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The Combined Effect of Composted Filter Mud, Inorganic Fertilizer and Seaweed Extract on Growth, yield and fruits quality of Williams Banana

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Abstract: Although the application of inorganic fertilizers to plants boosts their growth and yield, their persistent apply impacts soil heath and engenders environmental pollution. On the other side, plant organic fertilization and bio stimulants upgrade nutrients absorption, growth, yield and fruit quality as well as are environment-friendly. Thus, the current experiment was devised during 2022/2023 and 2023/2024 to explore the influence of composted filter mud (CFM), recommended fertilizer doses (RFD) and seaweed extract (SW) on the performance of the banana CV. Williams, planted in a clay loam soil at Dandara, Qena governorate, Egypt. Banana plants were planted at a distance of 3.5x3.5 m and three suckers were selected for each hole in a completely randomized block design consisting of three replicates. The quantities of RDF or half RDF were added twice monthly from April to October for both seasons. The CFM is added once around plants at a depth of 15 cm and covered with soil in mid-December for both seasons. Seaweed extract (SW) is added as soil drench three times per season from March to May. Seven treatments were applied i.e. 1) Control (RFD), 2) 10 ton/fed CFM+1/2 RFD, 3) 5 ton/fed CFM + 1/2 RFD, 4) 10 ton/fed CFM+1/2 RFD+ 0.1% SW, 5) 10 ton/fed CFM+1/2 RFD+ 0.2% SW, 6) 5 ton/fed CFM+1/2 RFD+ 0.1% SW and 7) 5 ton/fed CFM+1/2 RFD+ 0.2% SW. Results elucidated that applying 10 ton/fed CFM+1/2 RFD+0.2% SW, followed by 10 ton/fed CFM+1/2 RFD+0.1% SW positively improved the growth parameters, fruit yield and fruit quality.

Key words: Banana plants; Composted filter mud; Inorganic fertilizer; Seaweed extracts.

1. Introduction

Banana (*Musa* spp.) belongs to the Musaceae family, is one of the oldest fruits known to humanity. It is also called the apple of paradise and one of the most important fountains of the tropical fruits in the world as it is a staple food and an important export commodity **(Rahman *et al*., 2013)**. Banana holds a high rank in fruits and food crops for tropical and subtropical regions and a good source

of income for farmers. Its taste and high nutritional value keep it in high demand throughout the year by consumers **(Tanuja *et al*., 2021).** However, the fruit quality is impact by the genotypes as well as the nutritional state of the soil. Thus optimum fertilization is required for the growth, yield and quality of banana. Continuous and random use of inorganic fertilizer is debasing the agricultural lands which in return will decrease yield and quality of the fruits. This in future might give rise to menace of the global food security. Organic fertilization can be replacing for supplying nutrients to banana production. **Ramesh *et al*. (2010)** declared that organic fertilization ameliorates soil physical, chemical and biological characteristics, thus boosting the soil health and sustainability of the crop production. **Rahman *et al*. (2021)** denounced that organic fertilization boosts the fruit quality in banana as compared to inorganic treatment.

Filter mud (FM) also known as press mud or filter cake is an organic effluent from sugarcane factories, which represents some organic source rich in nutrients. It is a waste byproduct from sugarcane factories, is a smooth, spongy, erratic and dark brown to brown raw material which holds fiber, sugar, curd colloids, including albuminoids, cane wax, inorganic salts and uncleanness particles. It is one of the important organic wastes capable of providing sufficient amount of plant nutrients to the soil, due to its adequate effect on the soil texture, structure, organic matter content, the water holding capacity and soil aeration **(Ghulam *et al*., 2010).** It also includes auxins, plant growth regulators, vitamins, enzymes and hormones, which enhance soil fertility and productivity of agricultural soil **(Solaimalai *et al*., 2001). El-Tayeh *et al*. (2019)** notified that application of filter mud as an organic fertilizer improved the physico-chemical characteristics of the sandy soil to be more suitable for cultivation. There is big amount of filter mud that can be utilized by the sugarcane factory to support increased plant production by using it as compost that can be applied to the field **(Rahmad *et al*., 2019).**

Seaweeds or marine macro algae include three main groups i.e. green algae, brown algae and red algae based on their pigment contents. Seaweeds have long been used to improve the growth and productivity of agricultural crops **(Karthikeyan and Shanmugam, 2014).** Recently, high quality powder and liquid seaweed extract products are available in different forms, either as pure or mixed with other active ingredients as fertilizers and pesticides as well as non-traditional products as humates and fish extracts. In addition, a considerable evidence has been focused on the beneficial application of seaweed extract in the crop productions **(Khan *et al*., 2009).** Applying seaweed biostimulant on four banana varieties resulted in increasing the growth traits as tree height, tree girth, number of leaves, leaves length, and leaves breadth. Also, it resulted in improving yield characteristics as bunch weigh, number of hands/ bunch, hand weight, fruit weight **(Karthikeyan and Shanmugam, 2014).** Thus the aim of this study was to realize the effectiveness of composted filter mud, inorganic fertilizer and seaweed extract on the growth, yield and fruit quality of Williams banana cultivar.

