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Partial Replacement of Chemical NPK Fertilizers with Liquid Compost and Banana Pseudostem Sap in 'Sewy' Date Palm (*Phoenix dactylifera* L.)

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EFFECTS of partial or total replacement of inorganic fertilizers by liquid compost (LC) and banana pseudostem sap (BPS) on growth, yield and fruit physical and chemical characteristics of 'Sewy' date palm were investigated in this study. The recommended inorganic fertilization program (2.985 kg ammonium nitrate -0.5 kg mono calcium superphosphate – 1 kg potassium sulphate /palm/year) was applied as a control, and five rates of LC and BPS (4, 8, 12, 16 and 10 L/palm) in combination with 80, 60 and 20% of the control. Results show that using 60% inorganic fertilizers + 8 L BPS or LC enhanced vegetative growth in terms of leaf and leaflet parameters, leaf nutritional status, fruit set, yield and fruit physical (weight, diameters, length and flesh weight) and chemical properties (TSS, sugars, acidity, crude fiber, nitrate and nitrite contents). However, using 60% inorganic fertilizers+ 8 L BPS showed the highest significant effect on almost all studied parameters in both seasons. The results suggest that in 'Sewy' date palm, 40 % of inorganic fertilizers can be saved by using 8 L of BPS as a sustainable agricultural practice with improved yield and fruit quality.

Keywords: fruit quality; nutrients content; organic fertilizers; sustainability; yield.

Introduction

Egypt is ranked in the first place among the date fruits producing countries in the world with total production of 1.7 million ton, which produced from 15 million palm (El-Sharabasy and Rizk, 2019). Date palms are cultivated in both the Nile Valley and the desert areas of Egypt. Poor yield is considered a significant problem facing Sewy date palm growers in Egypt. Many causes are responsible for this problem, such as environmental conditions and malnutrition.

Fertilization is one of the main limiting factors for growth and productivity of various date palm cultivars, considering that each variety has different fertilization requirements (Minikaev et al., 2021; Abd EL-Rahman and Abd-Elkarim, 2022). Chemical fertilizers are considered a source of agricultural pollutants affecting negatively the ecosystem, especially with its excessive use (El-Ramady et al., 2020; Yadav et al., 2022). The reduction of chemical fertilization through combined application of organic and inorganic fertilizers into the soil is a sustainable approach for improving soil physical, chemical and biological properties (Girmay et al., 2008; Zhang et al., 2015). However, organic nutrients' efficiency is less than mineral fertilizers, but integrating organic and chemical nutrient sources effectively reduces environmental pollution and increases crop productivity and soil health for the long term. Organic sources of nutrients promote beneficial micro-organisms, increase growth, and minimize micronutrient deficiency, improving crop productivity and soil health (Nambiar et al., 1992; Hegazi et al., 2007).

Organic fertilizer is divided based on the shape into liquid organic and solid fertilizer (Ginandjar et al., 2019). Liquid organic fertilizer provides nutrients per the needs of plants and its application can be more

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evenly and concentration can be managed according to the plant's requirement (Sukamto, 2012; Ginandjar et al., 2019). Liquid organic fertilizers contain growth-promoting macro-nutrients, micro-nutrients, fulvic and humic acids (Moriguchi, et al., 2005; Fujisawa et. al., 2012). Furthermore, the liquid organic fertilizers are characterized by their cheapness and ease of use beside their excellent effects on the soil's physical, chemical and biological properties, moreover it is safe from a health point (Alwan and Al Hamdani, 2012). The use of solid and liquid organic fertilizers improves nutrients use efficiency, enhance plant growth and achieve higher yield (Nasution et al., 2014; Toonsiri et al., 2016;).

Banana pseudostem is a potential source for organic fertilizer (Syawal et al., 2018) and its chemical content were reported in various studies indicating abundance of macro-nutrients, other compounds such as tannins, spaonins and flovonides and growth promoting substances like cytokine and GA3 (Sugiarti, 2011; Bahtiar et al., 2016; Fernando and Brintha, 2020) and such compounds have excellent properties for plant tissue development. Effect of foliar spray with banana pseudostem sap were investigated on fruit quality of some crops (Anon 2014; Patel et al., 2018; Fernando and Brintha 2020). However, its soil application as a replacement of chemical fertilizer need to be explored.

