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Yield and Fruit Quality of Mango Trees as Affected by two Organic Matter Sources

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ABSTRACT

This experiment was carried out over two successive growing seasons (2020 and 2021) on 20 years-old Fagri Kalan mango trees grown in a private orchard located in El-Noubaria district, Behaira Governorate, Egypt. About 20, 30 and 40 kg/ tree were added from farmyard manure (FYM) and composted municipal solid wastes (CMSW) as an organic matters during the winter of each season of the experiment, in order to study the effect of each source on mango fruits physical and chemical characteristics, yield and leaf minerals and chlorophyll contents. Generally, using both organic matter sources, regardless the concentration on mango trees recorded significant effects on all studied parameters compared to the control trees. However, it is worth noting that the use of CMSW had the highest effect on increasing the number of fruits per tree, which reflected positively on the yield, and the higher concentration of CMSW led to an increase in the fruits' content of total sugars, TSS and vitamin C.

Keywords: Mango, Fagri Kalan, farmyard manure, composted municipal solid wastes, yield, fruit quality.

1. Introduction

The mango (*Mangifera indica* L.) is one of the important tropical fruits, ranking the fifth amongst fruit production and consumption worldwide. In Egypt, mango considered the most popular fruit crop and ranked the second place in area after citrus. The total acreage of mango reached about 307874 fed.; producing about 1395244 tons with an average of 4.53 tons/ fed, according to FAO statistics, (2020). Fagri Kalan mango is one of the local varieties cultivated in many regions of Egypt, which is characterized by its good flesh and pleasant taste.

Fruit tree cultivation on sandy soils has a number of challenges, including poor chemical and physical qualities of the soil, a lack of available nutrients, and a lack of organic matter. The greatest strategy to maintain soil fertility and productivity is to add organic matter on a frequent basis. This can supply nutrients that are sustainable and meet the needs of the plants for development and growth. Additionally, organic matter has shown significant promise in improving the physical properties of the soil, including moisture retention, accumulation soil stability, soil structure, and fertility. It also helps maintain soil organic matter levels and crop performance while lowering salinity, regulating soil pH, and meeting the needs of plants for certain minerals (Hati *et al*., 2006). By boosting soil microbial biomass, organic manures can improve soil microbial and enzyme activity (Sun *et al*., 2003; Lu *et al*., 2005). Moreover, applying organic manure has many benefits, including increasing soil fertility, cation exchange capacity, as well as promoting biological activity, the production of natural hormones, antibiotics, vitamins, and the development of roots (Russo and Berlyn, 1990).

Numerous studies show that boosting soil fertility, growth, and production as well as fruit quality for all evergreen fruit crops, including mango, is the best done by using organic and bio fertilization rather than mineral fertilization with nitrogen (Mouftah, 2007; Ibrahim, 2012), banana (Abd El-Naby and Gomaa, 2000; Abd El-Naby and El-Sonbaty, 2005), citrus (Abd El-Migeed *et al*., 2007; Abdelaal *et al*., 2012), and papaya (Shivakumar *et al*., 2012).