2. Material and Methods

Two field experiments entitled, synergistic effect of composted filter mud (CFM) and inorganic fertilizer and seaweed extract application on the growth and yield of Williams banana cultivar during 2022/2023 and 2023/2024 were conducted in a private farm located at Dandara, Qena Governorate, Egypt. Williams banana plants were grown in a clay loam soil irrigated with surface irrigation system. Analysis of soil under study was conducted based on **Wilde *et al*. (1985)** as shown in Table 1. Banana plants were planted at a distance of 3.5x3.5 m and three suckers were selected for each hole. The experiments were followed a completely randomized block design consisting of three replicates one hole each. The experimental banana plants received all the agricultural practices usually used in banana orchard, except for treatments under study.

2.1. Preparation of composted filter mud (CFM)

The two organic materials (e.g., of sugarcane filter mud and cow manure) were composted according to the local practices. In this composting method, placing the filter mud mixed with cow manure in piles about 1.5 m high and 1.8 m wide, which were regularly turned. The moisture level of materials was checked regularly (10 days), while the materials were sprinkled weekly with water. After about two months, the compost was ready for applying in the field **(Salman *et al*., 2023).**

Physiochemical characteristics and nutrient compositions of compost were: color of brown to black, pH = 7.2, EC = 0.6 dS/m^{-1}, total N = 15.2 g/kg, total P = 5.7 g/kg, and total K = 9.6 g/kg.

2.2. The treatments and application:

T1. Control (RFD)

T2. 10 ton/fed CFM+1/2 RFD

T3. 5 ton/fed CFM + 1/2 RFD

T4. 10 ton/fed CFM+1/2 RFD+ 0.1% SW

T5. 10 ton/fed composted FM+1/2 RFD+ 0.2% SW

T6. 5 ton/fed CFM+1/2 RFD+ 0.1% SW

T7. 5 ton/fed CFM+1/2 RFD+ 0.2% SW

The control plants were received only chemical fertilizers NPK at the recommended fertilization doses (RFD) of 800 kg N as ammonium nitrate 33.5 N%: 1000 kg P_2O_5 as phosphoric acid 80%: 800 kg/fed K_2O as potassium sulphate 48%. While half of these quantities were added to the plants in the other treatments. The quantities of inorganic fertilizer were divided into 14 equal doses and added twice monthly from April to October for the two studied seasons. The composted filter mud (CFM) is added once in mid-December for both seasons. It is added around plants at a depth of 15 cm and covered with soil. Seaweed extract (SW) is added as soil drench three times per season, with one-month interval starting from March to May. Power max as source of seaweed extract was purchased from the Egyptian Fertilizers Company, Cairo, Egypt; its nutritional components are listed in Table 2.

Table (1). Soil analysis of the studied Banana cv. Williams orchard

Character	Value	Character	Value
Particle size distribution			
Sand %	21.3	OM %	1.50
Silt %	25.3	$CaCO_3$ %	3.00
Clay %	53.4	Total N %	0.11
Texture	Clay loam	Available P (mg kg^{-1})	6.5
pH (1:2.5 extract)	7.55	Available K (mg kg^{-1})	250
EC (1:2.5 extract) dSm^{-1}	0.50	Available S (mg kg^{-1})	3.00
Available EDTA extractable micronutrients (mg kg^{-1})			
Zn	13.00	Mn	11.09
Fe	10.25	Cu	1.11

Table (2). Seaweed extract characters used in this experiment

Density (g/cm^3)	Algenic acid (%)	OM g/l	pH	Macronutrients content (g/l)		
0.63	11.5	440	5.5	N	P	K
				20	9	115
Cytokines, auxins and gibberellins (g/l)	Free amino acids (mg/kg)	Manitol (%)	Water solubility (%)	Appearance		
590	20.6	5.5	100	Black powder		

2.3. Recorded data

Data were estimated on the selected plants during both seasons

Vegetative characteristics

After the emergence of the inflorescence at the 3rd week of July for both the 4th and 5th ratoon, the following characteristics were recorded, vegetative characteristics included pseudo stem height (cm), pseudo stem girth (cm), total leaf area were estimated according to **Murry (1960)** as follows:

Leaf area (m^2) = length x width x 0.8, then the assimilation area/plant (m^2) was measured as follows: Leaves number x leaf area.