Therefore, this study aimed to evaluate the efficacy of two liquid organic fertilizers (liquid compost and banana pseudostem sap) as a partial replacement for regular inorganic fertilizers and exploring their effects on growth, yield and fruit quality of 'Sewy' date palm cultivar.

Materials and Methods

Plant materials and experimental site:

The experiment was carried out on eighteen-year-old healthy and uniform 'Sewy' date palms grown in sandy soil (Table 1) at the experimental farm of faculty of agriculture in El-Kawther region (26°36'11.4"N 31°47'44.9"E), Sohag Governorate. The palms were planted 7 meters apart, drip irrigated and pruned at 10:1 leaf bunch ratio and leaving 10 spathes/palm.

Applied treatments:

The selected palms were subjected to ten fertilization treatments with different chemical fertilization rates in combination with liquid compost [LC], which is a commercial product of Elshafie agricultural investment company (Table 2) or banana pseudostem sap [BPS], that was extracted by Badr association for local community development (NGO) in Tawail, Sohag (Table 3). The chemical fertilizers were added in the form of ammonium nitrate, calcium superphosphate and potassium sulphate.

Table 1. Physical and chemical soil analysis of the orchard.

Characters	Values
Particle size distribution	
Sand (g Kg^{-1})	800
Silt (g Kg^{-1})	91
Clay (g Kg^{-1})	109
Texture grade	Sandy
pH	8.00
E.C. (dS m^{-1})	1.20
Organic matter (g Kg^{-1})	5.8
$CaCO_3$ (g Kg^{-1})	82
Macronutrients values	
Total N (g Kg^{-1})	9.2
P (mg Kg^{-1})	13.00
K (mg Kg^{-1})	205.55
Mg (mg Kg^{-1})	1.22
S (mg Kg^{-1})	0.69
B (mg Kg^{-1})	0.27
EDTA extractable micronutrients (mg Kg^{-1})	
Zn	0.98
Fe	1.11
Mn	1.19
Cu	0.38

The treatments were as follows:

T1- Control: 100% chemical NPK (2.985 kg ammonium nitrate -0.5 kg mono calcium superphosphate – 1 kg potassium sulphate /palm/year)

T2- 80 % chemical NPK + 4 L LC/palm/year

T3- 80 % chemical NPK + 4 L BPS/palm/year

T4- 60 % chemical NPK + 8 L LC/palm/year

T5- 60 % chemical NPK + 8 L BPS/palm/year

T6- 40 % chemical NPK + 12 L LC/palm/year

T7- 40 % chemical NPK + 12 L BPS/palm/year

T8- 20 % chemical NPK + 16 L LC/palm/year

T9- 20 % chemical NPK + 16 L BPS/palm/year

T10- 10 L LC + 10 L BPS/palm/year

Table 2. Analysis of the liquid compost.

Parameters	Values
Amino acid (g L^{-1})	45
Organic matter (g L^{-1})	100
PH	5.9
Total N (g L^{-1})	50
Total P (g L^{-1})	0.196
Total K (g L^{-1})	130
Total B (mg L^{-1})	14
Total Fe (mg L^{-1})	130
Total Mn (mg L^{-1})	17
Total Zn (mg L^{-1})	7.4
Total Cu (mg L^{-1})	4.6

Table 3. Analysis of banana pseudostem sap

Constituents	Values
N (g L^{-1})	199
P (g L^{-1})	65
K (g L^{-1})	551
Fe (mg L^{-1})	220
Mn (mg L^{-1})	57
Zn (mg L^{-1})	65
Cu (mg L^{-1})	41

The ammonium nitrate as an inorganic N source was divided into three equal doses and applied at the first week of March, May and July in both seasons; phosphate fertilizer was added once a year during the first week of January and potassium fertilizer was added in two doses a year before bloom (1st week of March) and after fruit setting (2nd week of April). Liquid organic fertilizers were divided into three equal doses and applied to the soil at the first week of March, May and July in both seasons.

