Influence of type of solution and storage temperature on some storage traits for two dates cultivars

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ABSTRACT

The experiment was conducted in one of the private orchards in the Seyahi village, Babylon province to know the Influence of type of solution and storage temperature on some storage traits for two cultivars of dates (Maktoom and Barhi). The experiment included spraying fruits with gibberellin (GA3) solutions at a concentration of (250 $mg.L^{-1}$), licorice extract at a concentration of (4 $g.L^{-1}$) and a control treatment for both cultivars. The fruits were then stored at the cooling temperature of 5 °C and the traditional freezing at a temperature (-18 °C) for 60 days, the experiment was implemented according to the Randomized Complete Block Design (RCBD) as a factorial experiment. The results were analyzed using the Genastat program, The difference between the averages was compared according to the least significant difference test (L.S.D) at the 5% probability level. The most important results can be summarized as follows:

Maktoom cultivar was significantly excelled on the Barhi cultivar by giving it the highest percentage of total soluble solids (TSS). While the fruits treated with gibberellin (GA3) were significantly excelled on the fruits treated with licorice by giving them the lowest average of weight loss and respiration. The fruits treated with licorice extract have excelled by giving them the highest average of Total Soluble Solids and Pectin. The cryopreservation method was significantly excelled in reducing the average of weight loss and the average respiration rate for fruits compared to the cryopreservation method, which has excelled by increasing the percentage of total soluble solids and lower the percentage of pectin.

*Research paper from MSc thesis for the third author.

تأثير نوع المحلول ودرجة الحرارة الخزن في بعض الصفات الخزنية لصنفين من التمر

منار إسماعيل العنبكي حسين لفته الجبوري *آلاء باسم وتوت

كلية الزراعة/جامعة القاسم الخضراء

المستخلص

نفذت التجربة في احد البساتين الخاصة في قريه السياحي / محافظة بابل لمعرفه تأثير نوع المحلول ودرجه الحرارة الخزن في بعض الصفات الخزنية لصنفي من ثمار التمر المكتوم والبرحي. تضمنت التجربة رش الثمار بمحلولي الجبرلين (GA3) بتركيز 250ملغم.لتر$^{-1}$ومستخلص عرق السوس بتركيز4غم.لتر$^{-1}$ ومعاملة المقارنة لكلا الصنفين ، ثم خزنت الثمار على درجة حرارة التبريد 5 م° والتجميد التقليدي في درجة حرارة (-18م°) لمدة 60 يوم ،نفذت وفق تصميم القطاعات العشوائية الكاملة(RCBD) كتجربة عاملية ،وحللت النتائج باستخدام برنامج Genastat وقورنت الفروقات بين المتوسطات حسب اختبار أقل فرق معنوي L.S.D على مستوى احتمال 5%. ويمكن تلخيص أهم النتائج كالآتي: -تفوق صنف المكتوم معنويا على صنف البرحي بأعلى نسبة من المواد الصلبة الذائبة الكلية TSS، فيما تفوقت الثمار المعاملة بالجبرلينGA3 معنويا على الثمار المعاملة بعرق السوس بإعطاء اقل معدل من فقدان الوزن والتنفس ،وقد تفوقت الثمار المعاملة بمستخلص عرق السوس بإعطاء اعلى معدل للمواد الصلبة الذائبة الكلية والبكتين ،كما تفوقت طريقة الخزن بالتجميد معنويا في خفض معدل لفقدان الوزن ومعدل سرعة التنفس للثمار مقارنة بطريقة الخزن بالتبريد التي تفوقت بزياده نسبة المواد الصلبة الذائبة الكلية وانخفاض نسبة البكتين.