Yield and fruit quality

Bunches of banana cv. Williams were picked during November to January period in the two seasons, which bunches (fruits) were suitable for harvesting as fingers in full mature stage and fruits were artificially ripening, then the fruits quality were estimated. Weight of bunches and two hands/bunch were taken from the base, middle and distal end of each bunch for each replicate. Number of fingers/hand, weight of finger (g), pulp and peel percentages were recorded. Percentage of total soluble solids, total acidity (malic acid/100 g pulp), reducing, non-reducing and total sugars were determined based on **AOAC (1990).**

2.4. Statistical analysis

The obtained data were statistically analysis according to **Gomez and Gomez (1984)** and **Mead *et al*. (1993).** Duncan's test at the 5% level was used to compare the differences between means **(Duncan, 1955).**

3. RESULTS

3.1. Effect on the growth traits

3.1.1. Pseudo stem height (cm)

The results offered in Table 3 articulate that mixed treatments were significantly responsible for encouraging the growth traits namely height and girth of pseudo stem as well as total leaves area per plant of Williams banana in contrasted to the control during both seasons. Pseudo stem height recorded in banana cv. Williams during the two studied seasons was maximum (238.0 and 242.7 cm) in the treatment of T5: 10 ton/fed composted filter mud + 1/2 RFD + 0.2% seaweed, followed by T4: 10 ton/fed composted filter mud +1/2 RFD + 0.1% seaweed extract (238.0 and 242.7 cm) and T7: 5 ton/fed composted filter mud +1/2 RFD+0.2% seaweed extract (232.7 and 234.3 cm) in the 1st and 2nd seasons, respectively, pseudo stem height was minimum in the control (218.0 and 222.0 cm) in both seasons.

3.1.2. Pseudo stem girth (cm)

Pseudo stem girth listed in Williams banana cv. during the two studied seasons was maximum (86.0 and 87.7 cm) in the treatment of T5: 10 ton/fed composted filter mud + 1/2 RFD + 0.2% seaweed, followed by T4: 10 ton/fed composted filter mud +1/2 RFD + 0.1% seaweed extract (84.0 and 83.0 cm) and T7: 5 ton/fed composted filter mud +1/2 RFD+0.2% seaweed extract (81.0 and 79.3 cm) in the 1st and 2nd seasons, respectively

3.1.3. Total leaves area/ plant (m^2)

Total leaves area/ plant (m^2) registered in Williams banana cv. during the two studied seasons was maximum (37.0 and 39.0 m^2) in the treatment of T5: 10 ton/fed composted filter mud + 1/2 RFD + 0.2% seaweed, followed by T4: 10 ton/fed composted filter mud +1/2 RFD + 0.1% seaweed extract (34.0 and 36.0 m^2) and T7: 5 ton/fed composted filter mud +1/2 RFD+0.2% seaweed extract (34.0 and 35.0 m^2) in the 1st and 2nd seasons, respectively. Meanwhile, total leaves area/ plant was minimum in the control (24.3 and 25.0 m^2) in both seasons.

Table (3). Effect of composted filter mud), inorganic fertilizers and seaweed extracts on pseudo stem height (cm), pseudo stem girth (cm) and total leaf area/ plant (m^2) of banana

Treatment	Pseudo stem height (cm)		Pseudo stem girth (cm)		Total leaf area (m^2/ plant)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control (RFD)	218.0	222.0	66.0	66.3	24.3	25.0
10 ton/fed CFM+1/2 RFD	226.0	227.7	71.7	70.7	28.0	31.0
5 ton/fed CFM + 1/2 RFD	223.0	225.0	68.3	67.7	26.0	29.0
10 ton/fed CFM+1/2 RFD+0.1% SW	238.0	242.7	84.0	83.0	34.0	36.0
10 ton/fed CFM+1/2 RFD+0.2% SW	247.3	249.7	86.0	87.7	37.0	39.0
5 ton/fed CFM+1/2 RFD+0.1% SW	228.0	232.7	76.0	74.3	31.0	33.0
5 ton/fed CFM+1/2 RFD+0.2% SW	232.7	234.3	81.0	79.3	34.0	35.0
LSD 5%	2.7	2.6	1.7	2.4	1.9	1.3

3.2. Effect on the yield traits

3.2.1. Bunch weight (kg)

The results offered in Table 4 display that mixed treatments were significantly responsible for encouraging the yield measurements namely bunch weigh, hand weight, number of fingers/hand and finger weight of Williams banana in contrasted to the control during both seasons. Bunch weight recorded in banana CV. Williams was maximum (32.0 and 33.0 kg) in the treatment of T5: 10 ton/fed composted filter mud + 1/2 RFD + 0.2% seaweed, followed by T4: 10 ton/fed composted filter mud +1/2 RFD + 0.1% seaweed extract (31.0 and 31.7 kg) and T7: 5 ton/fed composted filter mud +1/2 RFD+0.2% seaweed extract (29.0 and 27.3 kg) Whereas, values bunch weight was minimum in the control (19.0 and 17.0 kg) in both seasons.