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Acosta *et al.,* (2003) applied chicken manure to the "Haden" mango as a part of an integrated technical management package. The outcomes demonstrated a higher yield under integrated management than under control. Corrales *et al.,* (2003) examined the results of applying NPK mineral fertilizer doses along with vermi-compost, they noticed that vermi-compost in combination with moderate and high doses of mineral sources produced higher yields than the control. Santos (2007) evaluated the soil addition of compost as well as the NPK percentage of 15–15–15, according to the obtained results; the Keitte mango tree had more fruits on average per tree than those weren't treated. Zang *et al.,* (2015) showed that substituting organic manure for chemical fertilizers increased the quality of the mango fruit and the amount of nutrients that were available to the soil, while it is still unknown what proportions are appropriate. Use of natural and organic fertilizers (*Azotobacter chroococcum* strain EB2) to Sukari mango trees improved the chemical characteristics and gave the highest values across all treatments for total sugars (%), TSS (%), Vitamin C, and the lowest value in total acidity (%). It also gave the highest yield values and the majority of physical characteristics of mango fruits, such as fruit weight and fruit firmness, (Omar and Belal, 2007). The obtained results by Abd El-hamid and El-Shazly (2019) showed that, the chicken manure tea + mycorrhizae + *A. chroococcum* + *B. circulans* treatment boosted chlorophyll and nitrogen contents, fruit set, weight and number, total yield, and vitamin C content in their study on Sukari mango. Chicken manure tea plus *A. chroococcum* treatment also increased the amount of phosphorus and potassium in the leaves, the length and diameter of the fruit, the total amount of soluble solids and sugar, and the acidity of the fruit. Habashy (2016) worked on Zebda mango trees, and found that increasing organic nitrogen and decreasing the percentage of mineral nitrogen, increased N, P, and K contents, the number of initial and retention fruit sets, and yield (kg/tree), also TSS, vitamin C content, fruit weight, and pulp firmness were all enhanced. The yield of mangoes increased when organic fertilizer took the place of chemical fertilizer, although the weight of a single fruit did not change significantly. In comparison to the control, the fruits had higher ratios of soluble solids, vitamin C, and hardness to acid, although their titratable acid levels were lower. A comprehensive comparison indicated that the replacement is 30% using organic fertilizer is the best way to increase soil fertility and fruit quality (Feng *et al*., 2020). Sau *et al.,* (2017) reported that for getting higher yield and quality produce from mango by maintaining soil health condition, biofertilizer along with liquid organic manure (*Azotobacter chorococcum* + *Azospirillum brasilense* + AM + Panchagavya 3%) may be a good alternative for the mango-growers. In addition, Boora (2016) showed that, maximum fruit yield and maximum number of fruits on Dushehari mango were obtained with the application of 50 kg farm yard manure along with 500 g each of nitrogen, phosphorus and potassium per tree before flower bud differentiation.

The aim of this experiment is to study the effect of the organic matter sources, such as Farmyard manure (FYM) and composted municipal solid wastes (CMSW) on the productivity of Fagri Kalan mango trees, as well as the quality of fruits, the content of major elements (N, P, K, Ca, and Mg) in the leaves, and leaves content of Chlorophyll.

2. Materials and Methods

2.1. Plant material

This experiment was carried out over the period of two successive growing seasons (2020 and 2021) on 20 years-old Fagri Kalan mango trees grown in a private orchard located in El-Noubaria district, Behaira Governorate, Egypt. The trees were grafted on seeded rootstocks and planted at a distance of 4 x 5 meters under drip irrigation system with 12 drippers per tree (Dripper discharge = 4 liters per hour), in a sandy soil, as in Table (1) shows the soil analysis according to the method of Wilde *et al.,* (1985).

The chosen trees had a vigor that was as uniform as possible. For each tree under investigation, the same horticulture practices including chemical fertilization were done.

Table 1: Mechanical and chemical analysis of experimental soil.

Sand (%)	Silt (%)	Clay (%)	pH	Organic Matter (%)	$CaCO_3$ (%)	E.C. (ds/m)	Soluble N (ppm)	Available P (ppm)	Exchangeable K (ppm)
91.2	3.7	5.1	7.3	0.3	1.4	0.3	8.1	3.2	20

2.2. Treatments

Farmyard manure (FYM) and composted municipal solid wastes (CMSW) were analyzed as presented in Tables (2) and (3), respectively, according to the methods of Wilde *et al.,* (1985).

Table 2: Some physical and chemical properties of tested Farmyard manure.

Cubic meter weight (kg)	650	EC (mmohs cm^{-1})	5.7	Total Ca (%)	1.82
Moister (%)	35	C/N ratio	24	Total Mg (%)	0.96
Organic Matter (%)	23	Total N (%)	0.89	Total Fe (ppm)	1500
Organic Carbon (%)	21.4	Total P (%)	0.32	Total Mn (ppm)	420
pH (1:10)	8.7	Total K (%)	0.92	Total Zn (ppm)	53

Table 3: Chemical analysis of composted municipal solid wastes organic fertilizer.

Moister (%)	27	EC (mmohs cm^{-1})	4	Total Ca (%)	1.82
Water saturated capacity (%)	350	C/N ratio	22.2	Total Mg (%)	0.96
Organic Matter (%)	40	Total N (%)	0.72	Total Fe (ppm)	1620
Organic Carbon (%)	16	Total P (%)	0.42	Total Mn (ppm)	115
pH	7.7	Total K (%)	0.08	Total Zn (ppm)	320
Humic/dry O.M. (%)	12	Ammonium N (ppm)	9	Cu (ppm)	130
Ash (%)	58	Nitrate N (ppm)	170		

About 20, 30 and 40 kg/ tree from each organic matter were added under the soil surface, during the winter of each year of the experiment, near the spread areas of tree roots, each treatment was repeated four times on a single tree plot as follows:

1- Without manure addition (Control).
2- Farmyard manure at 20 kg/tree (FYM 20).
3- Farmyard manure at 30 kg/tree (FYM 30).
4- Farmyard manure at 40 kg/tree (FYM 40).
5- Composted municipal solid wastes at 20 kg/tree (CMSW 20).
6- Composted municipal solid wastes at 30 kg/tree (CMSW 30).
7- Composted municipal solid wastes at 40 kg/tree (CMSW 40).

