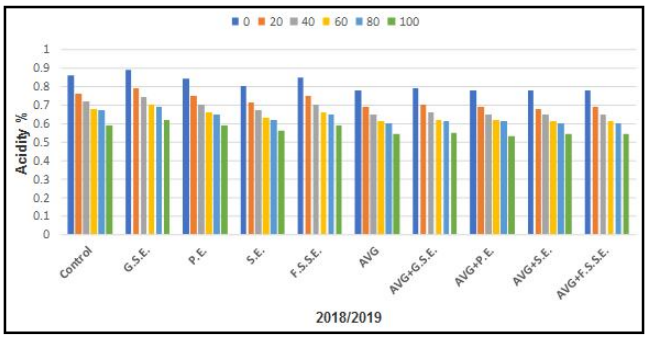

Fig. 15: Effect of preharvest foliar application with Aminoethoxy Vinyl Glycine and some natural extracts on acidity percentage of Washington Navel orange fruits at harvest and during cold storage in 2018/2019 season.

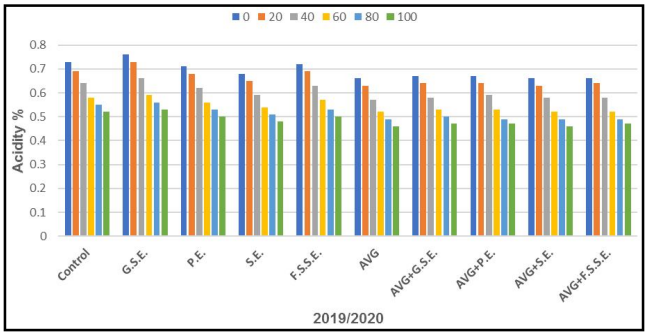

Fig. 16: Effect of preharvest foliar application with Aminoethoxy Vinyl Glycine and some natural extracts on acidity percentage of Washington Navel orange fruits at harvest and during cold storage in 2019/2020 season.

Results also, showed that, using AVG treatment caused the highest decrease in acidity (%) compared to the other treatments. on the other hand, in the two seasons of the study, statistical analysis showed that, using AVG application with each natural extract, the four treatments caused a significant decrease in acidity percentage of Washington Navel orange fruits compared to control in 2018/2019 and 2019/2020 seasons. Moreover, the statistical analysis showed that, in 2018/2019 and 2019/2020 seasons, AVG, AVG+ P.E., AVG+ S.E., AVG+ F.S.S.E. were more effective on decreasing acidity content.

As for the effect of storage periods, data indicated that, fruit acidity content significantly decreased, in both seasons, with increasing the storage periods of Washington Navel orange fruits, in Fig. 15, 16. This reduction in fruit acidity may be due to consumption in respiration as an expiratory substrate. Organic acids such as citric acid are primary substrates for respiration and a reduction in acidity is expected in highly respiring fruits and coating or wrapping treatments reduce respiration rates and may, therefore delay the utilization of organic acids during cold storage (Yaman and Bayoindirli, 2002; Abd El-Motty and Sawsan, 2013).

TSS/Acid ratio

In Fig. 17, 18, in both seasons of the study, the five treatments significantly increased TSS/Acid ratio of Washington Navel orange fruits as compared with control. Statistical analysis showed that, the highest ratio was obtained by AVG and S.E. treatments compared with other treatments that using individually. Moreover, using AVG application with each natural extract caused a significant increase in TSS/Acid ratio compared to the control, and significant differences were found among the four treatments. Furthermore, the highest increase in TSS/Acid ratio recorded by using AVG+ S.E. treatment.

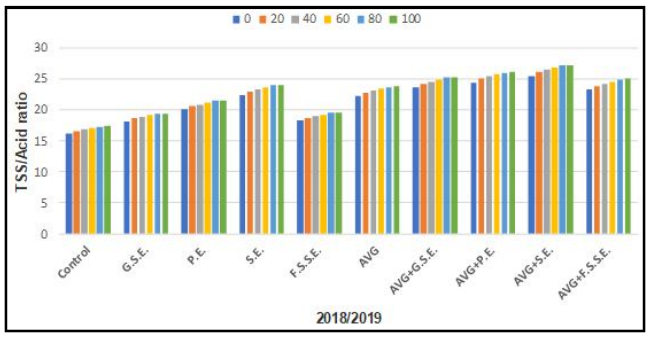

Fig. 17: Effect of preharvest foliar application with Aminoethoxy Vinyl Glycine and some natural extracts on TSS/Acid ratio of Washington Navel orange fruits at harvest and during cold storage in 2018/2019 season.

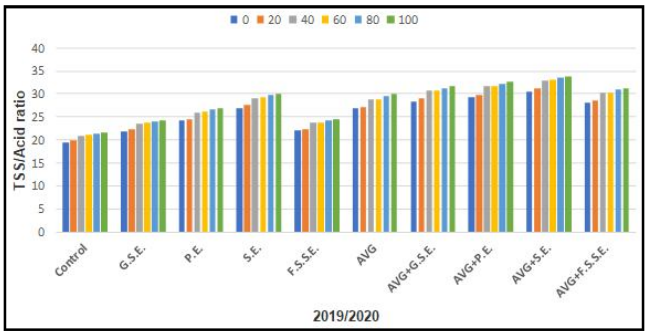

Fig. 18: Effect of preharvest foliar application with Aminoethoxy Vinyl Glycine and some natural extracts on TSS/Acid ratio of Washington Navel orange fruits at harvest and during cold storage in 2019/2020 season.

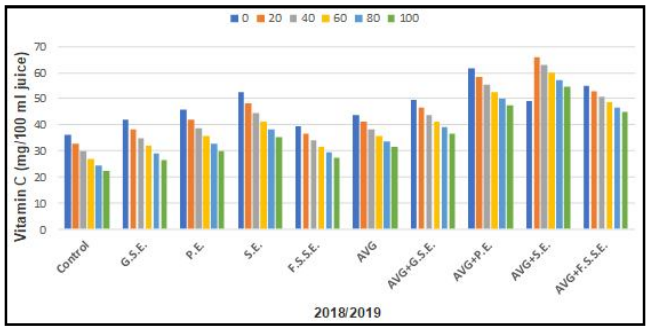

Fig. 19: Effect of preharvest foliar application with Aminoethoxy Vinyl Glycine and some natural extracts on vitamin C (mg/100 ml juice) of Washington Navel orange fruits at harvest and during cold storage in 2018/2019 season.

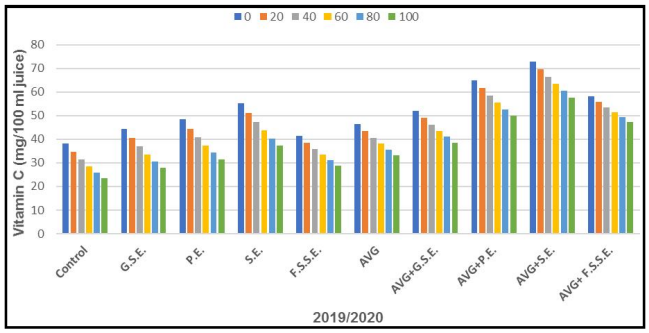

Fig. 20: Effect of preharvest foliar application with Aminoethoxy Vinyl Glycine and some natural extracts on vitamin C (mg/100 ml juice) of Washington Navel orange fruits at harvest and during cold storage in 2019/2020 season.

AVG + S.E. caused the highest increase in TSS/Acid ratio of Washington Navel orange fruits among all the treatments.

As for the effect of storage periods, data in Fig. 17, 18 revealed that, in the two experimental seasons, fruit TSS/Acid ratio significantly increased by increasing the storage period. These results are in agreement with those obtained by Rapisarda *et al.,* (2001). They worked on orange fruit of two blood varieties and they found that, the increase in total soluble solids observed and decrease in total acidity during storage in both varieties resulted in a higher maturity index (TSS/Acid) for the two cultivars. The obtained values are due to the use of citric acid in the process of respiration of fruits. Then with the passage of time degradation of citric acid lead to more TSS as structural formula of citric acid is similar to glucose therefore decrease in citric acid is correlated with increase in TSS/acid ratio so sugar contents had become higher than acids.

Vitamin C (mg/100 ml juice)

In Fig. 19, 20, the five individual treatments caused a significant increase in ascorbic acid content in juice fruit compared with the control. Using S.E. treatment individually caused the highest content of ascorbic acid compared with the four other treatments. As the effect of AVG application with each natural extract, the four treatments caused a significant increase compared to the control and significant differences were found among the four treatments. Using AVG + S.E. treatment caused the highest content in ascorbic acid compared with other treatments.

The changes in ascorbic acid values Fig. 19, 20 were decreased by prolonging the storage periods and the differences among them were significant. This reduction in ascorbic acid was significant among the storage periods, in both experimental seasons. The loss of ascorbic acid during storage may be attributed to the fact that, the ascorbic acid in its phosphorylated form acts as an oxidation reduction catalyst in the change of organic acids to sugars so during the storage, the amount of vitamin C in citrus fruit decreased (Ugon and Bertull, 1944). In addition, the ascorbic acid may be easily oxidized in the presence of O_2 so when the cellular disorganization occurs, as a result of senescence or rote the enzymes which may be responsible for the oxidative destruction of vitamin C (Ascorbic acid, phenolese, cytochrome oxidase and peroxidase) do thin oxidative activities (Hulme, 1970).

Total sugars (%)

In Fig. 21, 22, the five treatments caused a significant increase in total sugars (%) in fruits compared with the control, and significant differences were found among them. The highest value in total sugars content was recorded by AVG treatment, while, F.S.S.E. caused the lowest percentage among the five treatments. In the meantime, using AVG application with each natural extract caused a significant increase in total sugars content of Washington Navel orange fruits compared to control and significant differences were found among

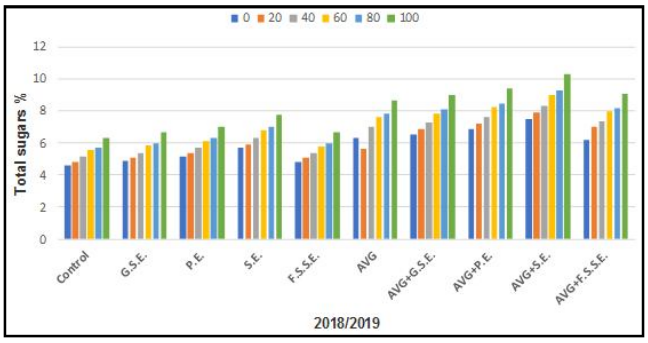

Fig. 21: Effect of preharvest foliar application with Aminoethoxy Vinyl Glycine and some natural extracts on total soluble solids percentage of Washington Navel orange fruits at harvest and during cold storage in 2019/2020 season.

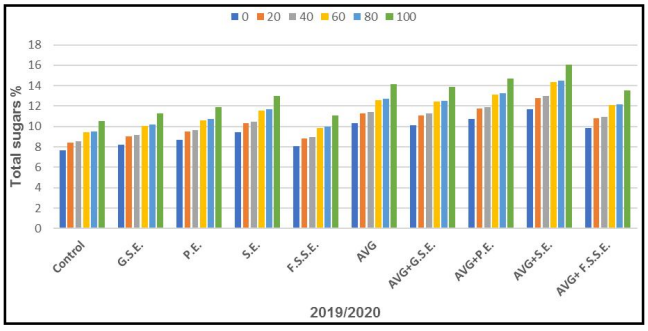

Fig. 22: Effect of preharvest foliar application with Aminoethoxy Vinyl Glycine and some natural extracts on total sugars percentage of Washington Navel orange fruits at harvest and during cold storage in 2018/2019 season.

the four treatments. Also, AVG+ S.E. treatment caused the highest percentage of total sugars content compared to the other three treatments. In general, AVG+ S.E was the most effective treatment in increasing total sugars content.

The changes in fruit total sugars, in Fig. 21, 22, were significantly increased by increasing the storage periods, and the differences among all tested storage periods were statistically significant, in the two experimental seasons. Moreover, this increase in total sugars during storage may be due to the water loss so the sugars concentrated in the same weight sample. In addition, the conversion of complex forms of carbohydrates to simple forms of sugars. The mentioned data were in accordance with those obtained by Ting and Attaway (1971), they found that, the increase of total sugars upon ripening, of Hamlin and Pineapple oranges and Dancy tangerines were mostly due to accumulation of sucrose.

Grapefruit seed extract (G.S.E) is an effective broad-spectrum bactericide (Lee *et al*., 2005), fungicide (Heggers *et al*., 2002) and antiviral and antiparasitic (Tirillini, 2000) natural extract. Grapefruit seed extract (G.S.E) is a natural antimicrobial agent, and that its antimicrobial activity is due to flavonoids, such as naringin and limonoid, quercetin, kaempferol, citric acid, and other compounds, which enhance fruit quality and storability (Jang *et al*., 2011). These results agree with Makai and Balatincz (1998). They indicated that, extract of fenugreek seeds is rich in carbohydrates additionally to fluid materials, nutrients, and vitamins so it improves fruit quality. Crews and Peoples (2004) found that, foliar application of fenugreek seed sprouts had an obvious promotion on the fruit quality through supplying the plants with their requirements from organic and mineral nutrients, natural hormones, and antioxidants. Propolis is a resinous substance; the most important pharmacologically active constituents in propolis are flavonoids, phenolics, and aromatics. Flavonoids are thought to account for much of the biologic activity in propolis. The antimicrobial properties of this mixture of natural substances are mainly attributed to the flavonone pinocembrin, to the flavonol galangin and to the caffeic acid phenethyl ester, with a mechanism of action probably based on the inhibition of bacterial RNA-polymerase (Takaisi- Kikuni and Schilcher, 1994). The precise composition of raw propolis has a long history of being antioxidant (Isla *et al*., 2001), antibacterial (Velikova *et al*., 2000) and antifungal (Ota *et al*., 2001), which has an effect in improving fruit quality and storability of fruits. Seaweed extracts in either liquid or water-soluble powder form provide a readily available source of nutrients and organic compounds. Of course, characteristics of commercial extracts are dependent on seaweed species and the methods of preparation. Commercial and academic reports make claims such as enhanced resistance to pests and disease, improved resistance to abiotic stresses (*e.g.,* drought, salinity, temperature extremes), and improvements to fruit quality and shelf-life (Ross *et al*., 2011). Masia *et al.,* (1998) worked on 'Golden Delicious' apples, they reported that, spraying AVG four weeks before harvesting prevent ethylene production.

Leaf nitrogen showed positive and significant correlation with fruit weight, number of fruits/ tree, yield (kg)/ tree, total soluble solids, TSS/Acid ratio, vitamin C and total sugars contents of Washington Navel orange trees tables 2, 3. Moreover, significant negative correlation was found with fruit drop, weight loss and acidity. This may be due to the role of nitrogen as an essential constituent of cell and its effect on cell division and cell elongation leading to growth and development of large leaf area, stimulation of buds, flower initiation, fruit set with significant increase in yield and improvement in quality attributes through photosynthetic activity. While no

significant correlation was found between nitrogen and fruit disorders. This is supported with the findings observed by Kumar *et al*., (2007). A significant and positive relationship of leaf phosphorus was observed with fruit weight, number of fruits/ tree, yield (kg)/ tree, total soluble solids, TSS/Acid ratio, vitamin c and total sugars. This could be attributed to its role as an essential constituent of cell and its components, in plant metabolism and in energy transfer. Furthermore, significant negative correlation was found with fruit drop, weight loss and acidity. Moreover, no significant correlation was found between phosphorus and fruit disorders. These results are in conformity with the finding of Kumar *et al.,* (2007) tables 2, 3. Leaf potassium level revealed positive and significant relationship with fruit weight, number of fruits/ tree, yield (kg)/ tree, total soluble solids, TSS/Acid ratio, vitamin c and total sugars, tables 2, 3. In addition, significant negative correlation was found with fruit drop, weight loss and acidity. This may be due to its role in plant metabolism and is known as quality nutrient because of its effect on fruit qualities through activation of enzymes, regulating cell hydration, in water economy etc. Moreover, no significant correlation was found between potassium and fruit disorders. These results are in line with the findings of Kumar *et al*., (2007). Leaf calcium in tables 2, 3 indicated positive and significant correlation with fruit weight, number of fruits/ tree, yield (kg)/ tree, total soluble solids, TSS/Acid ratio, vitamin c and total sugars. This can be due to its role in the synthesis of pectic substances which provide strength to cell wall and thereby enhance fruit firmness. Calcium acts as cofactor of enzymes and is essential for cellular organization and is component of chromosomes. Moreover, significant negative correlation was found with fruit drop, weight loss and acidity. Furthermore, no significant correlation was found between calcium and fruit disorders. Similar observations were also reported by Kumar *et al.,* (2007). A significant and negative relationship, in tables 2, 3 was observed between leaf magnesium and fruit weight, number of fruits/ tree, yield (kg)/ tree, total soluble solids, TSS/Acid ratio, vitamin c and total sugars, which may be due to Mg/K+ Ca ratio. Moreover, significant negative correlation was found with fruit drop and weight loss. While no significant correlation was found between magnesium with fruit disorders and acidity. This could be due to its role in plant metabolism for enhancing biosynthesis of organic food and in cell division. In addition, magnesium is a major component of the chlorophyll molecule, and it participates in the photosynthesis process and aids in phosphorus absorption and translocation (Hawkesford *et al.,* 2002). Leaf zinc exhibited positive and significant relationship with fruit weight, number of fruits/ tree, yield (kg)/ tree, total soluble solids, TSS/Acid ratio, vitamin c and total sugars. This could be due to its role in metabolism of plants especially, as an activator of enzymes and precursor of auxins. It also functions in enzyme activation which play important role in protein synthesis and carbohydrate metabolism. Significant negative correlation was found with fruit drop and weight loss. Moreover, no significant correlation was found between zinc with fruit disorders and acidity. These results are in confirmation with the findings of Singh *et al.,* (2007) and Babu and Yadav (2005) tables 2, 3.

A positive and significant correlation of leaf copper was found with fruit weight, number of fruits/ tree, yield (kg)/ tree, total soluble solids, TSS/Acid ratio, vitamin c and total sugars. This can be due to its role in plant metabolism tables 2, 3. Copper plays important role in synthesis of proteins, coenzyme in various reactions, lignification and electron transfer. Moreover, significant negative correlation was found with fruit drop, weight loss and acidity. While no significant correlation were found between copper and fruit

Table 2: Correlation coefficient (r) between leaf mineral content and fruit drop, fruit weight, No. of fruits/ tree and yield (kg) / tree at harvest time of Washington Navel orange trees in the two seasons of the study.

Characters Leaf mineral	Fruit drop (%)	Fruit weight (g)	No. of fruits/ tree	Yield/ tree(kg)
Season 2018/2019				
Nitrogen (%)	-0.90 ***	0.93 ***	0.86 **	0.89 ***
Phosphorus (%)	-0.81 **	0.97 ***	0.79 **	0.89 ***
Potassium (%)	-0.82 **	0.98 ***	0.79 **	0.90 ***
Calcium (%)	-0.81 **	096 ***	0.75 *	0.86 **
Magnesium (%)	-0.79 **	0.89 ***	0.89 ***	0.94 ***
Iron (ppm)	-0.86 **	0.98 ***	0.84 **	0.92 ***
Copper (ppm)	-0.85 **	0.99 ***	0.85 **	0.94 ***
Zinc(ppm)	-0.78 **	0.79 **	0.90 ***	0.89 ***
Manganese (ppm)	-0.86 **	0.98 ***	0.84 **	0.93 ***
Season 2019/2020				
Nitrogen (%)	-0.90 ***	0.94 ***	0.85 **	0.91 ***
Phosphorus (%)	-0.81 **	0.97 ***	0.80 **	0.91 ***
Potassium (%)	-0.82 **	0.98 ***	0.79 **	0.91 ***
Calcium (%)	-0.82 **	0.96 ***	0.74 *	0.87 **
Magnesium (%)	-0.79 **	0.89 ***	0.91 ***	0.94 ***
Iron(ppm)	-0.86 **	0.98 ***	0.83 **	0.93 ***
Copper (ppm)	-0.85 **	0.99 ***	0.85 **	0.95 ***
Zinc (ppm)	-0.79 **	0.82 **	0.92 ***	0.90 ***
Manganese (ppm)	-0.86 **	0.97 ***	0.83 **	0.92 ***

*=Significant at Prob< 0.01, **=Significant at Probe" 0.01, ***=Significant at Probe" 0.01, ns= Not significant.

Table 3: Correlation coefficient (r) between leaf mineral content and weight loss, disorders, firmness, total soluble solids, acidity, TSS/Acid ratio, vitamin c, reducing sugars, non-reducing sugars and total sugars contents at harvest time of Washington Navel orange trees in 2018/2019 season.

Characters Leaf mineral	Weight Loss (%)	Disorders (%)	Total Soluble Solids (%)	Acidity (%)	TSS/Acid ratio	Vitamin C (mg/100ml juice)	Total Sugars (%)
Season 2018/2019							
Nitrogen (%)	-0.94 ***	-0.17 ns	0.97 ***	-0.76 *	0.95 ***	0.87 ***	0.90 ***
Phosphorus (%)	-0.96 ***	-0.23 ns	0.97 ***	-0.69 *	0.92 ***	0.94 ***	0.89 ***
Potassium (%)	-0.90 ***	-0.08 ns	0.95 ***	-0.77 **	0.95 ***	0.95 ***	0.94 ***
Calcium (%)	-0.91 ***	-0.19 ns	0.96 ***	-0.77 **	0.96 ***	0.92 ***	0.91 ***
Magnesium (%)	-0.92 ***	-0.14 ns	0.83 **	-0.63 ns	0.80 **	0.81 **	0.87 **
Iron (ppm)	-0.90 ***	-0.11 ns	0.95 ***	-0.81 **	0.96 ***	0.93 ***	0.97 ***
Copper (ppm)	-0.96 ***	-0.16 ns	0.96 ***	-0.75 *	0.95 ***	0.94 ***	0.95 ***
Zinc (ppm)	-0.85 **	-0.02 ns	0.75 *	-0.59 ns	0.73 *	0.72 *	0.79 **
Manganese (ppm)	-0.91 ***	-0.12 ns	0.95 ***	-0.81 **	0.96 ***	0.93 ***	0.97 ***
Season 2019/2020							
Nitrogen (%)	-0.94 ***	-0.30 ns	0.97 ***	-0.78 **	0.95 ***	0.88 ***	0.90 ***
Phosphorus (%)	-0.97 ***	-0.28 ns	0.97 ***	-0.75 *	0.93 ***	0.94 ***	0.89 ***
Potassium (%)	-0.90 ***	-0.14 ns	0.96 ***	-0.81 **	0.95 ***	0.95 ***	0.94 ***
Calcium (%)	-0.90 ***	-0.22 ns	0.96 ***	-0.82 **	0.96 ***	0.92 ***	0.91 ***
Magnesium (%)	-0.92 ***	-0.33 ns	0.82 **	-0.59 ns	0.79 **	0.80 **	0.86 **
Iron (ppm)	-0.90 ***	-0.17 ns	0.95 ***	-0.84 **	0.96 ***	0.93 ***	0.97 ***
Copper (ppm)	-0.96 ***	-0.26 ns	0.96 ***	-0.78 **	0.94 ***	0.94 ***	0.95 ***
Zinc (ppm)	-0.85 **	-0.25 ns	0.76 *	-0.56 ns	0.74 *	0.74 *	0.79 **
Manganese (ppm)	-0.93 ***	-0.15 ns	0.97 ***	-0.84 **	0.97 ***	0.92 ***	0.94 ***

*=Significant at Prob< 0.01, **=Significant at Probe" 0.01, ***=Significant at Probe" 0.01, ns= Not significant

disorders. This is supported with the findings of Singh *et al.,* (2007). Iron content in leaves of Washington Navel orange exhibited positive and significant relationship with fruit weight, number of fruits/ tree, yield (kg)/ tree, total soluble solids, TSS/Acid ratio, vitamin c and total sugars. This can be due to its role in plant metabolism. Furthermore, significant negative correlation was found with fruit drop, weight loss and acidity. While no significant correlation were found between Iron and fruit disorders. These findings are in line with the results of Jeyabaskaran and Pandey (2008) tables 2, 3. Leaf manganese level in Washington Navel orange revealed significant and positive relationship with fruit weight, number of fruits/ tree, yield (kg)/tree, total soluble solids, TSS/Acid ratio, vitamin C and total sugars tables 2, 3. This can be due to its involvement in physiological processes of plants, leading to quality production. It is essential for enzyme activation involved in respiration, nitrogen fixation, protein synthesis, carbohydrate synthesis and synthesis of chlorophyll. Moreover, significant negative correlation was found with fruit drop, weight loss and acidity. While no significant correlation were found between manganese and fruit disorders. This is supported by Babu and Yadav (2005). Plant nutrition is one of the key factors influencing yield and quality of crop plants. The importance of plant nutrition in yield enhancement and quality up gradation has been widely emphasized. Each essential element plays a vital role in growth and development of plants. There exists a relationship between essential nutrients and quality attributes as well as fruit yield, which serves as a guide to obtain maximum productivity of quality fruits. Awasthi *et al*., (1998) reported a direct relationship of leaf nutrients with yield and quality of apple. Thus, it can

Table 4: Correlation coefficient (r) between storage periods and some parameters at storage time of Washington Navel orange fruits in 2018/2019 and 019/2020 seasons.

Characters	Storage periods	
	2018/2019	2019/2020
Weight Loss (%)	0.99 ***	0.99 ***
Disorders (%)	0.93 *	0.81 ns
Firmness (Ib/inch^2)	-0.99 ***	-0.99 ***
Total Soluble Solids (TSS)	0.98 ***	0.99 ***
Acidity (%)	-0.97 **	-0.99 ***
TSS/Acid ratio	0.98 ***	0.96 **
Vitamin C (mg/100ml juice)	-0.99 ***	-0.99 ***
Total Sugars (%)	0.98 ***	0.98 ***

*=Significant at Prob< 0.01, **=Significant at Probe" 0.01, ***=Significant at Probe" 0.01, ns= Not significant.

be concluded that leaf nutrients have pronounced effect on fruit yield and quality parameters of pear.

Relationship between storage periods and fruit quality of Washington Navel orange

Statistical analysis in table 4, indicated that, in 2018/2019 and 2019/2020 season, there were positive and significant correlations between storage periods with weight loss, disorders, total soluble solids, TSS/Acidity ratio, non-reducing sugars, total sugars contents, except for disorders in 2019. Moreover, negative correlation was found between storage periods with firmness, acidity percentage, vitamin C and reducing sugars, in Washington Navel orange.

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