3.2.2. Hand weight (kg)

Hand weight recorded in Williams banana CV. was maximum (2.47 and 2.45 kg) in the treatment of T5: 10 ton/fed composted filter mud + 1/2 RFD + 0.2% seaweed, followed by T4: 10 ton/fed composted filter mud +1/2 RFD + 0.1% seaweed extract (2.33 and 2.28 kg) and T7: 5 ton/fed composted filter mud +1/2 RFD+0.2% seaweed extract (2.26 and 2.19 kg) in the 1st and 2nd seasons, respectively. Meanwhile, hand weight was minimum in the control (1.44 and 1.40 kg) and in T3: 5 ton/fed composted filter mud + 1/2 RFD in both seasons.

3.2.3. Number of fingers/hand

Number of fingers/hand registered in Williams banana CV. was maximum (23.1 and 2.9) in the treatment of T5: 10 ton/fed composted filter mud + 1/2 RFD + 0.2% seaweed, followed by T4: 10 ton/fed composted filter mud +1/2 RFD + 0.1% seaweed extract (22.2 and 21.8) and T7: 5 ton/fed composted filter mud +1/2 RFD+0.2% seaweed extract (21.6 and 21.3) Meanwhile, number of fingers/hand was minimum in the control (15.7 and 15.2) in both seasons.

3.2.4. Finger weight (g)

Finger weight registered in Williams banana CV. was maximum (106.87 and 106.73 g) in the treatment of T5: 10 ton/fed composted filter mud + 1/2 RFD + 0.2% seaweed, followed by T4: 10 ton/fed composted filter mud +1/2 RFD + 0.1% seaweed extract (104.87 and 104.60 g) and T7: 5 ton/fed composted filter mud +1/2 RFD+0.2% seaweed extract (104.27 and 103.10 g) Meanwhile, finger weight was minimum in the control (92.07 and 92.10 g) in both seasons.

Table (4). Effect of composted filter mud, inorganic fertilizers and seaweed extracts on bunch weight (kg), hand weight (kg) and of banana

Treatment	Bunch weight (kg)		Hand weight (kg)		Number of fingers/hand		Finger weight (g)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control (RFD)	19.0	17.0	1.44	1.40	15.7	15.2	92.07	92.10
10 ton/fed CFM+1/2 RFD	25.0	24.0	1.76	1.69	18.1	17.5	97.53	96.63
5 ton/fed CFM + 1/2 RFD	23.0	22.0	1.69	1.67	17.8	17.6	95.13	95.07
10 ton/fed CFM+1/2 RFD+0.1% SW	31.0	31.7	2.33	2.28	22.2	21.8	104.87	104.60
10 ton/fed CFM+1/2 RFD+0.2% SW	32.0	33.0	2.47	2.45	23.1	22.9	106.87	106.73
5 ton/fed CFM+1/2 RFD+0.1% SW	27.0	25.0	2.11	2.08	20.6	20.5	102.43	101.70
5 ton/fed CFM+1/2 RFD+0.2% SW	29.0	27.3	2.26	2.19	21.6	21.3	104.27	103.10
LSD 5%	1.58	2.29	0.07	0.07	0.54	0.68	1.18	1.18

3.3. Effect on the fruit quality

3.3.1. Pulp weight (%)

The results offered in Tables 5&6 and Figs. 1&2 display that mixed treatments were significantly responsible for improving the fruit quality measurements namely pulp weigh, peel weight, total sugar, reducing and non-reducing sugars, total soluble sugar and total acidity percentages of Williams banana in contrasted to the control during both seasons. Pulp weight registered in banana CV. Williams was maximum (84.62 and 84.63 %) in the treatment of T5: 10 ton/fed composted filter mud + 1/2 RFD + 0.2% seaweed, followed by T4: 10 ton/fed composted filter mud +1/2 RFD + 0.1% seaweed extract (82.65 and 83.39 %) and T7: 5 ton/fed composted filter mud +1/2 RFD+0.2% seaweed extract (81.15 and 81.82 %) Meanwhile, pulp weight % was minimum in the control (73.65 and 73.49 %) in both seasons.

3.3.2. Peel weight (%)

Peel weight registered in Williams banana CV. was minimum (15.38 and 15.37 %) in the treatment of T5: 10 ton/fed composted filter mud + 1/2 RFD + 0.2% seaweed, followed by T4: 10 ton/fed composted filter mud +1/2 RFD + 0.1% seaweed extract (17.35 and 16.61 %) and T7: 5 ton/fed composted filter mud +1/2 RFD+0.2% seaweed extract (18.85 and 18.18 %) Meanwhile, peel weight % was maximum in the control (26.35 and 26.51 %) in both seasons.

3.3.3. Total sugars (%)

Total sugars percentage registered in Williams banana cv. was maximum (17.98 and 17.08 %) in the treatment of T5: 10 ton/fed composted filter mud + 1/2 RFD + 0.2% seaweed, followed by T4: 10 ton/fed composted filter mud +1/2 RFD + 0.1% seaweed extract (16.90 and 16.69 %) and T7: 5 ton/fed composted filter mud +1/2 RFD+0.2% seaweed extract (15.92 and 15.50 %) Meanwhile, total sugars % was minimum in the control (14.39 and 14.35 %) in both seasons.