2.3. Measurements

At the harvest time (on the last week of July in each season), tree yield was estimated as a number and weight as kg/tree of the harvested fruits per tree, the following measurements were carried as follows:

2.3.1. Fruit physical characteristics

Fruits of each replicate (tree) were separately weighed, and samples of five fruits from each replicate tree were collected to determine the following parameters: fruit weight (g), fruit length (cm), fruit width (cm) and fruit circumference (cm).

2.3.2. Fruit chemical characteristics

Samples of the fruit juice were used to determine the total soluble solids percentage (TSS %) using hand refractometer. Total sugars percentage (g/100 g fresh weight) was determined as the method described by Dubois *et al.,* (1956). In addition, the total acidity was measured as percentage of citric acid according to A.O.A.C (1985). Fruit ascorbic acid (V.C) content in milligrams was determined in 100 ml of the juice, A.O.A.C (1985).

2.3.3. Leaf minerals and Chlorophyll content

In August of each season, twenty leaves were collected to clear the effect of organic matter sources on the content of the major elements in the leaves as well as leaves content of the chlorophyll. Leaf samples were cleaned using distilled and tap water, then dried at 70°C before being ground and digested. Due to the procedures outlined by Cottenie *et al.,* (1982), the digested solution was utilized to determine N, P, K, Ca, and Mg content as percentages on dry weight. Using a Minolta chlorophyll meter (SPAD 502), the total chlorophyll in the fresh leaves was determined as SPAD units (SPAD = 100 mg chlorophyll/g fresh weight).

2.4. Statistical Analysis:

The experimental layout was a randomized complete block design (RCBD). The obtained data were subjected to analysis of variance (ANOVA) using COSTAT software (Alessandro and Guy, 2013). The least significant difference (LSD) was used to compare the means of treatments according to Snedecor and Cochran (1990) at a probability of 5%.

3. Results and Discussion

3.1. Number of fruits and yield as kg/tree

The results presented in Table (4) show the number of fruits per tree, and the yield of each tree. The obtained results show that both FYM and CMSW led to an increase in fruits number significantly than the control. Moreover, CMSW at 30 and 40 kg/tree raised fruits number significantly per tree to the maximum (34.67 and 34.33 fruits) in the first season, also (40.00 and 37.67 fruits) in the second one, sequentially without significant difference between them, meanwhile, the control treatment shows the lowest fruits number/tree (19.00 and 21.67 fruits) in the two seasons, respectively. In addition, results show that various treatments increased trees yield significantly than the control where CMSW at 30 kg/tree followed by CMSW at 40 kg/tree yielded the highest values (16.33 and 16.31 kg/tree) at the first season; conversely, the following season, CMSW at 40 and 30 kg/tree did (18.84 and 18.40 kg/tree) in both studied seasons without significant difference between them, respectively. However, the control gave the lowest yield (7.60 and 8.73 kg/tree) in both studied seasons, successively.

Table 4: Effect of organic matters on fruit No. and yield of Fagri Kalan mango trees in 2020 and 2021 seasons

Treatments	Fruit No.		Yield /tree (kg)	
	2020	2021	2020	2021
Control	19.00	21.67	7.60	8.73
FYM 20	21.67	24.33	10.04	11.36
FYM 30	26.00	30.33	10.75	13.50
FYM 40	25.00	31.00	11.08	14.05
CMSW 20	32.33	35.33	14.76	17.14
CMSW 30	34.67	40.00	16.33	18.40
CMSW 40	34.33	37.67	16.31	18.84
L.S.D $_{at0.05}$	7.36	7.76	2.42	2.46

It is well-known from the results, the significant effect of adding CMSW than FYM, and this may be due to the decomposition of CMSW more than FYM, which made the nutrients available during the growing stages and their availability in an accessible form for trees during the flowering, fruit set, and fruit growth stages. These results generally correspond to those obtained by Hati *et al*., (2006), Russo and Berlyn (1990). Moreover, Mouftah (2007) and Ibrahim (2012) indicated that adding elements, especially nitrogen, through organic and bio fertilization preferred to use mineral fertilization with nitrogen in enhancing soil fertility, growth and yield of mango. The same results were obtained by Acosta *et al.,* (2003), Corrales *et al.,* (2003), Abd El-hamid and El-Shazly (2019), Boora (2016), Santos (2007).

