RESEARCH | Egyptian Journal of Agricultural Research | Horticulture

Spraying biostimulants on Le Conte pear trees reduces fruit drop and enhances yield, improves fruit quality, and storability

Hamdy E. Elzayat[1], *Nevien M. Taha*[2] *and Naglaa H. Shakweer*[2]*

Address:

[1]*Fruit Handling Research Department, Horticulture Research Institute, Agricultural Research Center, Giza, Egypt*

[2]*Deciduous Fruit trees, Horticulture Research Institute, Agricultural Research Center, Giza, Egypt*

*Corresponding Author: ***Naglaa H. Shakweer***, **e-mail:** naglaashakweer1@gmail.com

Received: 29-10-2023; **Accepted:** 05-05-2024; **Published:** 06-05-2024 **DOI:** 10.21608/ejar.2024.245336.1457

ABSTRACT

The aim of this research paper is to compare the effects of spraying four affordable plant biostimulants on the yield of pear trees and fruit quality at harvest and during cold storage for 2 months at 0 ºC. This study investigated the effect of bean extract solution of a concentration 0.1, 0.2 %, sodium alginate at 0.1, 0.2 %, succinic acid at 200 or 400 ppm, salicylic acid at 200 or 400 ppm, and a combination of bean extract at (0.1 % + succinic acid at 200 ppm), and treatments, in addition to control. Trees of "Le-Conte" cv. of 10 years old were sprayed with the above-mentioned substances three times: at bud swelling date, at onset of fruit set, and after 2 months of the 2nd estimation. At harvest, pear fruits were stored at 0 ºC for 2 months. The present results clearly showed that, all treatments yielded in good results of increasing fruit number per tree and all parameters of fruit quality especially the combination of bean extract 0.1 %+ succinic acid 200 ppm induced the highest fruit yield, T.S.S., hue angle, fruit shape index, and increased T.S.S. and vitamin C content compared to control during cold storage. In the meantime, these treatments these treatments decreased fruit weight loss and acidity percentage. Bean extract at 0.1 or 0.2 % increased fruit yield, weight, volume, T.S.S., vitamin C content and fruit lightness, but caused a decrease in acidity and fruit weight loss during 2 months of cold storage. Therefore, we can recommend for "Le-Conte" pear growers to spray trees with a combination of the extract of germinated bean seeds at 0.1% + succinic acid at 200 ppm three times: at growth start, at onset fruit set, and after 2 months, to raise fruit yield, and to improve fruit quality expressed as T. S. S., hue angle and vitamin C content at harvest and after cold storage at 0 ºC for 2 months.

Keyword: Le-Cont Pear, Bean extract, Sodium alginate, Succinic acid, Salicylic acid, fruit quality.

INTRODUCTION

Pear is one of the most nutritious and beneficial fruit in human's food. Pear fruits contain many vitamins and essential elements, like vitamin C, in addition to its content of fibers which help in weight loss regimes beside its contribution in limiting cholesterol absorption in the body. Pear trees need a cold climate to give a good fruit crop and that's the reason behind the widespread of Le-Conte variety in Egypt because of its low chilling unit's needs, (about 400 hours under 7.2 Cº). The pear trees cultivated area in Egypt was about (12989) feddans (M. O. A. statistics) most of them is situated in EL Behira, Noubaria and new desert reclaimed lands, with a production of 82746 Ton (FAO statistics in 2021). Some factors affect pear production quantity and quality in Egypt as some pear cultivars needs a high number of chilling hours at winter which is not the case in Egypt with a mild winter that is not favorable for giving high yield of deciduous fruits. In addition, climate changes during fruit set and growth stages (heat waves, and violent storms in the spring) may negatively influence the fruit setting number and by consequence, the final crop. In addition, good farming due care may be given to pear trees like irrigation regularity and the effective fertilization. Pear fruits have a rapid ripening stage that shorten their storage life and necessitate a great care in handling and transporting, therefore, it is important to search for treatments to improve fruits characteristics especially storability aptitude (Dou *et al.* 2002; Xylia *et al.,* 2021). Many strategies are adapted to enhance pear tree cropping and quality (Ahmed *et al.,* 2021). Using plant biostimulants that contain a wide range of substances (humic, vulvic acids, protein hydrolysates, seaweed extracts, chitosan, biopolymers, essential oils and others) may promote plant growth, and resist biotic and abiotic stress and help in growth development and productivity (Brown and Saa, 2015, Ahmed *et al,* 2022; Maan *et al.,* 2021; Abdullah *et al.,* 2023; Kaur *et al.,* 2023).

Germinated bean extract as a natural affordable material contains some compounds that may help in enhancing plant growth, of which a hormonal substance called "GABA". Gamma Amino butyric acid and may be used to enhance tree nutrient uptake and stimulate fruit setting. GABA is a ubiquitous carbon non protein amino acid, and is present in the plant kingdom, and when plants are sprayed by GABA it raises plant stress tolerance by improving photosynthesis and resisting drought by enhancing osmoregulatory metabolism and synthesis of secondary products (Li *et al.,* 2017). Numerous research studies indicate that GABA participates is enhancing tolerance to stresses such as temperature fluctuations (Nayyar *et al.,* 2014), water scarcity (Yang *et al.,* 2011), and salinity (Chung *et al.*, 2009). GABA also increased fruit diameter and yield of lemon Fruit and enhanced its shelf life when applied preharvest on lemon trees as indicated (Badiche *et al.,* 2023). Another biostimulant is Succinic acid, an organic acid used generally with orchids as a fertilizer in all growth stages, and help to prevent appearance of diseases, pests and stimulate root growth. Succinic acid is an inexpensive plant growth stimulator and stress adaptogen, it increases resistance to adverse environmental effects and accelerates flowering and increases productivity when using a mixture of succinic and lactic acids 45: 55 (10 ppm) by treating root of Asparagus officinal seedlings increased root mass 40% (Yoshikawa *et al.,* 1993).

Alginates are natural polysaccharide copolymers and obtained generally from algae (*Loroum algea*). They are useful biostimulant as they stimulate seed germination, plant growth and development (Nagasawa *et al.,* 2009) and increase the synthesis of various enzymes and secondary metabolites related to plant resistance under drought conditions (FAO-STAT, 2021). Coating of Eucomis autumnalis bulbs by the oligo-alginate exert, caused biostimulatory effect on plant growth and development (Salachna *et al.,* 2018). In another research by Park and Shin., (2021) sodium alginate plus $CaCl_2$ postpone flowering of peach trees and delayed flowering for avoiding frost wave.