Vegetative growth parameters:

Leaf and leaflet length, width and area were measured according to Ahmed and Morsy (1999) and number of leaflets/leaf was counted.

Leaf nutrients content:

In September of both seasons, leaf samples were collected for analyzing leaf N, P, K and Mg content as described by Summer (1985) and Wilde et al. (1985).

Fruit set and yield:

Initial fruit setting and fruit retention percentages were calculated on the 1st week of April and September respectively, using four selected bunches. Bunch weight (Kg) was recorded and yield/palm was calculated.

Fruit physical and chemical properties:

At harvest fruit quality parameters were determined including; fruit weight (g), diameter (cm) and length (cm), pulp weight %, T.S.S.%, total and reducing sugars % (Lane and Eynon, 1965; A.O.A.C, 2000), titratable acidity (as g malic acid/100 g pulp) (A.O.A.C. 2000), total crude fiber % (Balbaa, 1981), and nitrite in the fruits (mg/100 g) (A.O.A.C. 2000).

Experimental design and statistical analysis:

The experiment was laid out in complete randomized block design with three replicates per treatment. Each replicate was represented with one palm. The obtained data were statistically analyzed using the analysis of variance (Snedecor and Cochran, 1980), Means of treatments were compared according to Duncan Multiple Range Test at 0.5 level of probability.

Results

Vegetative growth parameters:

Data in Table 4 shows that leaflet characteristics, including leaflets length, width, area and number were improved by using LC and BPS at 4 and 8 L of both sources with reduction in chemical fertilizer up to 60%, compared to the control. The highest significant value of leaflet characters was recorded at 60% of chemical fertilizers accompanied with 8 L BPS. The lowest values were found at 10 L of both LC+BPS.

Table 4. Effect of different combinations of mineral NPK, liquid compost (LC) and banana pseudostem sap (BPS) on leaflet characteristics of 'Sewy' date palm.

Treatments	leaflet length (cm)		leaflet width (cm)		leaflet area (cm^2)		No. of leaflet/leaf	
	2019	2020	2019	2020	2019	2020	2019	2020
Control (100% chemical NPK)	42.67 cde	46.00 bc	2.40 cd	2.53 e	78.90 de	88.41 cde	169.00 def	170.67 d
80 % NPK + 4 L LC	47.33abcd	48.33 abc	2.50 bc	2.67 cd	89.57 cd	96.68 bcd	175.00 cd	180.00 bc
80 % NPK + 4 L BPS	49.33 abc	48.67 abc	2.60 b	2.73 bc	96.23 bc	99.44 bc	180.00 bc	180.67 bc
60 % NPK + 8 L LC	51.67 ab	51.00 ab	2.71 a	2.80 ab	103.98 ab	105.97 ab	185.00 ab	184.33 b
60 % NPK + 8 L BPS	53.67 a	55.00 a	2.80 a	2.87 a	110.97 a	116.26 a	188.00 a	191.67 a
40 % NPK + 12 L LC	46.67 bcd	46.33 bc	2.50 bc	2.60 de	88.46 cd	91.00 cde	173.33 cde	177.33 c
40 % NPK + 12 L BPS	39.00 e	42.00 cd	2.30de	2.40 f	70.39 ef	77.826 ef	165.00 fgh	170.00 de
20 % NPK + 16 L LC	41.33 de	43.67 cd	2.37 d	2.50 ef	75.86 ef	83.43 def	167.00 efg	170.00 de
20 % NPK +16 L BPS	37.00 e	39.00 de	2.30 de	2.37 f	67.31 ef	72.41 fg	161.67 gh	166.33 de
10 L LC + 10 L BPS	36.67 e	35.00 e	2.20 e	2.24 g	64.34 g	62.92 h	158.33 g	163.67 e

Treatment of 60% of chemical fertilizers+8 L BPS showed the highest significant increase in leaf area, length and width, followed by 60% of chemical fertilizers +8 L LC in both seasons (Table 5).