*بحث مستل من رسالة ماجستير للباحث الثالث

1. INTRODUCTION

The date palm tree (Phoenix dactylifera L.) belongs to the Arecaceae family, which is one of the oldest evergreen fruit trees spread in tropical and subtropical regions of the world, and opinions meet with their differences that the Arabs are the oldest who knew the date palm, especially ancient Iraq in Babylon, and they used their fruits as a staple food for more than four thousand years BC (2). Date palm cultivation is spread in all Iraqi region, where statistics indicated that its numbers in the year 2018, for all cultivars, and for the central and southern regions, where productivity was estimated (646.2 thousand tons), with an increase of 4.4% over last year's production, which was estimated 618.8 thousand tons (3). Dates are used in various food industries, including the manufacture of molasses, jams, refreshments, and children's food because it is an important source for many nutrients, where carbohydrate ratios reach 70%, fiber 6-2%, 3-1 protein and fats 7.5-2.5%.In addition to containing many different mineral elements, one kilogram of dates provides 3000 calories as well as vitamins B1, B2, A, nicotine acid and folic acid (24). Palm trees have an importance that exceeds the benefits achieved by their products in terms of food and economics, where it highlights its important and essential role in combating oases and semi-dry regions and protecting them from desertification, as well as adapting the desert environment to suit other crops (11). The Khalal stage is considered a physiological ripening stage where the fruits are hard and turn from green to the distinctive color for the cultivar and the fruit growth is slow or non-existent, and the fruits reach their final size at the end of that stage, which continues from 3-4 weeks. The percentage of moisture in this stage ranges from 58 to 50%, the high percentage of the holding material, among the fruits that are consumed in the Khalal stage, including Maktoom and Barhi (22). Plant growth regulators are used to improve the characteristics of the fruits in line with the consumer's desire for the role of these regulators in increasing the yield and improving some desirable traits in the fruits intended for storage. Among these regulators is the GA3 (9). However, studying the role of this growth regulator on palm fruits during storage is almost negligible. Recent research has also concerned with the use of plant extracts as a substitute for growth regulators or as an alternative to them because they are considered natural materials that leave no impact on humans and the environment, including licorice extract (13). Prolonging the duration of the Khalal stage in the different cultivars of dates is considered one of the challenges that it faces, especially the cultivars that are consumed in the Khalal stage, including the two cultivars (Maktoom and Barhi), where increases the period of retention of the two cultivars by the desired traits for the consumer, which increase the period of their marketing the longest possible period. The cryopreservation for dates is considered one of the important means that are used to try to keep these fruits in the Khalal stage as long as possible and to improve their storability, and then prolonging the period of displaying those fruits in the market during the Khalal stage, where the freezing storage works to limit the growth of pathogens and reducing the bio-activities of the fruits, especially the respiration process and the production of ethylene (8). Storage at low temperatures is also used to preserve the traits of the fruits in terms of color, taste, flavor and nutritional value for long periods as well as the ease of preparing them for human consumption, as indicated by (7). It also works to reduce spoilage, prolong its storage age, It prevents staking it in the markets and improving the economic return for the product and its delivery to the consumer in the off-season, so the aim of the study is:

prolonging the period of cryopreservation of two cultivars for dates (Maktoom and Barhi) in the Khalal stage for the longest period possible by using gibberellin and licorice extract under different storage temperature conditions to know the changes that occurred during storage.

2. MATERIALS AND METHODS

The experiment was conducted in one of the private orchards in the Seyahi village, Babylon

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province to know the Influence of type of solution and storage temperature on some storage traits for two cultivars of dates (Maktoom and Barhi). The experiment included spraying fruits with gibberellin (GA3) solutions at a concentration of (250 $mg.L^{-1}$), licorice extract at a concentration of (4 $g.L^{-1}$) and a control treatment (distilled water only) in the green Khalal stage for both cultivars of the dates (Maktoom and Barhi). The treated fruits were harvested at the beginning of the yellow Khalal stage on the date of (1/9/2017). The fruits were washed and dried at room temperature, then distributed according to the treatments, placed in polyethylene bags with the inflorescence and stored at a temperature of (-18 °C ± 5) for a period of 60 days in the warehouses belonging to Abbasid threshold honors in Karbala province. Physical and chemical changes were followed in the fruits during the storage period. Physical and chemical changes were followed in the fruits during the storage period. The experiment was carried out according to The Randomized Complete Block Design (RCBD) as a factorial experiment as indicated by (6), the first factor represents by cultivar (Barhi and Maktoom) which is symbolized by (V1, V2), respectively. The second factor represents field treatments T where the T1 symbolized for the treatment of spraying with gibberellin, T2 symbolized for the treatment of spraying with licorice extract, T0 for the control treatment (without spraying). The third factor represents the storage temperature S (S1: the cooling temperature 5 ºC, S2: the freezing temperature -18 ºC (conventional freezing)). The results were analyzed using the Genestat program, and the differences between the averages were compared by testing the least significant difference (L.S.D) at the probability level 0.05.