Salicylic acid (SA) is a plant growth regulator of phenolic nature which participates in the regulation of physiological processes in plants and plays an important role in the plant response to adverse environmental conditions such as soil which salinity restricts use of land previously uncultivated (Khalil *et al.,* 2022). Salicylic acid plays an essential role in preventing oxidative damage in plants by detoxifying super oxide radicals, produced because of salinity. Salicylic acid proved to be beneficial in enhancing photosynthesis, growth, and various other physiological and biochemical characteristics of plants (Ahmed *et al.,* 2015). Bal and Çelik (2010) showed that Salicylic acid may affect the uptake of sugar and amino acids by plants. Strawberry plants that received Salicylic acid in their nutrient solution had higher fruit weight and firmness (Dou, *et al.* 2002) while decreased fruit weight loss and decay through cold storage of peach fruits (El-Shazly *et al.,* 2013, Nadeem *et al.,* 2022). Salicylic acid has a preventive role in limiting oxidative damages caused by superoxide radicals in cells plant, in cases of high salinity and violent climate changes. Also, SA induced higher peach fruit firmness and acidity (El-Shazly *et al.,* 2013). However, SA has a noticeable effect on growth and productivity of most fruit trees where it catches or chelates the free radicals inside cells which could result in extending the shelf life of plant cells and stimulating growth aspects (Rao *et al.,* 2000; Ragab 2002).

This study aimed at revealing the effects of these above-cited biostimulants on pear fruit tree yield and quality after foliar application of four biostimulants: (GABA), Succinic acid, Sodium Alginates and Salicylic acid on Le-Conte pear trees especially on fruit set, dropping fruit %, yield, fruit quality criteria at harvest and through cold storage for 2 months at 0 Cº

MATERIAL AND METHODS

The present work was performed in a private farm situated at Cairo - Alex. Desert rood (86 km) on10 years old pear trees (*Pyrus Communis L.*) "Le-Conte" cv. during 2019 and 2020 seasons. The trees were grown on sandy soil, planted at 5 x 5 m. apart and received the same agricultural practices under drip irrigation system. The trees were subjected to foliar sprays three times at, bud swelling, fruit set and after two months from 2nd spray, with the following promoting natural substances:

1– Bean extract,2 treatments (0. 1 & 0. 2 %) whose composition contains 4-aminobutyric acid, GABA) by following the method explained by (Keyembe and Van 2013)

A) Green beans were soaked in a wet cloth for 48 hours and then the sprouts were, taken, washed, from which 100 gm was placed in water, homogenized and mixed with acetic acid solution (4%) and shaken at 150 RPm for 20 min., then filtered by a cloth and the soluble extract was used.

2 - Sodium Alginate,2 treatments (0.1 and 0.2 %) ($C_6H_7O_6Na$). Sodium alginate is dissolved with water through a

magnetic stirrer then heated with medium heat until complete dissolution.
3 - Succinic acid ($C_4H_6O_4$) 200 ppm and 400 ppm.
4 - Salicylic acid ($C_7H_6O_3$) 200 and 400 ppm.
5 - Combination of Bean extracts 0. 1 % + Succinic acid 200 ppm.
6 - Control plants sprayed by tab water.

The following data were recorded: -

1 - Fruit set % = No. of fruitlets x 100/ No. of opened flowers as A. O. A. C. (1995).
2 - Fruit drop % = No. of dropped fruits x 100/ No. of setting fruits.
At harvest date, fruits were collected on 20 / 8 in the first season, and on the first of August in the second season.
3 - Fruit yield was calculated as kg / tree = No. fruits per tree x Average of fruit weight.
4 - fruit quality : pear fruits were picked at maturity stage according to Attia (2022) and the fruit quality parameters were determined : fruit weight (g.), volume (cm^3) , shape index (length / width), firmness as Lb / $inch^2$ (by Advanced force Gauge RH 13, UK), T.S. S.%, percentage of acidity (as g. of malic acid / 100 ml fruit juice), and Ascorbic acid content (V. C.) as mg. / 100 ml fruit juice as A. O. A. C. (1995).
5 - Storability: Sixty fruits were stored at 0 ºC for two months and investigated monthly for: weight loss %, decayed fruits %, peel color, lightness, firmness, T. S. S., acidity and Ascorbic acid content.
6_fruit flesh color and Peel brightness (freshness): this parameter was estimated by Hue angle estimation, and L value as cited by McGuire,1992.
7_Decay of fruit: this quality parameter was measured by counting number of distorted fruits or with blemishes or disorders as follows: formula, decay incidence (%) = (number of decayed fruits/ total number of fruits) × 100%
Calculation of person correlation coefficient was carried out looking for relations between pear quality criteria as cited by Snedecor and Cocharn (1990).
The experiment was conducted in a randomized complete block design with 3 replicates (one tree / replicate). Four branches / tree were labeled at four tree directions. The obtained data were subjected to analysis of variance according to Snedecor and Cachran (1990). Means were compared according to Duncan multiple. Test at 5 % level using a Microsoft program.

RESULTS

#Fruit set, fruit drop and yield (kg/tree): - As shown in Table 1, all treatments resulted in a higher percentage of fruit set after approximately 4-5 weeks from full flowering stage, compared to control. Succinic acid treatments (especially high concentration) gave the best results in the two seasons (7.7 % - 8.1 %) followed by treatment No. 7 (mixture) while control trees recorded the lowest fruit set percentage (4.3 % - 4.6 % in both seasons respectively). Sodium alginate and salicylic acid treatments had intermediate fruit set results in the range of 4.3 % - 7.4 %.

All treatments lowered fruit drop estimated in June as opposed to control which recoded 33.7 % - 48.3 % of drop in 1^{st} and 2^{nd}, respectively. Treatment no. 7 (mixture of bean extract + succinic acid) resulted in the lowest drop (12.3 % and 10.3 % at 1^{st} and 2^{nd}, respectively) while sodium alginate treatments had the highest drop % in the 2^{nd} season (17.7-36.0 %) for concentration of 0.1 % and 0.2 % for the two successive years of the study.

For the crop yield, it was found that, all treatments ended in a significantly higher yield of pears per tree, than control. The highest yield was achieved by treatment no. 7 (mixture of bean extract and succinic acid) giving 169.4 kg and 137.9 kg/tree for the two consecutive seasons. Salicylic acid treatments yield was the lower among the treatments, but significantly higher than control (88.1 vis 66.9 kg/tree at 1^{st} year and 69.3 vis 51.6 kg/tree at 2^{nd} year). All other treatments had intermediate yield values in the range of (86.7 kg – 124.6 kg / tree) in both years, with clear superior result by mixture (169.4 and 137.9 kg/tree at 1^{st} & 2^{nd} seasons).

Fruit volume, weight and shape index: Data in Table 2, revealed that, fruit physical parameters "volume weight, and shape index" were significantly improved by treating tress with the above cited biostimulants compared to control trees, bean extract treatments have led to bigger fruits volume, weight and more spherical shape index than all other treatments in both seasons and averaging for both treatments in both seasons, (165.5 cm^3 for fruit volume 185.2 gm. for fruit weigh and 1.23 for fruit shape index). The group of succinic acid treatments and treatment no.7 (mixture of bean extract + succinic acid) came second and had almost similar results in both seasons averaging for this group 144.3 cm^3 for fruit volume 155.3 gm. for fruit weight and 1.26 for fruit shape index while a third group of sodium alginate and salicylic acids had lower values in both seasons with fruit volume (in the range of 105.1 - 140.7 cm^3) and fruit weight in the range of 121.5 - 161 gm. and a shape index in the range of 1.27-1.31. Control fruits volume and

Table 1. Effect of treatments on fruit set %, fruit drop % and yield kg /tree on Le- Conte pear.

Treatments	Fruit set (%)		Fruit drop (%)		Yield (kg/tree)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
1- Bean extract 0.1 %	7.30 B	4.67 F	19.33D	21.00E	100.3 C	124.6 B
2. Bean extract 0.2 %	3.20 E	5.67 E	14.67E	21.00E	101.8 B	89.6 F
3- Sodium Alginate 0.1 %	6.67 C	5.63 E	20.33B	36.00B	86.7 H	91.3 E
4-Sodium Alginate 0.2 %	6.47 C	6.53CD	17.67D	31.00C	91.0 F	120.8 C
5- Succinic acid 200 ppm	7.60 AB	6.90 BC	16.00E	17.67F	90.3 F	105.0 D
6- Succinic acid 400 ppm	8.13 A	7.67 A	21.82B	21.67E	98.4 D	69.3 H
7- Bean extract 0.1% + Succinic acid 200 ppm	7.67 AB	6.00 DE	12.33F	10.33G	169.4 A	137.9 A
8- Salicylic acid 200 ppm	4.33 D	7.43 AB	32.67A	25.33D	95.1 E	86.9 G
9- Salicylic acid 400 ppm	6.43 C	4.60 F	21.00C	26.67D	88.1 G	69.3 H
10- Control	4.33 D	4.57 F	33.67A	48.33A	66.9 I	51.6 I

Means in the same column followed by the same letter(s) are not significantly different according to Duncan's Multiple Test at 5% level. Treatment no. 7 (mixture).

weight was significantly lower than all treatments (110.5 cm^3, and 120 gm. respectively) with a shape index of 1.20.

Fruit weight loss during cold storage: it is clear from data displayed in Table 3, that during 2 months of cold storage, all treatments caused fruits to lose less weight than control in all cases and that pear fruits loss was higher in the 2nd month of cold storage compared to the first month of fruit refrigeration. It is noticed that, after one month in cold storage, this weight loss didn't exceed 2.8%, while this loss after 2 months in cold room raised sharply for all treatments. The biggest weight loss was recorded for succinic acid (high concentration) 11% at 1st season 8% in the 2nd year, compared to control (12.3% and 8.9 % weight loss at 1st and 2nd seasons consecutively). This indicates a low aptitude of "Le-Conte" pears in tolerating prolonged cold storage. The best results of weight loss were recorded by salicylic acid treatment fruits which came first in keeping weight loss to a minimum, after 2 months in cold storage with values ranged from 3.87 % to 5.67 %, in both seasons followed by the mixture of bean extract and succinic acid (6.3%) after 2 months at 1st season and 5.67 % at 2nd season. And other treatments had intermediate value ranged 6.6 % to 11% of weight loss.

Table 2. Effect of treatments on fruit volume cm^3, weight (gm.) and shape index at zero time on Le- Conte pear.

Treatments	Fruit volume cm^3		Fruit weight (gm.)		Fruit shape index	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
1- Bean extract 0.1 %	162.7B	158.0B	176.0B	177.8B	1.23DE	1.24FG
2. Bean extract 0.2 %	167.7A	173.7A	189.3A	199.1A	1.26BC	1.22G
3- Sodium Alginate 0.1 %	140.7E	105.7I	134.8F	135.0DE	1.31A	1.39A
4-Sodium Alginate 0.2 %	129.7G	139.2D	141.1EF	163.2C	1.28A-C	1.27DE
5- Succinic acid 200 ppm	142.7E	136.0E	145.9DE	158.9C	1.25CD	1.27DE
6- Succinic acid 400 ppm	154.3C	147.0C	150.2CD	160.4C	1.21E	1.26EF
7- Bean extract 0.1% + Succinic acid 200 ppm	149.7D	136.0E	155.5C	161.0C	1.27BC	1.28CD
8- Salicylic acid 200 ppm	123.3H	121.2G	121.5G	125.1E	1.29AB	1.30C
9- Salicylic acid 400 ppm	133.7F	132.7F	136.9 F	137.0 D	1.29AB	1.35B
10- Control	110.7I	110.0H	116.0GH	124.7E	1.27BC	1.13H

Means in the same column followed by the same letter(s) are not significantly different according to Duncan's Multiple Test at 5% level. Treatment no. 7 (mixture).

Table 3. Effect of treatments on fruit weight loss (%) during cold storage on Le- Conte pear.

Treatments	Weight loss (%) during cold storage					
	1st season			2nd season		
	At harvest	After 1 month	After 2 month	At harvest	After 1 month	After 2 month
1- Bean extract 0.1 %	0.00	0.48E	8.23D	0.00	2.57B	5.87CD
2. Bean extract 0.2 %	0.00	0.83DE	7.53E	0.00	1.97D	5.93CD
3- Sodium Alginate 0.1 %	0.00	0.73DE	7.93DE	0.00	2.13C	7.17B
4-Sodium Alginate 0.2 %	0.00	0.60DE	8.97C	0.00	3.23A	6.57BC
5- Succinic acid 200 ppm	0.00	0.67DE	9.43C	0.00	1.10F	7.23B
6- Succinic acid 400 ppm	0.00	1.13C-E	11.00B	0.00	1.57E	8.00A
7- Bean extract 0.1% + Succinic acid 200 ppm	0.00	2.47AB	6.33F	0.00	2.17CE	5.67D
8- Salicylic acid 200 ppm	0.00	1.37CD	5.40G	0.00	1.53E	5.67D
9- Salicylic acid 400 ppm	0.00	2.83A	5.17G	0.00	2.50B	3.87E
10- Control	0.00	1.73BC	12.33A	0.00	3.50A	8.93A

Means in the same column followed by the same letter(s) are not significantly different according to Duncan's Multiple Test at 5% level. Treatment no. 7 (mixture).