Leaf nutrients content:

Leaf nutritional status was improved due to application of both organic fertilizers with reduction of the used amount of inorganic fertilizer up to 60% (Table 6). Leaf nitrogen content decreased

progressively by reduction of inorganic fertilizer to 40 and 20%, showing the lowest content when organic sources were added alone (10 L LC + 10 L BPS). Whereas, the highest content was recorded at 60 % NPK + 8 L BPS. Although the same trend was observed for phosphorus, potassium and magnesium content, however higher reduction in inorganic fertilizer up to 20% or even using organic form alone the content of such nutrients was higher than the control. A remarkable increase in leaf minerals content was observed by using 60 % NPK + 8 L BPS.

Table 5. Effect of different combinations of mineral NPK, liquid compost (LC) and banana pseudostem sap (BPS) on leaf area, length and width of 'Sewy' date palm.

Treatments	Leaf area (m^2)		Leaf length (m)		Leaf width (m)	
	2019	2020	2019	2020	2019	2020
Control (100% chemical NPK)	1.48 d	1.56 bcd	3.69 cde	3.70 cd	0.92 bcd	0.96 d
80 % NPK + 4 L LC	1.33 cd	1.74 bcd	3.72 cd	3.75 bc	0.98 bcd	0.98 cd
80 % NPK + 4 L BPS	1.56 bc	1.79 bc	3.78 bc	3.84 ab	1.02 bc	0.99 bc
60 % NPK + 8 L LC	1.92 b	1.95 b	3.89 b	3.97 a	1.04 b	1.03 b
60 % NPK + 8 L BPS	2.08 a	2.22 a	4.03 a	4.07 a	1.12 a	1.15 a
40 % NPK + 12 L LC	1.53 bc	1.61 bcd	3.64 de	3.67 cd	0.90 cde	0.92 de
40 % NPK + 12 L BPS	1.16 cd	1.37 de	3.43 fg	3.50 ef	0.82 ef	0.86 ef
20 % NPK + 16 L LC	1.27 cd	1.43 cde	3.56 ef	3.58 de	0.82 ef	0.89 ef
20 % NPK +16 L BPS	1.08 ef	1.20 de	3.37 gh	3.42 fg	0.84 fg	0.82 fg
10 L LC + 10 L BPS	1.04 ef	1.02 e	3.20 e	3.24 g	0.76 g	0.75 g

Means followed by the same letter are not significantly different at 5% level by DMRT.

Fruit set and yield:

Initial fruit set percentage significantly improved as a result to both liquid organic fertilizers at the rate of 4, 8 and 12 L/palm, while the highest significant percentage was recorded at 4 and 8 L/palm either with 80 or 60% of chemical fertilizers (Table 7). The same effect was found on fruit retention; however, the highest fruit retention percentage was recorded at 8 L LC+60% inorganic fertilizers with no significant difference with 8 l with the same NPK level and 4 L BPS+80% Inorganic fertilizers.

Table 6. Effect of different combinations of mineral NPK, liquid compost (LC) and banana pseudostem sap (BPS) on the percentages of N, P, K and Mg in the leaves of 'Sewy' date palm.

Treatments	N %		P %		K %		Mg %	
	2019	2020	2019	2020	2019	2020	2019	2020
Control (100% chemical NPK)	2.28 d	2.18 de	0.13 h	0.16 h	1.51 i	1.65 g	0.32 f	0.34 b
80 % NPK + 4 L LC	2.44 c	2.31 cd	0.34 c	0.39 cd	2.31 cd	2.47 bcd	0.55 c	0.63 ab
80 % NPK + 4 L BPS	2.55 bc	2.44 bc	0.37 c	0.42 bc	2.44 bc	2.53 bc	0.60 b	0.67 ab
60 % NPK + 8 L LC	2.67 b	2.59 b	0.41b	0.45 ab	2.59 b	2.68 ab	0.67 a	0.70 ab
60 % NPK + 8 L BPS	2.87 a	2.82 a	0.45 a	0.48 a	2.82 a	2.88 a	0.69 a	0.85 a
40 % NPK + 12 L LC	1.99 ef	1.88 fg	0.25 e	0.32 e	2.02 ef	2.1 def	0.48 d	0.51 ab
40 % NPK + 12 L BPS	2.12 e	2.02 ef	0.29 d	0.36 d	2.18 de	2.23 cde	0.53 c	0.57 ab
20 % NPK + 16 L LC	1.89 fg	1.79 gh	0.19 fg	0.23 g	1.79 gh	1.90 fg	0.40 e	0.43 ab
20 % NPK +16 L BPS	1.79 gh	1.68 hi	0.22 ef	0.27 f	1.88 fg	1.91 efg	0.44 d	0.45 ab
10 L LC + 10 L BPS	1.64 h	1.51 i	0.17 g	0.20 g	1.68 hi	1.77 g	0.35 f	0.37 ab

Bunch weight significantly increased due to LC and BPS application respectively at 8 L/palm with 60% NPK compared to the control (Table 7), leading to higher yield/palm in both seasons (Figure 1).

Table 7. Effect of different combinations of mineral NPK, liquid compost (LC) and banana pseudostem sap (BPS) on initial fruit set and fruit retention, yield and bunch weight of 'Sewy' date palm.

Treatments	Initial fruit set (%)		Fruit retention (%)		Bunch weight (kg)	
	2019	2020	2019	2020	2019	2020
Control (100% chemical NPK)	36.67 e	35.00 e	42.20 e	42.24 g	6.43 bc	6.30 cd
80 % NPK + 4 L LC	62.33 ab	62.33 ab	45.67 bc	47.00 bc	6.30 bc	6.40 c
80 % NPK + 4 L BPS	67.33 a	66.67 a	47.00 abc	50.00 ab	6.33 bc	7.10 b
60 % NPK + 8 L LC	68.00 a	69.00 a	53.00 a	53.00 a	7.23 a	7.53 a
60 % NPK + 8 L BPS	67.90 a	67.53 a	49.66 ab	50.66 ab	6.83 ab	7.33 ab
40 % NPK + 12 L LC	54.37 bcd	56.80 bc	43.53 bcd	42.33 de	5.60 cde	5.80 de
40 % NPK + 12 L BPS	59.17 bc	58.00 bc	43.60 bcd	44.00 cd	5.73 cd	6.03 d
20 % NPK + 16 L LC	56.16 cde	53.60 c	40.73 de	40.33 de	5.13 def	5.36 f
20 % NPK +16 L BPS	52.56 cde	53.87 c	38.70 cde	41.00 de	5.43 de	5.60 ef
10 L LC + 10 L BPS	51.00 de	52.93 c	37.37 de	38.66 ef	4.86 ef	4.90 e

Fruit physical and chemical properties:

Data in Table 8, shows improvement in fruit physical characters as a result of using LC and BPS either alone or combined with reduced amount of inorganic fertilizer. The highest significant values of fruit weight, diameter and length and so flesh weight was recorded at 60% NPK+8 L BPS.

Table 8. Effect of different combinations of mineral NPK, liquid compost (LC) and banana pseudostem sap (BPS) on fruit physical characteristics of 'Sewy' date palm.

Treatments	Fruit weight (g)		Fruit diameter (cm)		Fruit length(cm)		Flesh weight (%)	
	2019	2020	2019	2020	2019	2020	2019	2020
Control (100% chemical NPK)	8.33 g	8.17 f	2.33 f	2.37 d	3.38 f	3.42 e	82.00 d	82.26 d
80 % NPK + 4 L LC	10.74 abc	10.81 ab	2.95 bc	2.83 abc	3.97 c	4.14 abc	84.93 ab	85.30 abc
80 % NPK + 4 L BPS	10.80 abc	10.95 ab	3.04 abc	3.02 abc	4.02 bc	4.18 abc	84.90 ab	86.16 ab
60 % NPK + 8 L LC	10.93 ab	11.05 ab	3.07 ab	3.35 ab	4.14 ab	4.31 ab	85.43 ab	85.73 ab
60 % NPK + 8 L BPS	11.18 a	11.31 a	3.22 a	3.25 a	4.18 a	4.35 a	85.73 a	86.50 a
40 % NPK + 12 L LC	10.47 cd	10.60 bc	2.90 bcd	2.92 abcd	3.93 c	4.10 bc	84.73 ab	84.43 bc
40 % NPK + 12 L BPS	10.70 bc	10.76 bc	2.93 bc	2.95 abc	3.93 c	4.10 bc	85.00 ab	84.86 abc
20 % NPK + 16 L LC	9.73 e	9.70 d	2.75 d	2.77 bcd	3.74 d	3.85 d	84.33 bc	84.30 cd
20 % NPK +16 L BPS	10.17 de	10.30 c	2.87 cd	2.94 abcd	3.90 c	4.07 cd	84.30 bc	83.63 bc
10 L LC + 10 L BPS	9.17 f	9.15 e	2.55 e	2.57 cd	3.53 e	3.55 e	83.56 c	83.60 cd