3.2. Fruit physical characteristics

Average fruit weight (Table 5) varied significantly among treatments as the heaviest fruits (475.0 and 500.0 g) were weighed with CMSW at 40 kg/tree in both seasons, successively. Whereas the lightest fruits (400.0 and 403.0 g) were weighed with the control trees in both seasons, by order. Regarding fruit length, results reveal that all treatments raised it significantly in both seasons than the control since the tallest fruits (14.20 and 14.10 cm) were measured with FYM at 20 kg/tree and CMSW at 20 kg/tree in the first and second seasons, respectively. On the contrary, the shortest fruits (13.17 and 13.13 cm) were measured with FYM at 40 and 30 kg/tree in the first and second seasons, significantly. Similarly, fruit width was positively responded significantly to various treatments where the maximum widths (9.00 and 9.13 cm) were recorded with CMSW at 30 kg/tree in the two seasons, successively. Whereas, the minimal fruit width (7.87 and 7.97 cm) was measured with control trees at the two seasons, sequentially.

Table 5: Effect of organic matters on fruit physical characteristics of Fagri Kalan mango trees in 2020 and 2021 seasons

Treatments	Fruit weight (g)		Fruit length (cm)		Fruit WIdth (cm)		Fruit circumference (cm)	
	2020	2021	2020	2021	2020	2021	2020	2021
Control	400.0	403.0	13.23	13.23	7.87	7.97	23.73	23.93
FYM 20	463.3	466.7	14.20	13.70	8.63	8.43	25.50	25.67
FYM 30	413.3	445.0	13.77	13.13	8.23	8.77	25.47	25.47
FYM 40	443.3	453.3	13.17	13.80	8.77	8.43	25.77	25.17
CMSW 20	456.7	485.0	13.47	14.10	8.83	8.97	26.03	25.83
CMSW 30	471.1	460.0	13.33	13.97	9.00	9.13	26.10	26.17
CMSW 40	475.0	500.0	13.37	13.93	8.30	8.23	23.50	24.57
L.S.D $_{at0.05}$	27.40	34.89	0.78	0.35	0.49	0.42	0.85	0.82

Considering fruit circumference, it was significantly affected by different treatments significantly as the highest values (26.10 and 26.03 cm) were sized with CMSW at 30 and 20 kg/tree without significant difference between them in the first season and with CMSW at 30 kg/tree (26.17 cm) in the second season. The least values (23.73 and 23.93 cm) were measured with the control fruits in both seasons, by the order. Results are agree with that obtained by Habashy (2016) who reported that reducing the percentage of mineral nitrogen and increasing organic nitrogen on Zebda mango trees led to increase yield and fruit weight. Omar and Belal (2007) showed that application of organic and bio fertilizers (*Azotobacter chroococcum* strain EB2) on mango cv. Sukari affected the most physical characteristics of mango fruits. At the same trend, Abd El-hamid and El-Shazly (2019) on mango Sukari cultivar indicated that chicken manure tea + mycorrhizae + *A. chroococcum* + *B. circulans* treatment increased fruit weight. The obtained results are agreed with those of Sau *et al.,* (2017) and Feng *et al.,* (2020).