Fruit firmness in Table 4, indicated that fruits treatment of bean extract (0.2 %) had the highest firmness 24 and 25.7 Lb / inch^2 in both seasons respectively, followed by sodium alginate (0.2 %) and the treatment No. 7 (mixture) came third with 22.7 Lb / inch^2 in both seasons. The fruit firmness decreased gradually in cold store as expected, to reach a lower value after 2 months, taking in consideration that control fruit in both seasons by end storage registered (11.6 and 10.7 Lb / inch^2 at 1st and 2nd, respectively) whose fruits were softer than fruits of all treatments. Succinic acid and treatment No. 7 (mixture) had the highest firmness values (16.66 Lb/inch^2) in 1st season but in 2nd season succinic acid (400 ppm) was the best among all treatments in keeping higher fruit firmness by end of cold storage (16 Lb/inch^2) followed by bean extract fruits (15.3 Lb/inch^2) while salicylic acid treatment fruits had the least firmness values by end of cold storage and a little bit higher than control fruit with firmness values (12.4 and 11.7 Lb/inch^2 at 1st and 2nd season consecutively). Also, control treatments had higher fruit firmness at harvest than most of other treatments, while had lower firmness after 2 months of cold storage at 0°C. That clearly means that the studied treatments effectively helped fruits to maintain their firmness throughout cold storage to stay marketing and edible.

Total soluble solids (T.S.S.%): - Data in Table 5, indicate that all treatments caused more accumulation of soluble solids (mainly sugars) in fruits by harvest time than control fruits which recorded 11% and 10.3% at 1st and 2nd, respectively. Control fruits ended with a relatively high TSS% values after 2 months in cold storage (14.3% and 14.2%) which were significantly higher than fruits of treatments of bean extract and sodium alginate. Salicylic acid fruits (both concentrations) recorded the highest T.S.S. (14.8 &14.7%) in the 1st season among all treatments while succinic acid (200 ppm) treated fruits recorded higher values of T.S.S by end of cold storage in both seasons (14.6% and 15.1% respectively). In the meantime, sodium alginate treatment fruits (0.1% and 0.2%) recorded relatively lower T.S.S values, especially in 2nd season (13.8% -13.2%).

Table 4. Effect of treatments on fruit firmness Lb/inch^2 during cold storage on Le-Conte pear.

Treatments	Fruit firmness Lb/inch^2					
	1st season			2nd season		
	At harvest	After 1 month	After 2 month	At harvest	After 1 month	After 2 month
1- Bean extract 0.1 %	19.33 D	18.64 B	12.18 BC	22.0 BC	18.7 AB	12.0 B
2. Bean extract 0.2 %	24.06 AB	19.82 AB	11.87 C	25.7 A	18.7 AB	15.3 AB
3- Sodium Alginate 0.1 %	19.89 CD	17.78 C	14.71 ABC	22.0 BC	18.8 AB	14.0 AB
4-Sodium Alginate 0.2 %	24.51 A	18.69 B	12.71 ABC	23.8 AB	19.3 A	14.8 AB
5- Succinic acid 200 ppm	23 ABC	18.0 B	16.66 A	20.3 C	16.5 BC	13.7 AB
6- Succinic acid 400 ppm	22.5 ABCD	18.9 B	15.70 AB	21.0 C	18.0 AB	16.0 A
7- Bean extract 0.1% + Succinic acid 200 ppm	22.7 ABC	20.7 A	16.6 A	22.7 BC	19.7 A	13.0 AB
8- Salicylic acid 200 ppm	21.10 BCD	19.83 AB	12.18 BC	22.0 BC	17.2 ABC	13.8 AB
9- Salicylic acid 400 ppm	20.71 CD	20.14 A	12.39 BC	21.0 C	15.2 C	11.7 B
10- Control	21.61 ABCD	19.74 AB	11.60 C	26.0 A	18.3 AB	10.7 B

Means in the same column followed by the same letter(s) are not significantly different according to Duncan's Multiple Test at 5% level. Treatment no. 7 (mixture).

Table 5. Effect of treatments on fruit TSS % during cold storage on Le- Conte pear.

Treatments	TSS (%)					
	1st season			2nd season		
	At harvest	At 1 month	At 2 month	At harvest	At 1 month	At 2 month
1- Bean extract 0.1 %	11.70 CD	13.67 AB	13.83 DE	11.37 D	12.90 C	13.50 CD
2. Bean extract 0.2 %	11.33 E	13.17 CD	14.00 CD	11.80 CD	12.50 C	13.17 D
3- Sodium Alginate 0.1 %	11.87 BC	13.17 CD	13.33 F	11.40 D	13.00 C	13.83 C
4-Sodium Alginate 0.2 %	11.37 E	13.33 BC	14.00 CD	12.43 B	12.62 C	13.20 D
5- Succinic acid 200 ppm	12.40 A	13.25 BC	14.57 AB	12.97 A	14.58 A	15.10 A
6- Succinic acid 400 ppm	11.73 CD	12.73 D	13.50 EF	12.30 B	13.90 B	14.33 B
7- Bean extract 0.1% + Succinic acid 200 ppm	12.07 B	13.83 A	14.33 BC	12.23 BC	12.83 C	13.33 D
8- Salicylic acid 200 ppm	11.53 DE	12.73 D	14.83 A	11.50 D	11.17 D	11.47 E
9- Salicylic acid 400 ppm	11.07 F	13.08 CD	14.67 AB	11.53 D	13.83 B	13.95 C
10- Control	11.00 F	12.67 D	14.33 BC	10.33 E	12.73 C	14.17 B

Means in the same column followed by the same letter(s) are not significantly different according to Duncan's Multiple Test at 5% level. Treatment no. 7 (mixture).