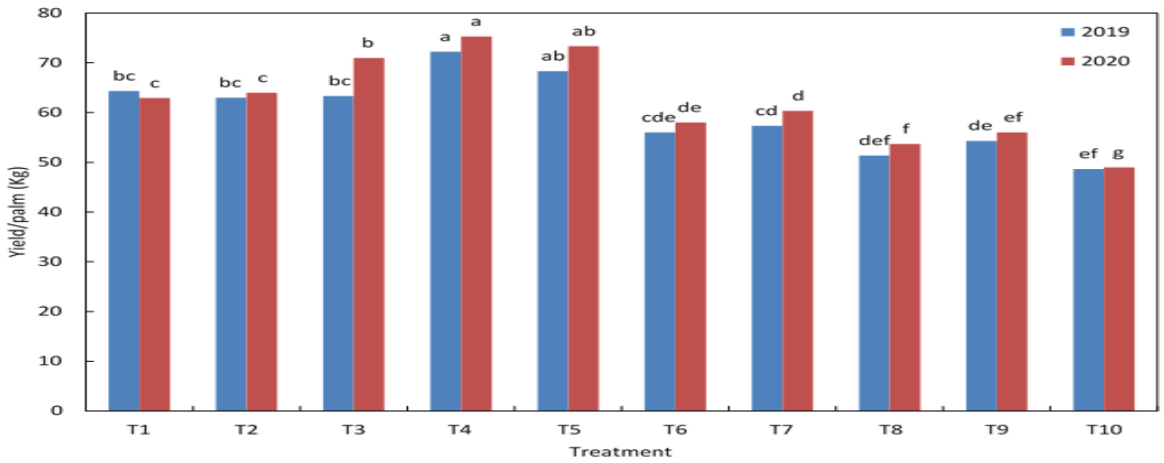

Fig. 1. Effect of different combinations of mineral NPK, liquid compost (LC) and banana pseudostem sap (BPS) on yield/palm of 'Sewy' date palm. T1- Control: 100% chemical NPK (2.985 kg ammonium nitrate -0.5 kg mono calcium superphosphate – 1 kg potassium sulphate /palm/year), T2- 80 % chemical NPK + 4 L LC/palm/year, T3- 80 % chemical NPK + 4 L BPS/palm/year, T4- 60 % chemical NPK + 8 L LC/palm/year, T5- 60 % chemical NPK + 8 L BPS/palm/year, T6- 40 % chemical NPK + 12 L LC/palm/year, T7- 40 % chemical NPK + 12 L BPS/palm/year, T8- 20 % chemical NPK + 16 L LC/palm/year, T9- 20 % chemical NPK + 16 L BPS/palm/year, T10- 10 L LC + 10 L BPS/palm/year

Fruit TSS, total sugars and reducing sugars generally increased, while total acidity decreased as a result of LC and BPS at all rates of application compared to the control (Table 9). The most effective treatment was 60% NPK+8 L BPS.

Table 9. Effect of different combinations of mineral NPK, liquid compost (LC) and banana pseudostem sap (BPS) on TSS, acidity, total and reducing sugars of 'Sewy' date palm.

Treatments	T.S.S (%)		Total acidity (%)		Total sugars (%)		Reducing sugars (%)	
	2019	2020	2019	2020	2019	2020	2019	2020
Control (100% chemical NPK)	46.77 h	47.00 i	0.26 a	0.28 a	35.00 h	36.00 h	27.33 g	25.66 e
80 % NPK + 4 L LC	61.60 bc	62.33 cd	0.18 de	0.21 cd	49.03 c	48.86 c	35.33 bcd	35.86 abc
80 % NPK + 4 L BPS	63.16 ab	64.36 bc	0.18 e	0.20 cd	50.33 c	50.80 b	36.66 abc	36.86 ab
60 % NPK + 8 L LC	64.33 ab	66.53 ab	0.18 e	0.19 d	53.03 b	52.90 a	37.73 ab	38.00 ab
60 % NPK + 8 L BPS	65.86 a	67.76 a	0.17 e	0.18 d	55.33 a	53.33 a	39.33 a	40.00 a
40 % NPK + 12 L LC	56.66 de	58.53 ef	0.19 de	0.20 cd	43.93 de	44.66 e	32.33 def	33.86 bcd
40 % NPK + 12 L BPS	59.43 cd	60.60 de	0.19 de	0.21 cd	45.93 d	46.66 d	33.93 cde	34.80 bc
20 % NPK + 16 L LC	52.30 fg	55.03 gh	0.22 bc	0.23 b	41.00 f	41.80 f	30.00fg	31.66 cd
20 % NPK +16 L BPS	54.33 ef	56.60 fg	0.21 cd	0.22 bc	42.60 ef	43.00 f	31.46 ef	32.53 cd
10 L LC + 10 L BPS	49.83 gh	52.43 h	0.23 b	0.24 b	38.10 g	39.00 g	29.00 fg	30.26 d

Means followed by the same letter are not significantly different at 5% level by DMRT.

Concerning total crude fiber, nitrite and nitrate content in fruits, significant reduction was noticed in such parameters due to LC and BPS application, where the control recorded the highest content (Table 10). Nitrate and nitrite content in fruits significantly decreased by increasing the dependency on the two organic fertilizers (LC and BPS) especially from the rate of 8 L recording the lowest values when using it alone (10 L of each LC and BPS) followed by 20% inorganic NPK+ either 16 L of LC or BPS.

Table 10. Effect of different combinations of mineral NPK, liquid compost (LC) and banana pseudostem sap (BPS) on fruit crude fibers, nitrite and nitrate contents of 'Sewy' date palm.

Treatments	Total crude fiber (%)		Nitrite in the fruits (mg/ 100 g)		Nitrate in the fruits (mg/ 100 g)	
	2019	2020	2019	2020	2019	2020
Control (100% chemical NPK)	1.90 a	1.85 a	6.30 a	6.11 a	12.21 a	11.73 a
80 % NPK + 4 L LC	1.74 b	1.71 b	5.93 ab	5.66 ab	10.50 b	9.1 7 b
80 % NPK + 4 L BPS	1.95 bc	1.60 c	5.66 ab	5.14 bc	9.70 bc	7.80 c
60 % NPK + 8 L LC	1.58 cd	1.55 cd	5.20 b	4.3 7 c	8.80 c	6.80 cd
60 % NPK + 8 L BPS	1.42 fg	1.40 ef	5.10 b	3.20 d	7.20 d	6.13 de
40 % NPK + 12 L LC	1.54 de	1.52 cd	3.96 c	2.90 de	6.067 e	5.10 ef
40 % NPK + 12 L BPS	1.47 ef	1.48 de	3.20 cd	2.60 def	4.00 f	4.6 7 f
20 % NPK + 16 L LC	1.37 g	1.37 f	2.50 de	2.33 ef	3.23 fg	2.93 g
20 % NPK +16 L BPS	1.35 g	1.33 f	2.06 e	2.11 ef	3.20 fg	2.20 g
10 L LC + 10 L BPS	1.25 h	1.20 g	1.86 e	1.78 f	2.97 g	1.70 g

Means followed by the same letter are not significantly different at 5% level by DMRT.

Discussion

The misuse/excessive use of chemical fertilizers and its effects on environment and health is well known. Therefore, looking for alternatives or partial replacement is crucial for attaining sustainability in agriculture.

Using the two-liquid organic fertilizers (BPS & LC) at 8 l/palm along with 60% of recommended chemical fertilizers showed the highest significant effects on vegetative growth parameters (Table 4, 5) and leaf nutritional status (Table 6). Higher leaf phosphorus and potassium content under these treatments led to higher fruit retention, bunch weight and consequently enhanced yield (Table 7).

The correlation between Potassium and fruit quality is profound, affecting fruit size, color, TSS, acidity and vitamin content. This is due to its vital function in photosynthesis, translocation of proteins and sugars, water balance and others (Ramesh Kumar et al., 2006; Woldemariam et al., 2018). This was found in this study, where treatments that showed the highest potassium content recorded the highest TSS and total sugars and lowest acidity (Table 9).

Increased usage of nitrogen fertilizers and its effect on nitrate and nitrite content of agricultural products has a great concern and becoming an important issue due to its effect on health (Fewtrell, 2004; Chan, 2011). The main concern regarding nitrate is its potential of causing some acute and chronic toxicities such as methemoglobinemia, thyroid disorders and carcinogenesis (Fewtrell, 2004; Gilchrist et al., 2010; Bahadoran et al., 2015). The results of this study revealed that combined application of BPS and LC with chemical fertilizers reduced the nitrite and nitrate content in the fruits, compared to the control which recorded the highest significant content (Table 10).

Combined application of both chemical and organic sources and its positive effects on growth parameters and fruit quality was proved in previous studies (Al-Wasfy and El- Khawaga, 2008; Fernando and Brintha, 2020; Zhang et al., 2021). This may be attributed to its effect in improving soil properties, accelerating soil microbial growth and enhanced enzyme activities (Kamaa et al., 2011; Chaudhry et al., 2012; KhHM and Fandi, 2013; Lazcano et al., 2013; Zhang et al., 2015; Pan et al., 2020; Han et al., 2021;). Meanwhile, the poor performance of chemical fertilizers when applied alone (control) in this study may be attributed to soil properties, which have a high pH value and low cation exchange capacity, high leaching of these nutrients via drainage water due to the greatest solubility in water of such mineral fertilizer (Nijjar, 1985) and poor fertile, which reduces chemical fertilization efficiency.

Conclusions

The results of this study demonstrated that BPS and LC can be considered as potential organic fertilizers for 'Sewy' date palm and were able to save 40% of chemical fertilizers. The recommended treatments are 60% of chemical fertilizers+ 8 L/palm BPS or LC, respectively. However, further studies for optimum

combination of both organic sources without chemical fertilizers are needed.

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الإحلال الجزئي للأسمدة الكيماوية بالكمبوست السائل وعصارة الساق الكاذبة للموز في نخيل البلح السيوي

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أجرى هذا البحث لدراسة تأثير استخدام كل من الكمبوست السائل وعصارة الساق الكاذبه للموز كبدائل للسماد الكيماوى على كل من النمو والمحصول وخصائص الثمار الكيماويه والطبيعيه للبلح السيوى. استخدم كلا المصدرين من السماد العضوى بخمس معدلات (٤، ٨، ١٠، ١٢، ١٦ لتر/النخله) بتوليفات مع السماد الكيماوى والذى استخدم بنسب مختلفه من الموصى به (٢٠، ٦٠، ٨٠٪ بالاضافه للكنترول ١٠٠٪). اظهرت النتائج ان استخدام ٦٠٪ من السماد الكيماوى بالإضافه لـ ٨ لتر/نخله من اى من المصدرين العضويين أدى الى تحسين النمو الخضرى ومحتوى الأوراق من العناصر الغذائيه والعقد والمحصول وكذلك صفات جودة الثمار الطبيعيه والكيماويه.

اظهرت المعامله ٨ لتر/نخله من عصارة الساق الكاذبه للموز مع ٦٠٪ من السماد الكيماوى أعلى تأثير معنوى فى معظم الصفات المدروسة، وبالتالى فإنه يمكن توفير ٤٠٪ من السماد الكيماوى مع محصول أعلى وصفات جوده افضل والذى يعد من الممارسات الزراعية المستدامة.