3.3.4. Reducing sugar (%)

Reducing sugar percentage registered in Williams banana CV. was maximum (8.19 and 7.22 %) in the treatment of T5: 10 ton/fed composted filter mud + 1/2 RFD + 0.2% seaweed, followed by T4: 10 ton/fed composted filter mud +1/2 RFD + 0.1% seaweed extract (7.61 and 7.31 %) and T2: 10 ton/fed composted FM+1/2 RFD (7.17 and 7.23 %) in the 1st and 2nd seasons, respectively. Meanwhile, reducing sugars % was minimum in the control (6.65 and 6.83 %) in both seasons.

3.3.5. Non-reducing sugar (%)

Non-reducing sugar percentage registered in Williams banana CV. was maximum (9.79 and 9.87 %) in the treatment of T5: 10 ton/fed composted filter mud + 1/2 RFD + 0.2% seaweed, followed by T4: 10 ton/fed composted filter mud +1/2 RFD + 0.1% seaweed extract (9.29 and 9.39 %) and T7: 5 ton/fed composted filter mud +1/2 RFD+0.2% seaweed extract (8.64 and 8.52 %) Meanwhile, non-reducing sugars % was minimum in the control (7.74 and 7.52 %) in both seasons.

3.3.6. Total soluble sugar (%)

Total soluble sugars % registered in Williams banana CV. was maximum (21.34 and 21.40 %) in the treatment of T5: 10 ton/fed composted filter mud + 1/2 RFD + 0.2% seaweed, followed by T4: 10 ton/fed composted filter mud +1/2 RFD + 0.1% seaweed extract (21.11 and 21.13 %) and T7: 5 ton/fed composted filter mud +1/2 RFD+0.2% seaweed extract (21.08 and 21.09 %) Meanwhile, total soluble sugars % was minimum in the control (19.19 and 19.14 %) in both seasons.

3.3.7. Total acidity (%)

Total acidity % registered in Williams banana CV. was minimum (0.284 and 0.282 %) in the treatment of T5: 10 ton/fed composted filter mud + 1/2 RFD + 0.2% seaweed, followed by T4: 10 ton/fed composted filter mud +1/2 RFD + 0.1% seaweed extract (0.285 and 0.288 %) and T7: 5 ton/fed composted filter mud +1/2 RFD+0.2% seaweed extract (0.292 and 0.290 %) Meanwhile, total acidity % was maximum in the control (0.346 and 0.347 %) in both seasons.

Table (5). Effect of composted filter mud, inorganic fertilizers and seaweed extracts ~~(SW)~~ on pulp weight (%) and peel weight (%) of banana

Treatment	Pulp weight (%)		Peel weight (%)	
	1st season	2nd season	1st season	2nd season
Control (RFD)	73.65	73.49	26.35	26.51
10 ton/fed CFM+1/2 RFD	79.02	79.12	20.98	20.88
5 ton/fed CFM + 1/2 RFD	77.18	77.96	22.82	22.04
10 ton/fed CFM+1/2 RFD+0.1% SW	82.65	83.39	17.35	16.61
10 ton/fed CFM+1/2 RFD+0.2% SW	84.62	84.63	15.38	15.37
5 ton/fed CFM+1/2 RFD+0.1% SW	78.86	78.72	21.14	21.28
5 ton/fed CFM+1/2 RFD+0.2% SW	81.15	81.82	18.85	18.18
LSD 5%	0.65	1.13	0.65	1.13

Table (6). Effect of composted filter mud, inorganic fertilizers and seaweed extracts on total sugars (%), non-reducing sugar (%), and reducing sugar (%) of banana

Treatment	Total sugars (%)		Reducing sugar (%)		Non-reducing sugar (%)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control (RFD)	14.39	14.35	6.65	6.83	7.74	7.52
10 ton/fed CFM+1/2 RFD	15.36	15.46	7.17	7.23	8.19	8.23
5 ton/fed CFM + 1/2 RFD	14.85	14.56	6.70	6.28	8.15	8.28
10 ton/fed CFM+1/2 RFD+0.1% SW	16.90	16.69	7.61	7.31	9.29	9.39
10 ton/fed CFM+1/2 RFD+0.2% SW	17.98	17.08	8.19	7.22	9.79	9.87
5 ton/fed CFM+1/2 RFD+0.1% SW	15.50	15.32	7.01	6.81	8.49	8.50
5 ton/fed CFM+1/2 RFD+0.2% SW	15.92	15.50	7.28	6.98	8.64	8.52
LSD 5%	0.64	0.52	0.65	0.48	0.11	0.11

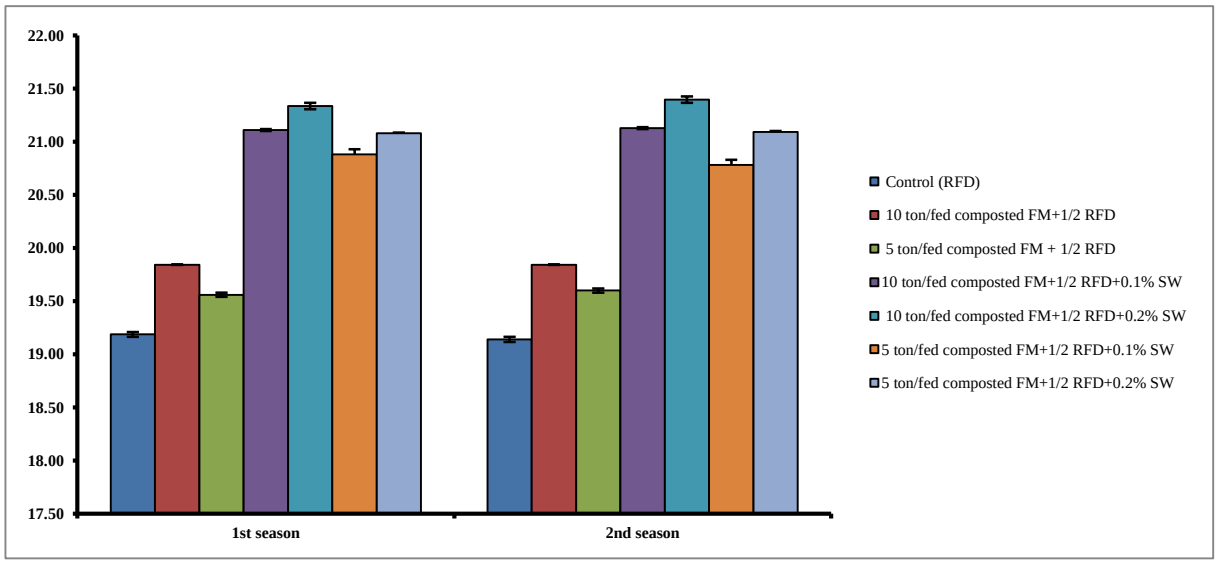

Fig. (1). Effect of organic and inorganic fertilizer and seaweed extracts on Total soluble sugar % of banana

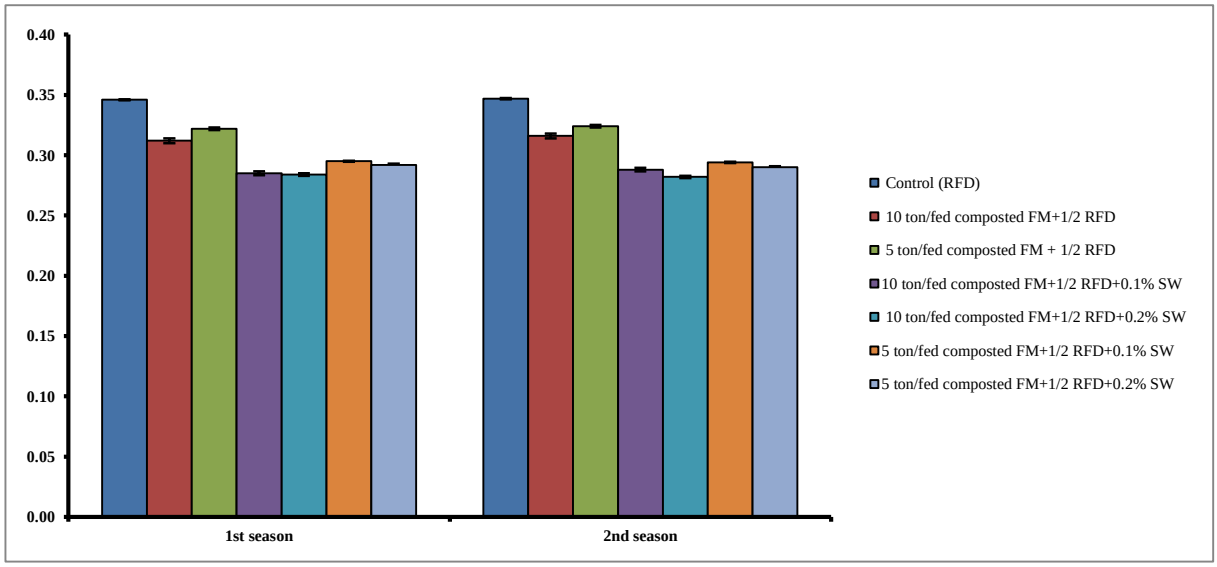

Fig. (2). Effect of organic and inorganic fertilizer and seaweed extracts on Total acidity % of banana

4. Discussion

The obtained results showed that adding composted filter mud as organic fertilization, especially at a level 10 ton/fed resulted in the best growth measurements. These results may be due to the positive action of organic fertilization in improving activity of micro-flora, soil structure aggregation, water holding capacity, soil organic matter, soil humus content and the availability of important nutrients. Such energizing on the uptake of nutrients leads to progress the biosynthesis of cell division and organic foods **(Miller *et al.*, 1990). Zhang *et al.* (2020)** articulated that the application of organic fertilizer is recommended to improve soil health and elevate the yield and quality of banana in density managed plantations in the subtropical regions. The beneficial effect of organic fertilizers is associated with elevated soil structure **(Bronick and Lal, 2005)**, higher soil enzyme activity **(Mangalassery *et al.*, 2019)**, better root growth [58], and augmented soil microbial profusion or beneficial microbes

(Hartmann *et al*., 2014; Bonanomi *et al*., 2018). Under organic fertilizer, banana roots were increased and extended deeper down the soil profile than in the other treatments with following increases in nutrient uptake as inverted by the higher nutrient content in shoots throughout the growth periods. On the other hand, NPK fertilization in the root zone encouraged NPK absorption and thus its accumulation in leaves and improving growth characteristics. These results are in parallel with findings of **Abd El-Naby (2000); Abd El-Aziz (2002); Rabie and Saad (2007) and Zeid *et al*. (2009)** on banana plants.

Adding seaweed extract improved growth characteristics of banana plants. The stimulating effects of seaweed extract on the growth traits might be attributed to its important action in promoting cell division as it contains large amounts of nutrients such as N, P, K, Mg, Ca, S, Cu, Fe, Mn, B and Mo, natural hormons like IAA and GA_3, cytokinins, vitamins, amino acids, and antioxidants **(James, 1994; Soliman *et al*., 2000; Roshdy, 2014).** These constituents play crucial roles in protecting plant cells from stresses and damage on plants and improving biosynthesis of organic foods **(Kulk, 1995 and Strick *et al*., 1997).** The obtained results of the effect of seaweed extract on the growth characters are in agreement with those recorded by **El-Sawy (2005); Oraby (2013); Eisa *et al*. (2023).** The obtained results concerning banana yield were corroborative by the findings of **EL-Kholy (2004); Vazquez-Ovando and Andrino-Lopez (2012)**; **Baiea *et al.* (2015)** and **Baiea and EL-Gioushy (2015)** on banana plants.

Banana yield characteristics i.e. bunch weight, number of fingers/ bunch, and number of hands/ bunch was increased when fertilizer with organic fertilization comparing with the control (100% NPK). These results were emphasized by **Chezhiyan *et al.* (1999); El- Kafrawy (2005); Merwad (2007); Zeid *et al*. (2009)** on banana plants. on the other side, seaweed application on banana plants increased fruit yield. Similar improve in yield has been proved with other seaweed extracts **(Kumari *et al.*, 2011; Zodape *et al.*, 2011; Tabet *et al*., 2021)**, and on other crops sprayed with *A. nodosum* extract including cucumber, watermelon and pepper **(Abdel-Mawgoud *et al.*, 2010).** The improving effect of seaweed extracts on the yield and its components are in agreement with the previous results those obtained by **El-Sawy (2005); Merwad (2011); Mahmoud (2012); Oraby (2013); Roshdy (2014); Mosa *et al.* (2023).**

Result indicated that adding of composted filter mud, especially at 10 ton/fed level improved fruit quality of banana. Continuous application of organic fertilizer is a promising in the long term of banana, as a source of essential nutrients, organic matter, amino acids, natural hormones, antibiotics and vitamins. Also, improving both physical and chemical characters of soil. Filter mud has nitrogen and phosphorus content that is easily available **(Dotaniya *et al*., 2013).** Filter mud can be used to induce soil properties, and it contains different nutrients as N, P, K, Ca, Mg and SO4 **(Devarajan *et al*., 1996; Rahmad *et al*., 2019).** Furthermore, the results of **Guntoro *et al*. (2003)** declared that bagasse compost fertilizer combined with cow dung contains 1.12% N, 0.1% P_2O_5, 0.008% K_2O and 0.02% S (SO4). Application of compost underground improves the supply of organic C and N for microbial communities, increases the nutrient recycling process, soil environmental conditions and soil health for plants and thereby increases productivity **(Rahmad *et al*., 2019).** Organic fertilizers enhance the physical, chemical and biological properties of soil types, increasing soil solubility adjusting soil pH and production of the plants. Adding organic fertilizer not only improve organic matter in the soil but also induce the exchangeable potassium, available phosphorus, calcium, and the other micro-elements, through its impact on soil pH, promotes proliferation of soil microorganisms, encourages microbial population and activities of microbial enzymes, viz. dehydrogenase, urease and nitrogenase **(Abou-Hussein *et al.*, 2002).** Applying nitrogen as organic or mineral source was significantly favored in inducing fruit quality of banana in terms of improving T.S.S.% and total sugar % as well as decreasing the percentages of starch and total acidity compared to completely N mineral source **(Hammam, 2003).** These results are in agreement with previously reported by **Abd El-Moniem and Radwan (2003), Gogoi *et al.* (2004), El-Kafrawy (2005)** and **Merwad (2007)** on banana. The biochemical characters of banana fruits in terms TSS, acidity, sugar content percentages were found better in organic as compared to inorganic. The findings are in parallel with the those recorded by **Athani and Hulamani (2000); Anonymus (2001) and Rahman *et al.* (2021).** TSS percentage has been proved associated with regular and sustained of nitrogen from the soil as declared by **Chattopadhyay *et al.* (1980); Bellie (1987). Bakheit and Elsadig (2015)** also estimated higher TSS at green and ripe stage in banana plants treated with organic fertilizer (Manures and Compost) than inorganic fertilizer (Urea and NPK). Moreover,

Butani and Chovatia (2014) indicated that application of vermicompost at 8 kg/plant recorded the highest total soluble solids, total sugar, reducing sugars and non-reducing sugar.

The stimulating effect of seaweed extract on the fruit quality may be related to its higher nutrients content especially Mg, amino acids and vitamins surely resulted in improving the biosynthesis of total carbohydrates and plant pigments consequently proceeding fruit quality **(Soliman *et al*., 2000).** The results were consistent with what had been achieved by **Bhalerao *et al*. (2009); Badgujar *et al*. (2010); Kuttimani *et al*. (2013); Abdel-Rahman and Mansour (2015); Abdel-Hafiz *et al*. (2016) and Gouda *et al*. (2021).** Spraying seaweed extract at a rate of 0.1% had a favorable significant effect on total soluble solids % and total sugars % in banana fruit **(Eisa *et al*., 2023).**

5. Conclusions

The obtained results pointed out that the application of composted filter mud and seaweed extract in combinations with half the recommended amount of NPK progressed the growth, yield and fruit quality of Williams banana cv. compared to inorganic fertilization only. Moreover, the best measurements of banana traits were recorded when these were added in combination at 10 ton/fed composted filter mud (CFM) + 1/2 RFD + 0.2% seaweed, suggesting that this combination with higher doses of composted filter mud and seaweed extract was more effective in upgrading the measured characteristics than the other combinations.

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التأثير المشترك لراسب ترشيح كمبوست وسماد غير العضوي ومستخلص الطحالب البحرية علي أداء الموز وليامز

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الملخص

بالرغم من فعالية التسميد المعدني في تحقيق زيادة نمو وإنتاجية النبات، إلا أن الاضافة بصورة مفرطة تؤثر علي التربة وتسبب زيادة في تلوث البيئة. علي الجانب الأخر فإن التسميد العضوي ومنشطات النمو البيولوجية تزيد من امتصاص العناصر الغذائية ومن النمو والانتاجية وجودة الثمار. من هنا أجريت هذه التجربة خلال موسمي 2023/2022 و 2024/2023 لبحث تأثير كمبوست طينة المرشحات والسماد المعدني ومستخلص الأعشاب البحرية علي أداء الموز صنف ويليامز بتربة طميية طينية بقرية دندرة بمحافظة قنا جنوبي مصر. صممت تجربة في قطاعات كاملة العشوائية في ثلاث مكررات لنباتات الموز المنزرعة علي مسافة 3,5 × 3,5 م بكل جورة ثلاث خلفات. تم اضافة السماد المعدني الموصي به أو نصف الكمية حسب المعاملات مرتين شهريا من شهر أبريل الي أكتوبر خلال الموسمين. أضيف كمبوست طينة المرشحات مرة واحدة في منتصف ديسمبر في الموسمين. أضيف مستخلص الطحالب اضافة أرضية ثلاث مرات لكل موسم بداية من شهر مارس الي مايو . وقد تضمنت التجربة علي سبع معاملات: 1) الكنترول (اضافة السماد المعدني الموصي به - 2) 10 طن/فدان كمبوست مع نصف كمية السماد المعدني الموصي به- 3) 5 طن/فدان كمبوست مع نصف كمية السماد المعدني الموصي به- 4) 10 طن/فدان كمبوست + نصف كمية السماد المعدني الموصي به +0.1% مستخلص طحالب- 5) 10 طن/فدان كمبوست + نصف كمية السماد المعدني الموصي به + 0.2% مستخلص طحالب- 6) 5 طن/فدان كمبوست + نصف كمية السماد المعدني الموصي به+0.1% مستخلص طحالب و 7) 5 طن/فدان كمبوست + نصف كمية السماد المعدني الموصي به+ 0.2% مستخلص طحالب. بينت النتائج ن اضافة كمبوست طينة المرشحات بمعدل 10 طن/فدان+نصف كمية السماد المعدني الموصي به+ 0.2% مستخلص طحالب يليه المعاملة 10 طن/كمبوست طينة مرشحات + نصف كمية السماد المعدني الموصي به + 0.1% مستخلص طحالب أدي الي أفضل قياسات للنمو والمحصول وجودة ثمار الموز صنف ويليامز.