Salicylic acid treatment (200 ppm) fruit in 2nd season had the least T.S.S values (11.5 %) which may be due to natural variability among pear fruits.

Fruit acidity and vitamin C: As displayed in Table 6, applied bio stimulants, affected fruit acidity and lowered it by end of storage. Pear fruits acidity was generally higher in first year than second year, and values are situated in the range of 0.25% - 0.30% for all treatments except with treatment no. 7 (mix of bean extract+ succinic acid) which recorded the lowest acidity percentage (0.20%) while in second season acidity of fruits in all treatments decreased in a net way and situated in the range of (0.18% - 0.22%) and were always lower than control fruits with acidity value 0.22%. It is noticeable that, treatment of bean extract + succinic acid in the 1st season as well as succinic acid at 400 ppm in the 2nd season, significantly decreased the acidity % in fruit juice after 2 months of cold storage at 0°C than control and the other treatments.

Vitamin C results of the 1st season were different than those of the 2nd season as the drop in vitamin C content in 1st season was more pronounced than in 2nd season as values decreased noticeably from those recorded at harvest (21.6 - 25.4 mg.) to a range of lower values from 9.7 to 14.0 mg. in 1st season as the lower values were registered for sodium alginate (9.7 and 10.1 mg. for low and high concentrations consecutively). Other treatments had higher vitamin C values by storage end compared to control (averaging 11.3 mg). In the second season all treatments had significantly higher vitamin C than 1st season by end of storage (19.6 mg to 26.5 mg) compared to control fruit with a low vitamin C of 17.2 mg. These results proved clearly that, bio stimulants, may direct fruit organic acids to be consumed in respiration and slowing vitamin C break down during cold storage.

Also, showed that, the content of vitamin C in pear fruits markedly increased through 2nd season than 1st at harvest and after cold storage for 2 months, and that may result from the effect of the present bio stimulants. However, increasing T.S.S and decreasing pear juice acidity throughout cold storage mean better taste.

Freshness of fruit and flesh color of fruit as represented by Hue angle and lightness values:

As shown in Table 7, freshness of fruits (peel brightness) has declined in a variable way for fruits of all treatments from the harvest time till the end of cold storage in contrast to the control fruits which kept more freshness. Fruit pulp turned to a yellowish color by end of cold storage especially with treatments of succinic acids, sodium alginate (0.1%)in 1st season, and also in 2nd season while control fruits flesh color had stayed almost unchanged and didn't develop to the same yellowish color of treatments fruits.

Decay % of pears: Results in table (8) indicated that all treatments had been efficient in limiting fruit cold storage damage by chilling injury but in a variable degree. Control pear fruits were more decayed in a significant way than treatment fruits (60 % and 75 % in 1st and 2nd seasons respectively).

Fruits of bean extract treatments (both concentrations in both years) and those of mixture of bean extract + succinic acid were remarkably less affected by 2 months of cold storage, with a range of percentage damaged fruits of (6.6 % - 20 %) in both seasons, while other treatments had an intermediate result in the range of (23 % - 50 %). Anyhow the most affected fruits by chilling injury were salicylic acid treatments (both concentrations) in both years especially 2nd year with 50% of damaged fruits, through flesh browning and cavity formation which were observed in pear fruits by end of 2 months in cold storage at 0 °C.

Table 6. Effect of treatments on fruit Acidity % and Vitamin C (mg. \ 100ml) during cold storage on Le- Conte pear.

Treatment	Acidity %				Vitamin C (mg. \ 100ml)			
	Season 1		Season 2		Season 1		Season 2	
	0 time	After storage	0 time	After storage	0 time	After storage	0 time	After storage
Bean extract 0.1%	0.359DE	0.294BC	0.269B-D	0.208AB	19.79G	12.88C	30.22C	24.65C
Bean extract 0.2%	0.345DE	0.250D	0.286BC	0222A	23.78D	13.59AB	30.49BC	26.48A
Sodium Alginate 0.1%	0.382CD	0.293BC	0.315AB	0.186CD	22.86D	9.70E	31.23A	25.33B
Sodium Alginate 0.2%	0.430AB	0.282BC	0.254CD	0.210AB	22.34E	10.12E	28.54D	22.04E
Succinic acid 200 ppm	0.334E	0.283BC	0.272B-D	0.199BC	25.12AB	13.12BC	28.65D	21.61E
Succinic acid 400 ppm	0.349DE	0.251D	0.272B-D	0.180D	24.29CD	14.04A	28.65D	23.76D
Bean extract 0.1% + Succinic acid 200 ppm	0.361DE	0.208E	0.270B-D	0.192B-D	25.39A	13.69AB	31.09AB	25.17BC
Salicylic acid 200 ppm	0.410A-C	0.276C	0.284B-D	0.196B-D	24.11CD	13.38A-C	26.04E	19.58F
Salicylic acid 400 ppm	0.407BC	0.299B	0.235D	0.220A	24.65BC	13.74AB	28.25D	19.64F
Control	0.449A	0.331A	0.338A	0.222A	2111.60F	11.31D	22.05F	17.1G

Means in the same column followed by the same letter(s) are not significantly different according to Duncan's Multiple Test at 5% level. Treatment no 7 (mixture).

Table 7. Effect of treatments on fruit flesh Hue angle degree and peel lightness of Le- Conte pear during cold storage.

Treatments	Flesh Hue angle degree during cold storage				Lightness during cold storage			
	season 1		season 2		season 1		season 2	
	0 time	After storage	0 time	After storage	0 time	After storage	0 time	After storage
1- Bean extract 0.1 %	64.13C	55.37CD	66.50 C	63.40B	65.70B	50.00C	55.10E	54.80B
2. Bean extract 0.2 %	63.80C	56.40C	60.70 E	58.50C	64.90 B	54.90B	62.90C	45.10E
3- Sodium Alginate 0.1 %	51.70H	49.77F	52.70F	50.60E	52.00F	48.40C	53.10G	38.60F
4-Sodium Alginate 0.2 %	60.90D	59.00B	63.70 D	55.40D	43.50H	34.90F	60.40D	53.10C
5- Succinic acid 200 ppm	68.10B	46.10G	64.80D	51.40E	61.40D	54.90B	54.30 EF	50.00D
6- Succinic acid 400 ppm	60.80D	39.53H	60.70 E	56.37D	63.10C	53.30B	65.70 B	56.47B
7- Bean extract 0.1% + Succinic acid 200 ppm	55.40G	52.83 E	73.43B	64.33B	63.10C	53.90B	38.53H	38.20F
8- Salicylic acid 200 ppm	56.60F	52.83E	51.40G	50.37E	43.77H	41.57E	53.60FG	45.10E
9- Salicylic acid 400 ppm	58.30E	53.80DE	60.70 E	51.23E	46.90G	43.50D	66.30B	54.80B
10- Control	73.43A	70.00A	77.90A	73.20A	71.20A	67.30A	70.70A	66.70A

Means in the same column followed by the same letter(s) are not significantly different according to Duncan's Multiple Test at 5% level. Treatment no.7 (mixture).