The studied traits:

1- Weight loss (%):

$$\text{Weight loss (\%)} = \frac{\text{Weight of fruits at the beginning of storage} - \text{Weight of fruits after a certain period}}{\text{Weight of fruits at the beginning of storage}} \times 100$$

2- Total soluble solids (TSS)

The percentage of total soluble solids (TSS) was measured using the Hand Refractometer, depending based on (23).

3- **Fruit content of pectin (%):** It was estimated based on (5).

4- **Respiratory speed (mg CO_2 / kg/hr):** The velocity of respiration was measured using the Closed System method according to (10).

3. RESULTS AND DISCUSSION

The results of the table show that there were no significant differences between the cultivars, treatments and their interactions before storage

The effect of the type of solution during the Khalal stage before storage on the two cultivars (Maktoom and Barhi)

The average of Field treatments T	TSS(%)			Pectin* (%)			Respiration ($mgCO_2$/kg/hr)		
T0	27.23			12.92			15.92		
T1	29.08			12.42			16.87		
T2	28.15			13.35			15.36		
L.S.D 0.05	**N.S**			**N.S**			**N.S**		
average of cultivar V	TSS(%)			Pectin* (%)			Respiration		
V1	27.72			12.99			17.25		
V2	28.59			12.80			14.85		
L.S.D 0.05	**N.S**			**N.S**			**N.S**		
interaction between cultivar and field treatment	TSS(%)			Pectin* (%)			Respiration ($mgCO_2$/kg/hr)		
	T0	T1	T2	T0	T1	T2	T0	T1	T2
V1	27.00	29.20	26.97	12.58	12.75	13.64	18.01	16.88	16.85
V2	27.47	28.97	29.33	13.27	12.09	13.05	13.84	16.85	13.87
L.S.D	**N.S**			**N.S**			**N.S**		

*** Pectin relativity was measured before storage according to dry weight and dry sample**

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Weight loss (%):

Table (1) indicates the presence of significant differences between field treatments, where the Gibberellin treatment (T1) has excelled by giving it the lowest percentage of weight loss amounted to (2.14) compared to the control treatment (T0), which recorded the highest percentage amounted to (3.05%). The freezing temperature (S2) was also excelled by giving it the lowest percentage of weight loss amounted to (2.14%) compared to the freezing temperature (S1) which recorded the highest percentage of weight loss amounted to (3.05%). As for the cultivars, there were no significant differences during storage, where the interaction treatment between the cultivars and the field treatment showed significant differences, where the V1T1 treatment gave the lowest percentage of weight loss amounted to (1.92%) compared to the V2T0 treatment which gave the highest percentage of weight loss amounted to (3.34%).As for the V1S2 treatment recorded the lowest percentage of weight loss amounted to (2.01%) compared to the V2S1 treatment, which recorded the highest percentage of weight loss amounted to (3.66%).The T1S2 treatment was also excelled by recording it the lowest percentage of weight loss amounted to (1.67%) compared to the T2S1 treatment which gave the highest percentage of Weight loss amounted to (3.45%). As for the triple treatment, the V2T1S2 treatment gave the lowest percentage amounted to (0.93%) compared to the V2T2S1 treatment which gave the highest percentage amounted to (4.90%). This is due to the decrease in the percentage of weight loss in the fruits treated with gibberellin and stored in the freezing, due to the joint role for the temperature and growth regulator in reducing the rate of respiration speed and ethylene production and increasing the thickness of the cell walls, which makes the frozen fruits more solid, thus prolonging the storage and marketing age. As for the reason for increasing the weight loss with the cooling temperature, which increases the activity of metabolic activities and consequently the increase in breathing. There is an inverse relationship between moisture content and weight loss where the moisture content increases with the freezing temperature due to a decrease in the percentage of weight loss at that degree. These results agree with (15, 1).

Table 1: Effect of type of solution and storage temperature on the percentage of weight loss for fruits of Maktoom and Barhi.

Cultivar V	**Field treatments T**	**The storage temperature S after 60 days**		**Interaction between cultivar and field treatments**
		S1	**S2**	
Barhi V1	T0	3.47	2.63	2.83
	T1	2.80	2.93	1.92
	T2	4.57	1.43	2.54
Maktoom V2	T0	2.83	2.80	3.34
	T1	3.07	0.93	2.76
	T2	4.90	3.00	2.64
L.S.D 0.05		**1.443**		**L.S.D=0.833**
Field treatments T		S1	S2	**Average of treatments T**
Control T0		2.73	2.63	3.05
Gibberellin T1		2.50	1.67	2.14
licorice T2		3.45	2.12	2.38
L.S.D 0.05		**1.021**		**L.S.D=0.589**
Cultivar		**S1**	**S2**	**Average of cultivars V**
Barhi V1		3.66	2.01	2.67
Maktoom V2		3.31	2.27	2.67
L.S.D 0.05		**0.833**		**L.S.D 0.05=N.S**
Average temperature		**S1**	**S2**	**L.S.D 0.05 =0.589**
		3.05	2.14	

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Total Soluble Solids (T.S.S)

Table (2) indicates the presence of significant differences between field treatments in the percentage of Total Soluble Solids, where the Gibberellin treatment (T2) has excelled by giving it the highest percentage of Total Soluble Solids amounted to (41.00 %) compared to the control treatment (T1), which recorded the lowest percentage amounted to (38.61%). The V2 treatment recorded the highest percentage of Total Soluble Solids amounted to (40.85%) compared to the V1 treatment which recorded the lowest percentage of Total Soluble Solids amounted to (38.61%), The freezing temperature (S1) was also excelled by giving it the highest percentage of Total Soluble Solids amounted to (46.56 %) compared to the freezing temperature (S2) which recorded the lowest percentage of Total Soluble Solids amounted to (37.72 %). As for the interaction treatment between the cultivars and the field treatment, it has shown significant differences, where the V2T2 treatment gave the highest percentage of Total Soluble Solids amounted to (43.00 %) compared to the V1T0 treatment which gave the lowest percentage of Total Soluble Solids amounted to (36.67 %). As for the V1S1 treatment recorded the highest percentage of Total Soluble Solids amounted to (47.68 %) compared to the V1S2 treatment, which recorded the lowest percentage of Total Soluble Solids amounted to (33.56%). As for the triple treatment, the V1T1S1 treatment gave the highest percentage of Total Soluble Solids amounted to (50.00%) compared to the V1T0S2 treatment which gave the lowest percentage amounted to (31.67%). The increase in the percentage of TSS in the cooling temperature is attributed to the moisture decrease for the fruit, thus the dissolution of tissues associated with the activity of cellular enzymes within the fruit, thus which was reflected in the increase in the average of weight loss by evaporation, thus increasing the TSS concentration in the fruits compared to the storage factor by freezing, this was confirmed by both (23, 7). As for the superiority of the Maktoom cultivar in this trait, it is attributed to the genetic factors for the cultivar due to its being semi-dry cultivars with low humidity (11).

Table 2: Effect of type of solution and storage temperature on the percentage of Total Soluble Solids (T.S.S) for fruits of Maktoom and Barhi.

Cultivar V	**Field treatments T**	**The storage temperature S after 60 days**		**Interaction between cultivar and field treatments**
		S1	**S2**	
Barhi V1	T0	45.33	31.67	36.67
	T1	50.00	33.00	38.67
	T2	48.00	36.00	39.00
Maktoom V2	T0	42.00	45.00	41.00
	T1	47.33	34.33	38.56
	T2	46.67	46.33	43.00
L.S.D 0.05		**3.075**		**L.S.D 0.05=1.775**
Field treatments T		S1	S2	**Average of treatments T**
Control T0		43.67	38.33	38.83
Gibberellin T1		47.33	33.67	38.61
licorice T2		48.67	41.17	41.00
L.S.D 0.05		**2.174**		**L.S.D= 1.255**
Cultivar		**S1**	**S2**	**Average of cultivars V**
Barhi V1		47.78	33.56	38.61
Maktoom V2		45.33	41.89	40.85
L.S.D 0.05		**1.775**		**L.S.D =1.025**
Average temperature		**S1**	**S2**	**L.S.D =1.255**
		46.56	37.72	

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Pectin (%)

Table (3) indicates the presence of significant differences between field treatments in the percentage of Pectin, where the Gibberellin treatment (T2) has excelled by giving it the highest percentage of Pectin amounted to (19.25 %) compared to the control treatment (T1), which recorded the lowest percentage amounted to (16.86%). As for the storage temperature, the freezing temperature (S2) was also excelled by giving it the highest percentage of Pectin amounted to (21.68 %) compared to the freezing temperature (S1) which recorded the lowest percentage of Pectin amounted to (8.81 %). The V2 treatment recorded the highest percentage of Pectin amounted to (18.47%) compared to the V1 treatment which recorded the lowest percentage of Pectin amounted to (17.32%). As for the interaction treatment between the cultivars and the field treatment, it has shown significant differences, where the V1T1 treatment gave the highest percentage of Pectin amounted to (20.44 %) compared to the V1T2 treatment which gave the lowest percentage of Pectin amounted to (14.61 %). As for interacting the storage method and the field treatment T0S2, it has recorded the highest percentage of pectin amounted to (20.85%) compared to the T2S1 treatment, which recorded the lowest percentage amounted to (8.20%) during the storage period. As for the V2S2 treatment recorded the highest percentage of Pectin amounted to (20.59 %) compared to the V2S1 treatment, which recorded the lowest percentage of Pectin amounted to (8.33 %). As for the triple treatment, the V2T2S2 treatment gave the highest percentage of Pectin amounted to (21.79 %) compared to the V2T1S1 treatment which gave the lowest percentage amounted to (7.58 %). The decrease in the percentage of pectin under cryogenic storage conditions compared to freezing storage is due to the increasing activity of enzymes that work to convert this compound into simple sugars (7). The role of gibberellin in maintaining a higher percentage of pectin comes by reducing the effectiveness of the enzyme pectin methylesterase, which helps to decomposition of pectic acid and polygalacturonase, which has a role in the decomposition of the glucoside bonds between the molecules of the acid Alkactoronic and that these two enzymes help to dissolve the first pectin, which facilitates the melting of pectic materials in fruits. These results agree with (21, 22, 18).

Table 3: Effect of type of solution and storage temperature on the percentage of Pectin for fruits of Maktoom and Barhi.

Cultivar V	**Field treatments T**	**The storage temperature S after 60 days**		**Interaction between cultivar and field treatments**
		S1	**S2**	
Barhi V1	T0	9.39	20.08	16.90
	T1	10.31	15.40	20.44
	T2	8.20	13.90	14.61
Maktoom V2	T0	9.19	19.24	18.06
	T1	7.58	20.75	19.10
	T2	8.21	21.79	18.25
L.S.D 0.05		**2.180**		**L.S.D = 1.259**
Field treatments T		S1	S2	**Average of treatments T**
Control T0		9.29	18.66	17.58
Gibberellin T1		8.95	20.08	16.86
licorice T2		8.20	20.85	19.25
L.S.D 0.05		**1.542**		**L.S.D=0.890**
Cultivar		**S1**	**S2**	**Average of cultivars V**
Barhi V1		9.30	19.79	17.32
Maktoom V2		8.33	20.59	18.47
L.S.D 0.05		**1.259**		**L.S.D = 0.727**
Average temperature		**S1**	**S2**	**L.S.D =0.890**
		8.81	21.68	

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Average of Respiratory speed (mg CO_2 / kg/hr)

Table (4) indicates the presence of significant differences between field treatments in the average of respiratory speed, where the Gibberellin treatment (T1) recorded the lowest average of respiratory speed amounted to (12.65) compared to the control treatment (T0), which recorded the highest average of respiratory speed amounted to (15.4). The freezing temperature (S2) also recorded the lowest average of respiratory speed amounted to (15.56) compared to the freezing temperature (S1) which recorded the highest average of respiratory speed amounted to (257). As for the cultivars, there were no significant differences during storage as shown in Table (4). The interaction treatment between the cultivars and the field treatment showed significant differences, where the V2T0 treatment gave the lowest average of respiratory speed amounted to (13.48) compared to the V1T0 treatment which gave the highest average of respiratory speed amounted to (16.33). The T1S2 treatment was also excelled by recording it the lowest average of respiratory speed amounted to (14.65) compared to the T2S1 treatment which gave the highest average of respiratory speed amounted to (30.72). As for the triple treatment, the V2S2 treatment gave the lowest average of respiratory speed amounted to (14.93) compared to the V1S1 treatment which gave the highest average of respiratory speed amounted to (26.11). The V1T1S2 treatment showed a significant excelling in decreasing the respiratory speed which amounted to (14.56) compared to the V2T0S1 treatment, which recorded an increase amounted to (37.06). The reduction of average of fruit respiration speed when storage at temperature (-18 °C) is attributed to the role of this degree in reducing physiological and bio-processes, where the respiration speed of stored fruits is greatly affected by the storage temperature and other conditions related to the same fruits, which leads to a reduction in ethylene production and reducing bio-activities. Including enzymatic activity as mentioned in (13). The reduction of an average of respiratory speed in the fruits treated with gibberellin is due to its role in reducing cellular permeability and limiting the gas exchange between the fruit and reducing the gas exchange between the fruit and the surrounding atmosphere as found in (17). As for the increase in that percentage in the fruits stored in the cooling temperature, perhaps the reason is attributed to the fact that metabolic activities inside the fruits are at a high level of those frozen fruits, which led to an increase in the respiratory speed as well as the role of freezing in maintaining the moisture content of the fruits, which was reflected in reducing weight loss at that degree. These results agree with (10).

Table 4: Effect of type of solution and storage temperature on the average of respiratory speed for fruits of Maktoom and Barhi.

Cultivar V	Field treatments T	The storage temperature S after 60 days		Interaction between cultivar and field treatments
		S1	S2	
Barhi V1	T0	21.61	19.03	16.33
	T1	19.66	14.56	6913.
	T2	27.74	16.02	15.82
Maktoom V2	T0	37.06	15.27	13.48
	T1	23.72	16.73	15.02
	T2	24.38	15.42	13.98
L.S.D 0.05		3.622		L.S.D 0.05=2.091
Field treatments T		S1	S2	
Control T0		30.72	5.141	
Gibberellin T1		21.69	4.651	
licorice T2		24.68	6.901	
L.S.D 0.05		2.561		
Cultivar		S1	S2	
Barhi V1		26.11	6.201	
Maktoom V2		25.28	4.931	
L.S.D 0.05		2.091		

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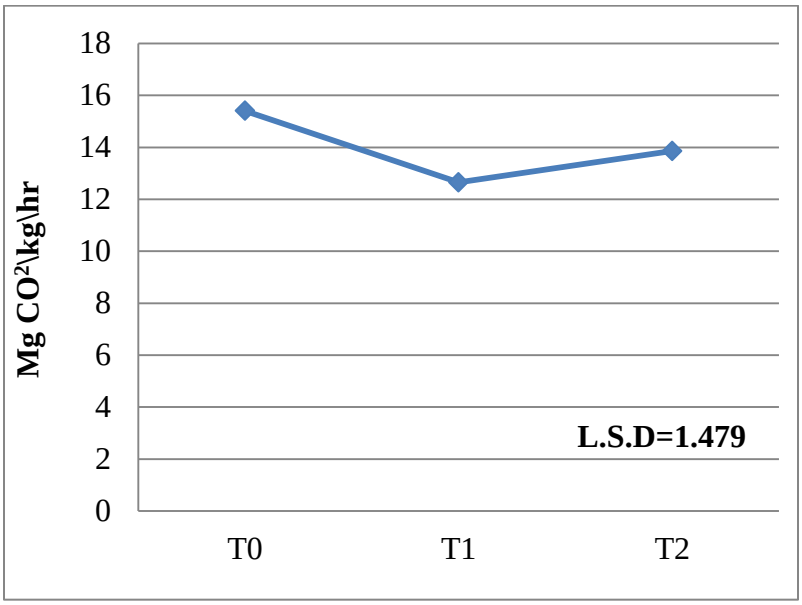

Figure 1: Effect of field treatments on the average of respiration speed after 60 days of storage.

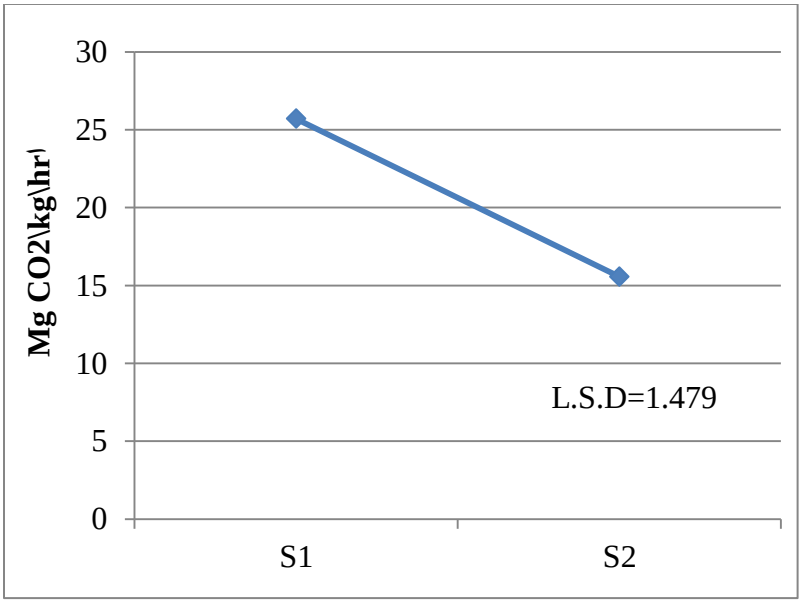

Figure 2: Effect of temperature on the average of respiration speed after 60 days of storage.

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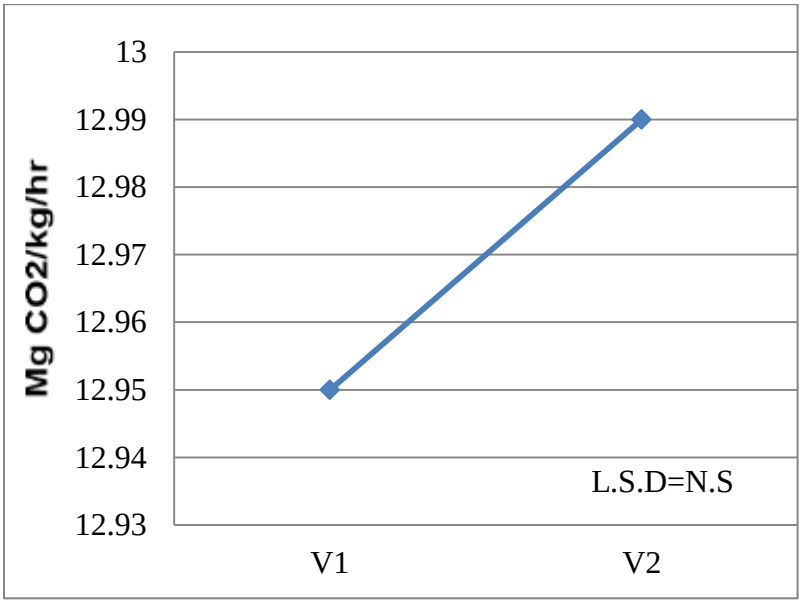

Figure 3: Effect of cultivars on the average of respiration speed after 60 days of storage.

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