3.3. Fruit chemical characteristics

Table (6) indicate that both FYM and CMSW affected vitamin C values, since the highest concentration (59.13 mg/g) was measured with CMSW at 40 kg/tree in the first season without significant differences among all treatments, meanwhile the highest significant content (54.87 mg/g) in the second season was measured with FYM at 20 kg/tree. The lowest concentrations of vitamin C (40.50 and 40.57 mg/g) were detected with the control in the two seasons, by the order. Regarding Table (6) results, TSS values were differed significantly among treatments where the highest TSS significant value (25.00%) was measured with CMSW at 40 kg/tree in the first season and (25.27 and 25.13%) with CMSW at 30 and 20 kg/tree in the second season, sequentially. While, the lowest values (20.50 and 20.43%) was recorded by the control in the two seasons, successively. The two sources of organic matter had significantly affected acidity values, since the most acidic juice (0.41 %) was detected with FYM at 40 kg/tree in the first season and with CMSW at 20 kg/tree (0.55 %) in the second season. However, the less acidic juice (0.31% in both seasons) was measured with the control. Results in Table (6) show that both sources of organic matter affected total sugars content where the highest significant contents (25.24 and 25.13 %) were measured with CMSW at 30 and 40 kg/tree in the first season without significant difference between them; while in the second season (24.77 %) was measured with CMSW at 40 kg/tree. The lowest total sugars values (19.83 and 20.47 %) were recorded with FYM at 40 kg/tree in the two seasons of the study. The results are consistent with the study conducted by Omar and Belal (2007) who reported that application of organic and bio fertilizers on mango cv. Sukari improved the chemical characters and gave the highest values among all treatments for total sugars (%), TSS (%), vitamin C and the lowest value of total acidity (%). Abd El-hamid and El-Shazly (2019) on Sukari mango indicated that chicken manure tea + mycorrhizae + *A. chroococcum* + *B. circulans* treatment increased vitamin C content, total soluble solids, and total sugars, while decreased fruit acidity. Habashy (2016) worked on Zebda mango trees, found that reducing the percentage of mineral nitrogen and increasing organic nitrogen led to increase TSS and vitamin C. In this respect, replacing the chemical fertilizer with the organic one, improved the ratio of soluble solids, vitamin C, and the titratable acid was decreased compared to control (Feng *et al*., 2020).

Table 6: Effect of organic matters on fruit chemical characteristics of Fagri Kalan mango trees in 2020 and 2021 seasons

Treatments	Vitamin C (mg/ g)		TSS%		Acidity (%)		Total sugars (%)	
	2020	2021	2020	2021	2020	2021	2020	2021
Control	40.50	40.57	20.50	20.43	0.31	0.31	20.67	21.50
FYM 20	48.67	54.87	22.20	22.20	0.36	0.55	23.07	22.43
FYM 30	48.60	48.43	23.07	24.60	0.35	0.36	23.80	22.57
FYM 40	44.83	44.93	24.93	24.13	0.41	0.35	19.83	20.47
CMSW 20	50.50	40.37	23.20	25.13	0.37	0.35	23.47	22.90
CMSW 30	39.73	45.50	22.67	25.27	0.39	0.35	25.24	22.34
CMSW 40	59.13	50.37	25.00	24.53	0.35	0.37	25.13	24.77
L.S.D $_{at0.05}$	N.S	14.115	2.291	1.971	0.053	0.106	2.591	N.S

3.4. Leaves mineral and chlorophyll content

Regarding N percentage in Table (7), a significant effect of both organic matters was found. The highest significant value (1.33 %) was equally detected by fertilizing trees with CMSW at 40 kg/tree in the two seasons. However, the lowest value (1.22 %) was obtained by CMSW at 20 kg/tree in the first season; while it was by the control in the second season, successively. Similarly, P content was affected significantly by different sources, since the highest values (0.305 and 0.304 %) were scored by FYM at 40 kg/tree in the two studied seasons, sequentially. The lowest values (0.185 and 0.193 %) were recorded by CMSW at 20 kg/tree in both seasons, respectively. In addition, K percentage was differed significantly among organic matters, since CMSW at 40 kg/tree increased K percentage significantly (1.031 and 1.055 %) in both seasons, by order. Meanwhile, the control and FYM at 20 kg/tree decreased K content significantly (0.745%) followed by CMSW at 20 kg/tree (0.749 %) without significant difference between them at the first season, while in the second season, the control, CMSW at 20 kg/tree and FYM at 20 kg/tree had significantly lowered K content (0.751, 0.759 and 0.762 %) without significant difference among them. As shown in Table (7), Ca values were affected significantly by various organic matter since the highest values (2.54 and 2.53 %) were measured with FYM at 40 kg/tree in both seasons, by order. However, the lowest significant values (1.57 and 1.61 %) were detected with control trees in the two seasons, respectively. Mg contents varied significantly among sources; where the highest significant content (0.282 and 0.285 %) was scored by FYM at 40 kg/tree in the two studied seasons, successively. Whereas, the least Mg content (0.209 and 0.205 %) was recorded by CMSW at 20kg/tree in both seasons, sequentially. Results in Table (7) reveal that, both FYM and CMSW increased chlorophyll content significantly as the highest significant content (51.73 and 55.30 SPAD) was scored by adding FYM at 40 kg/tree in both studied seasons, sequentially. Meanwhile, the lowest significant content (32.00 and 31.17 SPAD) was recorded by the control in the two seasons, successively. Our results are agree with the studies carried by Abd El-hamid and El-Shazly (2019) who reported that the chicken manure tea + mycorrhizae + A. chroococcum + B. circulans treatment increased chlorophyll and nitrogen contents of Sukari cultivar. Furthermore, chicken manure tea + A. chroococcum treatment increased leaf phosphorus and potassium content. In addition, Habashy (2016) in his study on Zebda mango trees reported that reducing the percentage of mineral nitrogen and increasing organic nitrogen led to increase N, P and K contents.

Table 7: Effect of both organic matters on leaves mineral and chlorophyll content of Fagri Kalan mango trees in 2020 and 2021 seasons

Treatments	N (%)		P (%)		K %)		Ca (%)		Mg (%)		Chlorophyll (SPAD)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
Control	1.28	1.22	0.196	0.195	0.745	0.751	1.57	1.61	0.222	0.239	32.00	31.17
FYM 20	1.26	1.26	0.235	0.234	0.745	0.762	2.10	2.13	0.225	0.223	43.23	46.70
FYM 30	1.27	1.29	0.267	0.264	0.865	0.865	2.35	2.36	0.249	0.248	46.33	49.67
FYM 40	1.31	1.32	0.305	0.304	0.923	0.931	2.54	2.53	0.282	0.285	51.73	55.30
CMSW20	1.22	1.23	0.185	0.193	0.749	0.759	1.98	2.01	0.209	0.205	50.17	52.10
CMSW30	1.28	1.29	0.217	0.216	0.848	0.842	2.29	2.31	0.225	0.227	48.87	50.70
CMSW40	1.33	1.33	0.245	0.243	1.031	1.055	2.35	2.43	0.265	0.251	43.53	45.20
L.S.D $_{at0.05}$	0.01	0.01	0.007	0.007	0.035	0.033	0.077	0.127	0.012	0.017	3.296	3.652

4. Conclusion

From the above mentioned results, the most important benefits reflected on mango trees can be summarized from the use of organic fertilizers as an addition under the ground in winter compared to the control trees in terms of an increase in the number of fruits per tree and an increase in the length of the fruit and its circumference, which reflected positively on the resulted yield as it helped to an increase in the nutrients content of the leaves, which was also reflected on increasing vitamin C in the fruits, increasing TSS and total sugars, while maintaining a lower acidity.

When comparing the yield produced from both sources, it could be concluded that using CMSW in general had a positive effect on most of the physical and chemical characteristics of the fruits, except for the percentage of acidity.

As shown in Fig. 1, the addition of CMSU at 40 kg/tree in winter had the best increase in yield during the two study seasons, which is estimated to be an approximate increase of 100% compared to the control, while retaining the rest of the fruit quality characteristics.

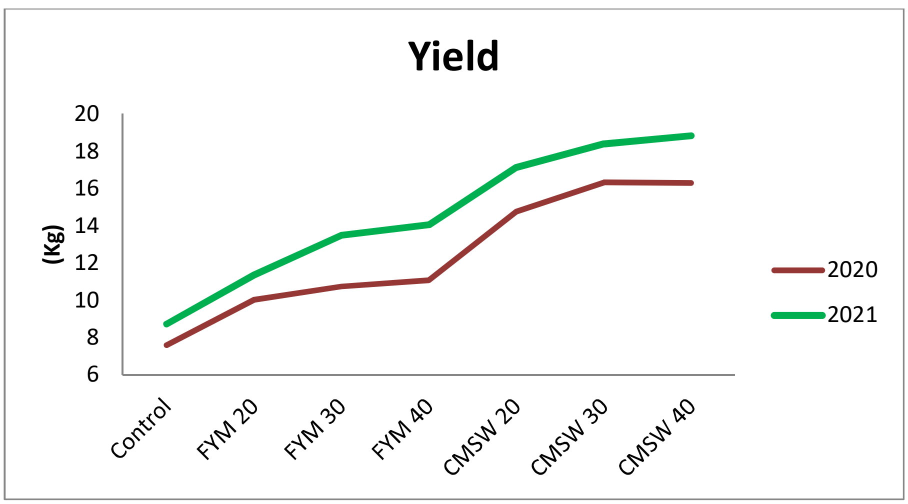

Fig. 1: Yield of Fagri Kalan mango trees as affected by two organic matter sources in 2020 and 2021 seasons.

References

Abd El-Hamid, Sheren A. and El-Shazly Mona M., 2019. Response of mango trees to organic and biofertilizers in north sinai. Egyptian J. Desert Res., 69 (1): 39-66.

Abd El-Migeed, M.M., M.S. Saleh and E.A. Mostafa, 2007. The beneficial effect of minimizing mineral nitrogen fertilization on Washington navel orange trees by using organic and biofertilizers. World J. of Agric. Sci., 3 (1): 80-85.

Abdelaal, A.M., F.F. Ahmed and K.M. Hassan, 2012. Partial replacement of chemical N fertilizers in Balady mandarin orchard through application of extracts of yeast, seaweed and farmyard manure. Minia J. of Agric. Res. & Develop. 32(1): 129- 148.

Abd El-Naby, S.K. and A.M. Gomaa, 2000. Growth nutritional status, yield and fruit quality of Maghrabi banana as affected by some organic manures and biofertilizers. Minufiya J. Agric. Res., 25(4): 1113-1129.

Abd El-Naby, S.K. and M.R. El-Sonbaty 2005. Effect of partial replacement of chemical fertilizers by organic manures in banana production and fruit quality. Assiut J. Agric. Sci., 36: 107-122.

Acosta-Ramos, M., D.H. Noriega-Cantú, D. Nieto- Ángel, and D. Téliz-Ortiz, 2003. Efecto del manejo integrado del mango (Mangifera indica L.) en la incidencia de enfermedades y en la calidad de frutos. Revista Mexicana de Fitopatología. 21: 46-55.

Alessandro C., and N. Guy, 2013. Costationarity of locally stationary time series using costat. Journal of Statistical Software, 55(1): 1-22.

A.O.A.C., 1985. Official Methods of Analysis of the Association of Official Analytical Chemists. 14th Ed., Journal of Association of Official Analytical Chemists, 68 (2): 346–368. https://doi.org/10.1093/jaoac/68.2.346

Boora, R.S., 2016. Effect of inorganic fertilizers, organic manure and their time of application on fruit yield and quality in mango (Mangifera indica) cv. Dushehari. Agric. Sci. Digest., 36 (3): 231-233.

Corrales, G.I., M. González, and L.P. López, 2003. Respuesta del mango (*Mangifera indica* L.) a las aplicaciones de humus de lombriz con fertilizante mineral. Centro Agrícola. 30: 45-50.

Cottenie, A., M. Verloo, L. Kiekens, G. Velgle and R. Amerlynuck, 1982. Chemical analysis of plant and soil. Laboratory of Analytical and Agroch. State Univ. of Belgium, Gent., 63.

Dubois, M., K.A. Gilles, J.K. Hamilton, P.A. Rebers, and F. Smith, 1956. Colorimetric method for determination of sugar related substances. Anal. Chem, 28 (3): 350-356.

FAO. FAOSTAT, 2020. Food and Agriculture Organization of the United Nations, Rome, Italy. 2017. Available online: http://www.fao.org/faostat/en.

Feng, H.D., H.Y. Chen, ZH.G. Dang, B. Ni, C.C. He, Z.H.Y. Wei, and Y.Y., Chen, 2020. Soil properties, leaf nutrients and fruit quality response to substituting chemical fertilizer with organic manure in a mango orchard. Applied ecology and environmental research, 18 (3): 4025-4033.

Habashy, S.I., 2016. Response of Zebda mango trees to organic and bio nitrogen fertilization as a partial substitute for mineral nitrogen. J. Product. & Dev., 21(3): 255- 274.

Hati K.M., K.G. Mandal, A.K. Misra, P.K. Ghosh, and K.K. Bandyopadhyay, 2006. Effect of inorganic fertilizer and farmyard manure on soil physical properties, root distribution, and water-use efficiency of soybean in Vertisols of central India. Bioresource Technology, 97 (16): 2182-2188.

Ibrahim, W.M., 2012. Behaviour of Taimour mango trees to inorganic and organic fertilization and application of EM. Ph. D. