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EFFECT OF POTASSIUM HUMATE APPLICATIONS ON FRUIT YIELD AND THEIR QUALITY OF *Carica papaya* PLANT GROWN UNDER ORGANIC CULTURE CONDITIONS

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ABSTRACT

In order to study the effect of potassium humate on yield and some fruit properties of seedling papaya plant, an experiment was conducted at an organic private orchard located in El Mamoura at Alexandria Governorate, Egypt during 2013/2014 and 2014/2015 seasons .The experiment included four complete treatments (Soil application of 5 or 10 ml potassium humate every two months to each plant from first of March to end of August), (Soil application of 2.5 or 5 ml potassium humate every month to each plant from first of March to end of August), and control (without application of potassium humate).

The yield per plant per period from September to next May (kg) and some fruit characteristics, such as fruit weight (g), length (cm), width (cm), flesh thickness (cm), total soluble solids (%), total sugar (%), total acidity (%) and content of β carotenes (mg / 100 g of fresh) were recorded

Results indicated that Soil application of (10 ml potassium humate every two months) and Soil application of (5 ml potassium humate every month) of both seasons gave the highest yield (kg) and the differences were being significant among them and the three other treatments. Also Soil application of (10 ml potassium humate every two months) gave the highest fruit weight, length and width and significantly increased compared with the other investigated treatments in most cases, in addition the differences between flesh thickness values were not big enough to be significant between treatments in most cases. According to chemical fruit properties, the highest TSS values were obtained under Soil application of (10 ml potassium humate every two months) and significantly increased compared with the other treatments, also Soil application of (10 ml potassium humate every two months) gave the highest total sugar and significantly increased compared with the other treatments except the difference between Soil application of (10 ml potassium humate every two months) and Soil application of (5 ml

potassium humate every month), was slightly not significant. A according to total carotenes, (control) gave the lowest values and significantly decreased compared with the other treatments

Conclusively, *the obtained results give basis to conclude that, soil applying seedling papaya plant with potassium humate had a positive effect on yield and fruit quality. The most beneficial treatment in this concern is applying with 10 ml potassium humate every two months started from beginning of March to end of August which gave a reasonable yield and high fruit weight and dimensions with high content of TSS and total sugar and could be considered as a recommended treatment under the conditions of this experiment.*

Keywords: Potassium Humate Applications,Fruit Yield, Quality Of *Carica Papaya* , Organic Culture Conditions.

INTRODUCTION

The papaya, *(Carica papaya* L.,) is a member of the small family *Caricaceae* allied to the Passifloraceae. Commonly and erroneously referred to as a "tree", the plant is properly a large herb growing at the rate of (1.8-3 m) the first year and reaching (6-9 m) in height, (30-40 cm) or more thick at the base and roughened by leaf scars. The leaves emerge directly from the upper part of the stem in a spiral on nearly horizontal petioles (30-105 cm) long. Generally, the fruit is oval to nearly round, somewhat pyriform, or elongated club-shaped, (15-50 cm) long and (10-20 cm) thick; weighing up to (0.9kg). Papayas are generally grown from seed. Germination may take 3 to 5 weeks. It is expedited to 2 to 3 weeks. In the usual papaya plantation, each plant may ripen 2 to 4 fruits per week over the fruiting season. Healthy plants, if well cared for, may average (34 kg) of fruit per plant per year, (Morton, 1987). Papaya is a climacteric fruit, which grows year-round, is an elongated berry of various sizes with a smooth thin skin and a greenish-yellow color (Fuggate *et al*., 2010). Its flesh is thick with a color ranging from yellow to red (Fuggate *et al*., 2010).

The papaya is a good source of calcium and an excellent source of vitamins A, B1, B2 and C. Its protein content is approximately 5%. The nutritional value of the fruit depends on the variety, growing conditions, and ripeness upon consumption (Sankat and Maharaj, 1997), the percent of sugars varies between 10 and 13% (Zhou and Paull, 2001). Hui (2006) observed that fruit quality and yield of papaya fruits are greatly influenced by N K fertilizer application.

The flowering and fruiting periods seemed to be continuous because of the interference of flowering and fruit set of new flushing, degrees of fruit set and fruiting of old flushing as a result of continuous flowering (Aisha, 2005).

In the usual papaya plantation, each plant may ripen 2 to 4 fruits per week over the fruiting season. Healthy plants, if well cared for, may average 75 lbs (34 kg) of fruit per plant per year, though individual plants have borne as much as 300 lbs (136 kg). Papaya plants bear well for 2 years and then productivity declines and commercial plantings are generally replaced after 3-4 years. By that time they have attained heights which make harvesting difficult. (Morton, 1987).

Humic substances are recognized as a key component of soil fertility properties, since they control chemical and biological properties of the rhizosphere (Nardi *et al*., (2005) that are divided into three main fractions: humic acids, fulvic acids and humin. Accordingly, humic acids are the main fractions of humic substances and the most active components of soil and compost organic matter (Ferrara and Brunetti, 2010). Humic substances have been used on plant production directly on soil or substrate due to the two relations of these substances with soil fertility and availability of nutrients (Eyheraguibel *et al*., 2008). But due to humic substance effects on plant nutrition and physiology, Trevisan *et al*., (2010) and Tahir *et al*., 2011), on the other hand (Ferrara and Brunetti, 2010) have been studied for use as foliar spray grape.

The potassium nutrition improved the fruit quality characteristics like TSS, pulp thickness and carotenes content (Kumar, *et al*., 2010).

Therefore, this study was undertaken to study the effect of potassium humate on yield and fruit quality of papaya under organic fertilization so as to standardize the optimum dose for papaya.

MATERIALS AND METHODS

This study was carried out during two successive seasons (2013/2014 and 2014/2015) on papaya seedlings plant at an organic private orchard located in El Mamoura at Alexandria governorate, Egypt. Twenty-five trees of about three years old, planted at 2.5×2.5 meters apart, in sandy loamy soil and irrigated by drip irrigation system were selected in random to study the effect of potassium humate on yield and fruit quality, the selected plants received the same cultural practices including fertilization which were about 1.5 kilogram rabbit manure to each plant per year (analysis of rabbit manure on dry weight basis in 2013 and 2014 seasons was tabulated in (Table 1).

Table 1: Analysis of rabbit manure (on dry weight basis) in 2013 and 2014

2013					
%					
N	**P**	**K**	**Mg**	**OM**	**Moisture**
5.09	0.43	1.10	0.64	83	6.30
2014					
5.62	0.45	1.18	0.67	85	6.11

Soil samples were taken at 0-30 cm, 30-60 cm and 60-90 cm from soil surface orchard for chemical analysis of experiments soil analysis was done according to Wilde *et al*., (1985). Analysis of the tested soil and the data are shown in (Table 2).

Five soil application treatments of potassium humate (potassium humate 85 %, soluble potassium 8 % and fulvic acid 3%) were practiced and the experimental units were arranged in a randomized complete block design with five replicates, one seedling plant per each

These treatments were:

- Soil application of 5, or 10 ml potassium humate every two months to each plant.
- Soil application of 2.5, or 5 ml potassium humate every one month to each plant.
- Soil no application with potassium humate (as a control).
- Soil application with potassium humate started in first of March and ending in end of August every experimental season.
- Yield per plant (kg) was estimated as total yield per period from September to next May according to the equation:

Total yield (kg)=Number of fruits during the period X Average fruit weight.

Fifteen fruits of papaya from each treatment were collected in September at green yellowish colure in peel and yellow orange color in pulp stage to determine fruit weight (g), fruit length (cm) and width (cm) as well as pulp thickness (cm) as physical properties. While chemical properties as total sugars (%) according to Dubios *et al.* (1956), the titratable acidity (%) as citric acid using 0.01N of NaOH, and total soluble solids (TSS %) using hand referactometer were determined in fruit juice. In addition, content of β carotenes (mg / 100 g of flesh) was determined according to Grodzinsky and Grodinsky (1973)**.**

Statistical analysis:

Data were subjected to statistical analysis according to Snedecor and Cochran (1990). The treatment means were compared using Least

Table (2): Soil analysis of the experimental orchard

Parameters / Soil Depth	pH	EC ds/m	Na^{+}	Ca^{++}	Mg^{++}	Cl^{-}	K
			meq/L				
0-30 Cm	7.87	0.73	2.76	2.97	1.0	3.99	0.223
30-60 Cm	7.92	0.42	1.14	1.74	0.6	1.49	0.157
60-90 Cm	7.81	0.44	1.81	1.70	1.0	2.24	0.142

Significant Difference (LSD) at 5% level of probability according to Waller and Duncan (1969).

RESULTS AND DISCUSSION

1. Yield and fruit physical properties:

The results of both seasons in Table (3) revealed that (Soil application of 10 ml potassium humate every two months to each plant from first of March to end of August) and (Soil application of 5 ml potassium humate every one month to each plant from first of March to end of August) recorded highest yield per plant (yield per period from September to next May) and the differences were statistically significant among them and the three other treatments during the two experimental seasons. All potassium humate treatments significantly increased the average of papaya fruit weight than that of the control except (Soil application of 5 ml potassium humate every one month) during the first season that the increase was slightly not significant.

Concerning the fruit length the data in Table (3) reveal that the heights fruit length observed for (10 ml every two months) compared with all other treatments. As for the effect of potassium humate treatments on average fruit width the data in Table (3) indicated that (10 or 5 ml every two months) recorded the highest values comparing with the other treatments in both seasons.

Regarding to the flesh thickness the lowest values recorded for the control comparing with the other treatments during the two experimental seasons in addition the differences between all application were not big enough to be significant in the first season while during the second season (Soil application of 10 ml potassium humate every two months) recorded highest flesh thickness and significantly increased compared with the other treatments except (Soil application of 5 ml potassium humate every one month). The same results were announced by Kumar, *et al*., (2006), Jeyakumar *et al*., (2010), Kumar *et al*., (2010) and Santos *et al*., (2015) they

found that fruit weight increased significantly with the application of potassium up to 300 g/plant/year and thereafter it declined. The potassium nutrition improved the fruit quality characters like pulp thickness.

2- Fruit chemical properties

The data representing the potassium humate effects on the total sugars (%), total soluble solids (%), acidity (%) and β carotenes (%) are listed in (Table 4). The results revealed that, fruit total sugars (%) was significantly higher for (Soil application of 10 ml potassium humate every two months) and (Soil application of 5 ml potassium humate every one month) in both seasons as compared with other three treatments. Regarding total soluble solids, % (Soil application of 10 ml potassium humate every two months) recorded highest value as compared with all other treatments and the differences were be significant in both seasons.

Concerning the fruit acidity the highest percentage recorded for (Soil application of 10 ml potassium humate every one month) and (control) and the differences were statistically significant as compared with all other treatments. As for β carotenes contents the lowest values observed under control treatment and the differences between treatments except control were not significant during the first season while during the second season the differences between treatments were significant between some cases and not significant between the other cases. These findings are partially agree with those of Kumar, *et al.,* (2006) found that TSS increased with increase in K levels but acidity was decrease. Campos *et al*. (2007) registered sweeter fruits in plants submitted to larger amounts of potassium, agreeing with Marschner (2012), who argue that potassium is known to promote sugar translocation in plants, thus it increases the sugar content as well as soluble solids in fruits, including papaya, as confirmed by Souza *et al*. (2009) and Kumar *et al.* (2010). Also Pessarakli (2014) explains that potassium is recognized as a quality element which improves major quality parameters of papaya fruits; it increases total soluble solids content and it decreases fruit titratable acidity. In addition these findings are disagreed with those obtained by Harjadi *et al*., (1995) who found that increasing the K level slightly decreased the total soluble solid of the fruit.

This result explains why all treatments reached the minimum average values required by papaya industry for processed fruits, since according to

Römheld and Kirby (2010) the physiological basis for the need of adequate K status of plants in quality development of crops is well recognized, *i.e.* potassium acts in plants increasing photosynthesis as consequence of a more efficient photosynthetic activity, increasing leaf size and number and more effective translocation of photo assimilates and amino N compounds into reproductive organs via the phloem Santos *et al*., (2015).

Conclusively, the obtained results give basis to conclude that, soil applying seedling papaya plant with potassium humate had a positive effect on yield and fruit quality. The most beneficial treatment in this concern is applying with 10 ml potassium humate every two months started from beginning of March to end of August which gave a reasonable yield and high fruit weight and dimensions with high content of TSS and total sugar and could be considered as a recommended treatment under the conditions of this experiment.

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اثر استخدام هيومات البوتاسيوم على محصول وصفات الجودة لنباتات الباباظ تحت التسميد العضوى

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اجريت هذه الدراسة على خمس وعشرون نبات من الباباظ المنزرعة باحدى المزارع العضوية بمنطقة المعمورة بمحافظة الاسكندرية وكانت الاشجار منزرعة على ابعاد٢،٥ X ٢،٥ م وكان عمر الاشجار فى بداية التجربة خمسة اعوام وخضع جميع الاشجار لنفس المعاملات الزراعية وكان التسميد العضوى للاشجار بواقع ١,٥ كيلو من سماد سبلة الارانب لكل شجرة في العام ، وذلك لدراسة تاثير الاضافات الارضية لهيومات البوتاسوم بمعدلات مختلفة على المحصول الكلى لكل شجرة وايضا بعض الصفات الطبيعية والكيميائية للثمار، وكانت المعاملات البحثية كالاتى:

١- اضافة هيومات البوتاسيوم بمعدل ١٥ سم لكل شجرة مقسمة علي ٣ دفعات بين كل منها شهرين بداية من اول مارس الى اخر اغسطس.

٢- اضافة هيومات البوتاسيوم بمعدل٣٠ سم لكل شجرة مقسمة علي ٣ دفعات بين كل منها شهرين بداية من اول مارس الى اخر اغسطس.
٣- اضافة هيومات البوتاسيوم بمعدل ١٥ سم لكل شجرة مقسمة علي ٦ دفعات بين كل منها شهر بداية من اول مارس الى اخر اغسطس.
٤- اضافة هيومات البوتاسيوم بمعدل ٣٠ سم لكل شجرة مقسمة علي ٦ دفعات بين كل منها شهر بداية من اول مارس الى اخر اغسطس.
٥- معاملة المقارنة (بدون إضافة هيومات البوتاسيوم)، فى بداية شهر سبتمبر ومع وصول الثمار لعلامات النضج (لون اخضر مصفر للقشرة وبرتقالى للحم الثمرة)، تم جمع الثمار لكل معاملة وتقدير وزن المحصول.

تم اخذ عينة عشوائية مكونة من خمس ثمار لكل معاملة وذلك لتقدير بعض الصفات الطبيعية والكيميائية:

١- **الصفات الطبيعية**: وزن الثمرة وطول الثمرة و(القطر وسمك اللحم باستخدام الأدمة).
٢- **الصفات الكيميائية**: تم تقدير النسبة المئوية لكل من المواد الصلبة الكلية و السكريات الكلية و الحموضة (حمض الستريك) وكذلك الكاروتين.

تم التحليل الاحصائى باستخدام طريقة دنكان وتمت مقارنة متوسط المعاملات **وكانت اهم النتائج المتحصل عليها كالاتى :**

١- **المحصول** : اعطت المعاملة الثانية (اضافة هيومات البوتاسيوم بمعدل ١٠ سم كل شهرين لكل شجرة بداية من اول مارس الى اخر اغسطس بواقع ٣٠ سم لكل شجرة) والمعاملة الرابعة (اضافة هيومات البوتاسيوم بمعدل ٥ سم كل شهر لكل شجرة بداية من اول مارس الى اخر اغسطس بواقع ٣٠ سم لكل شجرة) وفى كلا المومسمين اعلى قيم المحصول وبزيادة معنوية مقارنة بباقى المعاملات.

٢- **الصفات الطبيعية :**

- ادت جميع معاملات اضافة هيومات البوتاسيوم الى زيادة معنوية لوزن الثمرة بالنسبة لمعاملة المقارنة ماعدا المعاملة الثالثة حيث كانت زيادتها مقارنة بالكنترول غير معنوية فى الموسم الاول.
- سجلت المعاملة الثانية اعلى القيم لصفة طول الثمرة وبزيادة معنوية مقارنة بباقى المعاملات.
- سجلت المعاملتين الاولى والثانية اعلى قيم لقطر الثمرة وبزيادة معنوية مقارنة بباقى المعاملات.
- اعطت معاملة المقارنة اقل القيم لصفة سمك اللحم فى وبنقص معنوى مقارنة بباقى المعاملات وقد لوحظ ايضا ان الفروق بين قيم سمك اللحم للاشجار المعاملة كانت غير معنوية.

٣- **الصفات الكيميائية :**

- اعطت المعاملتين الثانية والرابعة اعلى قيم السكريات الكلية وبزيادة معنوية عن باقى المعاملات.

- اعطت المعاملة الثانية اعلى قيم لنسبة المواد الصلبة الذائبة وبزيادة معنوية مقارنة بباقى المعاملات.
- اعطت المعاملتين الثالثة ومعاملة المقارنة اعلى قيم لنسبة الحموضة وبزيادة معنوية مقارنة بباقى المعاملات.
- سجلت معاملة الكونترول اقل قيم الكاروتين الكلى وبنقص معنوى مقارنة بباقى المعاملات وقد لوحظ عدم وجود فروق معنوية فيما بين معاملات الاضافة.

التوصية: اوصت الدراسة بان معاملة اضافة هيومات البوتاسيوم بمعدل ١٠سم كل شهرين فى الفترة من اول مارس الى اخر اغسطس انسب المعاملات إذ أعطت اعلى محصول مع جودة عالية لثمار نبات الباباظ المنزرع تحت ظروف الزراعة العضوية فى اراضى طمية.