Table 8. Effect of treatments on fruit decay percentage at end of cold storage: -

treatments	Decayed fruits % at 1st season		Decayed fruits % at 2nd season	
1 – Bean extract (0.1 %)	10.00	F	6.66	E
2 – Bean extract (0.2 %)	10.00	F	10.00	E
3 – Sodium alginate (0.1 %)	31.67	C	40.00	C
4 – Sodium alginate (0.2 %)	23.33	D	35.00	C
5 – Succinic acid 200 ppm	23.33	D	23.33	D
6 – Succinic acid 400 ppm	13.33	EF	23.67	D
7 – Bean extract 0.1% + succinic acid 200 ppm	20.00	DE	11.67	E
8 – salicylic acid 200 ppm	43.33	B	50.00	B
9 - salicylic acid 400 ppm	40.00	B	50.00	B
10 - control	60.00	A	75.00	A

Means in the same column followed by the same letter(s) are not significantly different according to Duncan's Multiple Test at 5% level. Treatment no. 7 (mixture).

 # Interaction between variables (quality criteria):

Calculation of person correlation efficient was carried out, looking for relationships between quality criteria of pear in this experiment, that may explain the effect of biostimulants. The test was done according to Snedecor and Cochran (1990) and a positive correlation was found between fruit weight by end of 2 months of storage and fruit decay in both first and second seasons and which reveals that the bigger fruits are less prone to decay (caused mainly by cold storage).

Calculation: -

Parameter 1st season,	value
Pearson correlation	0.8734
P. value	0.0009625
E. variance	390.186
Sample size	10
Statistic	5.0721
Parameter 2nd season	value
Pearson correlation	0.8652
P. value	0.001225
E. variance	449.6504
Sample size	10
Statistic	4.8797

DISCUSSION

Biostimulants in this work affected pear trees positively in a variable degree, causing an increase in fruit setting, yield and fruit quality. This work on pears was guided partially by good results obtained when treating by a mixture of GABA and succinic acid according to the Patent No. 5604177, registered in 1997. For sake of simplicity and affordability when working on pear trees, bean sprouts extract was used as a source of GABA in addition to succinic acid and gave also similar good results.

GABA acts as a plant growth promoter and its mixing with synthetic succinic acid is a preferred biostimulant group for fruit trees because of low cost and better effectiveness than applying either one component alone (chung *et al.,* 2009). Moongngarm and Saetung (2010) cleared that, GABA has a significant physiological role where increase the rate of root formation thus allowing the plant to better utilize the available nutrients in the soil. In this work the mixture of GABA and succinic caused a gain in fruit yield (169.43 or 137.93 kg / tree 1st and 2 nd years reactively), compared to control (66.9 and 51.6 kg/tree). These results were sustained by the research of Lorente-Mento *et al.* (2023) as GABA,100 mM, application on pomegranate trees increased crop yield and fruit peel color.

The present results clearly showed that this mixture resulted in fruits with high T.S.S. value, good color (hue angle), acceptable fruit shape index, with an increase in vitamin C content during cold storage while significantly decreased fruit weight loss and acidity percentage. Bean extract alone at 0.1 or 0.2 % markedly increased fruit yield, weight, volume, T.S.S. and vitamin C and brightness, in the meantime it decreased acidity and weight loss during 2 months of cold storage. Meanwhile, succinic acid alone at 200 or 400 ppm showed an obvious increase in fruit juice T.S.S. (at harvest time and during cold storage), vitamin C content, good color (hue angle) and brightness while it decreased weight loss and acidity percentage. Treatments of bean extracts solely and a mixture of bean extract + succinic acid have contributed largely to protection of pear fruits from chilling injury because of the reported stimulation of antioxidant enzymes activity (superoxide dismutes, glutathione peroxidase…. etc.) and its effect in rising energy molecules (ATP) content in fruits as was cited by Yang *et al.* (2011). This stimulatory effect of GABA may be attributed to promoting of leaf photosynthesis thus leading to a certain growth gain of fruit, as mentioned by Salah *et al.* (2019) and also by the study of Cheng et al. (2023) on apple trees showing positive effect of GABA in limiting drought stress impact on apple trees as GABA increased photosynthetic rate and enhanced relative leaf water content in apple treated trees by 1 mM of GABA.

The treatment of salicylic acid at 200 or 400 ppm resulted in a high fruit weight and hue angle at harvest, and T.S.S. increased during cold storage, with a decrease in weight loss, and acidity by end of 2 months of storage. On the other hand, control fruits by end of the experiment decreased in firmness with less fruit brightness and a decrease in most of the quality properties. This certain positive effect of salicylic acid (SA) on growth and yield is

attributed to its influence on plant hormones as Salicylic acid altered the auxin, cytokinin and ABA balances inside plant and increased growth and yield under both normal and saline conditions (Babalar *et al.,* 2007; Xu et al., 2008). Also, El-Sayed and Habasy (2015) reported that application of SA enhanced the net photosynthetic rate, internal CO_2 concentration and water use efficiency. When observing closely Sodium alginate effects, it was found that, it acts as an active ingredient and co-polymer promoting plant growth and yield by enhancing the synthesis of various enzymes and secondary metabolites promoting plant resistance under harsh condition increased (FAO-STAT, 2021). These treatments also improved T.S.S., hue angle and vitamin C control through cold storage for 2 months at 0 ºC. It can be noticed after the aforementioned discussion, that there is a certain positive trend for using all mentioned biostimulants on pear trees and the mixture of GABA and succinic acid is on top of that trend for getting bigger crop and higher fruit quality. In the meantime, salicylic acid and sodium alginate treatments come second after the above cited mixture as they possess a good pear fruit protection against temperature fluctuations and chilling injury during fruit growth.

CONCLUSION

The mixture of bean extract 0.1 % + succinic acid at 200 ppm was the best the best treatment for getting a good pear crop and quality, in addition both bean extract treatments (0.1 % and 0.2 %) were also beneficial in increasing pear yield, through their effect in raising fruit set % and decreasing fruit drop. Succinic acid treatments displayed also a similar noticeable positive effect on Le-Cont pear. All treatments had a positive effect, and it is recommended to use the mixture of bean extract with succinic acid or any of these affordable plant biostimulants to get high yields of Le-Cont pear with acceptable quality.

REFERENCES

A.O.A.C. (1995). Official methods of analysis, pp.832-849, USA.

Abdullah, A. H., Awad-Allah, M. A., Abd-Elkarim, N. A., Ahmed, Z. F., & Taha, E. M. (2023). Carboxymethyl cellulose from banana rachis: A potential edible coating to extend the shelf life of strawberry fruit. *Agriculture*, *13*(5), 1058.

Ahmad , P, Hashem ,A. Abd-Allah,E. F., Alqarawi ,A.A. John,R. Egamberdieva ,D. and Gucel, S.(2015). Role of Trichoderma harzianum in mitigating NaCl stress in Indian mustard (Brassica juncea L) through antioxidative defense system. Front Plant Scince,6(868).

Ahmed, Z. F. R., Askri, A., Alnuaimi, A. K. H., Altamimi, A. S. H. R., & Alnaqbi, M. M. A. (2021, March). Liquid fertilizer as a potential alternative nutrient solution for strawberry production under greenhouse conditions. In *III International Symposium on Soilless Culture and Hydroponics: Innovation and Advanced Technology for Circular Horticulture 1321* (pp. 165-172).

Ahmed, Z. F., Kaur, N., Maqsood, S., & Schmeda-Hirschmann, G. (2022). Preharvest applications of chitosan, salicylic acid, and calcium chloride have a synergistic effect on quality and storability of date palm fruit (Phoenix dactylifera L.). *HortScience*, *57*(3), 422-430.

Attia, S. M. (2022). Enhancing fruit set, yield and quality of Le-Cont pear tree by preharvest foliar spray of some plant growth regulators. SVU-International Journal of Agricultural Sciences,4(4),1-7.

Babalar, M., Asghari, M., Talaei, A., & Khosroshahi, A. (2007). Effect of pre-and postharvest salicylic acid treatment on ethylene production, fungal decay and overall quality of Selva strawberry fruit. *Food Chemistry*, *105*(2), 449-453.

Badiche El Hilali, F. A. T. I. M. A., Valverde, J. M., Martínez-Romero, D., Castillo, S., Serrano, M., & Valero, D. (2023). Preharvest Use of γ-Aminobutyric Acid (GABA) as an Innovative Treatment to Enhance Yield and Quality in Lemon Fruit.

Bal, E., & Çelik, S. (2010). The effects of postharvest treatments of salicylic acid and potassium permanganate on the storage of kiwifruit. *Bulg. J. Agric. Sci*, *16*(2), 576-584.

Brown, P., & Saa, S. (2015). Biostimulants in agriculture. *Frontiers in Plant Science*, *6*, 155882.

Cheng, P., Yue, Q., Zhang, Y., Zhao, S., Khan, A., Yang, X., ... & Guan, Q. (2023). Application of γ-aminobutyric acid (GABA) improves fruit quality and rootstock drought tolerance in apple. *Journal of Plant Physiology*, *280*, 153890.

Chung, H. J., Jang, S. H., Cho, H. Y., & Lim, S. T. (2009). Effects of steeping and anaerobic treatment on GABA (γ-aminobutyric acid) content in germinated waxy hull-less barley. *LWT-Food Science and Technology*, *42*(10), 1712-1716.

Dou ShiJuan, D. S., Chen KunSong, C. K., LüJunLiang, L., & Zheng JinTu, Z. J. (2002). The storability and its regulatory mechanism of Huanghua pear (*Pyrus pyrifolia* Nakai.) fruit as influenced by postharvest treatments.

El-Sayed, R., & Habasy, Y. (2015). Effect of spraying salicylic acid on fruiting of Valencia orange trees. *Alexandria Journal of Agricultural Sciences,* 60(3), 119-126.

El-Shazly, S. M., Eisa, A. M., Moåtamed, A. M. H., & Kotb, H. R. M. (2013). Effect of some agro-chemicals preharvest foliar application on yield and fruit quality of 'Swelling'peach trees. *Alexandria Journal of Agricultural Research*, *58*(3), 219-229.

FAO-STAT. Food Agric. Organ. STAT, 2021. http//faostat.foo.org.

Kaur, N., Shahwar, D., Hassan, F.E. and Ahmed, Z.F.R. (2023). Antioxidant and antibacterial activities of date palm fruit (*Phoenix dactylifera* L.) in response to postharvest application with natural elicitors. Acta Hortic. 1364, 187-194.

Kayembe, N. C., & van Rensburg, C. J. (2013). Germination as a processing technique for soybeans in small-scale farming. *South African Journal of Animal Science*, *43*(2), 167-173.

Khalil, H. A., El-Ansary, D. O., & Ahmed, Z. F. (2022). Mitigation of salinity stress on pomegranate (Punica granatum L. cv. Wonderful) plant using salicylic acid foliar spray. *Horticulturae*, *8*(5), 375.

Li, Z., Zhang, Y., Zhang, X., Merewitz, E., Peng, Y., Ma, X., ... & Yan, Y. (2017). Metabolic pathways regulated by chitosan contributing to drought resistance in white clover. *Journal of Proteome Research*, *16*(8), 3039-3052.

Lorente-Mento, J. M., Guillén, F., Martínez-Romero, D., Carrión-Antoli, A., Valero, D., & Serrano, M. (2023). γ-Aminobutyric acid treatments of pomegranate trees increase crop yield and fruit quality at harvest. *Scientia Horticulturae*, *309*, 111633.

Maan, A. A., Ahmed, Z. F. R., Khan, M. K. I., Riaz, A., & Nazir, A. (2021). Aloe vera gel, an excellent base material for edible films and coatings. *Trends in Food Science and Technology*, *116*, 329-341.

McGuire, R. G. (1992). Reporting of objective color measurements. *HortScience,* 27(12), 1254-1255.

Moongngarm, A., & Saetung, N. (2010). Comparison of chemical compositions and bioactive compounds of germinated rough rice and brown rice. *Food Chemistry,* 122(3), 782-788.

Nadeem, Atif, Zienab Fawzy Reiad Ahmed, Syed Bilal Hussain, Alaa El-Din K. Omar, Muhammad Amin, Saqib Javed, Amjad Ali et al. "On-tree fruit bagging and cold storage maintain the postharvest quality of mango fruit." *Horticulturae 8,* no. 9 (2022), 814.

Nagasawa, N., Ha, V. T. T., Hien, N. Q., & Nakanishi, T. M. (2009). Enhancement of plant growth stimulation activity of irradiated alginate by fractionation. *Radiation Physics and Chemistry*, *78*(9), 796-799.

Nayyar, H., Kaur, R., Kaur, S., & Singh, R. (2014). γ-Aminobutyric acid (GABA) imparts partial protection from heat stress injury to rice seedlings by improving leaf turgor and upregulating osmoprotectants and antioxidants. *Journal of plant growth regulation*, *33*, 408-419.

Park, Y., & Shin, H. (2021). Frost avoidance: sodium alginate+ CaCl2 can postpone flowering of 'Kawanakajima Hakuto' peach trees. *Horticulture, Environment, and Biotechnology*, *63*(5), 643-650.

Ragab, M. M. (2002). Effect of spraying urea, ascorbic acid and NAA on fruiting of Washington Navel orange trees. *Master's Thesis, Faculty of Agriculture Minia University, Minya, Egypt*.

Rao, M. V., Koch, J. R., & Davis, K. R. (2000). Ozone: a tool for probing programmed cell death in plants. *Plant Molecular Biology*, *44*, 345-358.

Salachna, P., Grzeszczuk, M., Meller, E., & Soból, M. (2018). Oligo-alginate with low molecular mass improves growth and physiological activity of Eucomis autumnalis under salinity stress. *Molecules*, *23*(4), 812.

Salah, A., Zhan, M., Cao, C., Han, Y., Ling, L., Liu, Z., ... & Jiang, Y. (2019). γ-Aminobutyric acid promotes chloroplast ultrastructure, antioxidant capacity, and growth of waterlogged maize seedlings. *Scientific Reports*, *9*(1), 484.

Snedecor, G. W., & Cochran, W. G. (1980). Statistical methods. 7th. *Iowa State University USA*, 80-86.

Xu, Q., Xu, X., Zhao, Y., Jiao, K., Herbert, S. J., & Hao, L. (2008). Salicylic acid, hydrogen peroxide and calcium-induced saline tolerance associated with endogenous hydrogen peroxide homeostasis in naked oat seedlings. *Plant Growth Regulation,* 54, 249-259.

Xylia, P., Chrysargyris, A., Ahmed, Z. F., & Tzortzakis, N. (2021). Application of rosemary and eucalyptus essential oils and their main component on the preservation of apple and pear fruits. *Horticulturae,* 7(11), 479.

Yang, A., Cao, S., Yang, Z., Cai, Y., & Zheng, Y. (2011). γ-Aminobutyric acid treatment reduces chilling injury and activates the defence response of peach fruit. *Food Chemistry,* 129(4), 1619-1622.

Yoshikawa, M., Hirai, N., Wakabayashi, K., Sugizaki, H., & Iwamura, H. (1993). Succinic and lactic acids as plant growth promoting compounds produced by rhizospheric Pseudomonas putida. *Canadian Journal of Microbiology,* 39(12), 1150-1154.

تأثير رش أشجار الكمثرى الليكونت ببعض المعاملات الحيويه المنشطه للحد من التساقط و تحسين المحصول و الجودة و القدرة التخزينيه للثمار

[1]حمدى الزيات ، [2] نيفين مصطفي طه ، *[3] نجلاء حسيني شقوير

[1] قسم بحوث تداول الفاكهة-، معهد بحوث البساتين ، مركز البحوث الزراعية ، الجيزه ،مصر
[2] قسم الفاكهة المتساقطة الاوراق، معهد بحوث البساتين ، مركز البحوث الزراعية ، الجيزه ،مصر

*بريد المراسل: naglaashakweer1@gmail.com

يهدف هذا البحث لمقارنة تأثير رش اربع منشطات للنمو علي محصول الكمثري (صنف ليكونت بعمر عشر سنوات) وجوده الثمار عند الجمع و خلال التخزين لمدة شهرين علي درجة حرارة صفر مئوى . اشتملت المنشطات علي : مستخلص بذور الفول المنبت (تركيز 0,1 او 0,2 %) – صوديوم الجينات (تركيز 0,1 او 0,2 %) -حامض سكسنيك (تركيز 200 او 400 جزء في المليون) – خليط في مستخلص الفول بتركيز 0,1% + حامض سكسنيك بتركيز 200 جزء في المليون – حامض السلسيلك (بتركيز 200 او 400 جزء في المليون) بالاضافة الي الكنترول . تم رش منشطات النمو ثلاث مرات : مرحلة انتفاخ البراعم – بداية عقد الثمار- بعد شهرين من عقد الثمار . عند جمع الثمار تم تخزينها علي درجة حرارة صفر مئوى لمدة شهرين . اظهرت النتائج ان جميع المعاملات المستخدمة اعطت نتائج جيدة حيث زودت نسبة عقد الثمار و المحصول وزن و حجم الثمار مع الشكل الكمثري المثالي بينما قللت نسبه تساقط الثمار و كانت اكثر المعاملات تأثيرا معامله مخلوط من مستخلص الفول بتركيز 0,1 % + حامض سكسنيك 200 جزء في المليون . نفس هذة المعاملة كانت اكثر تأثيرا اثناء التخزين حيث قللت في نسبه فقد وزن الثمار وحموضه العصير و الثمار التالفه و زادت من قدرة الثمار علي الاحتفاظ بالصلابه و محتواها في المواد الصلبه الكلية ومن فيتامين ج و ايضا زودت لمعان الثمار . بحساب معامل الانحدار اظهر ان الثمار الاكبر وزنا كانت اقل عرضه للتلف الناتج عن التخزين .هذه النتائج تجعلنا نوصي مزارعي الكمثري صنف ليكونت لرش الاشجار بمخلوط من مستخلص الفول بتركيز 0,1% + حامض السكسنيك 200 جزء في المليون في مرحلة انتفاخ البراعم وبدايه عقد الثمار و بعد شهرين في عقد الثمار لزياده المحصول وتحسين موصفات الجودة و القدرة التخزينيه للثمار.

الكلمات المفتاحية: الكمثرى الليكونت، مستخلص الفول، الجينات الصوديوم، حمض السكسينيك، حمض الساليسيليك ، جودة الثمار .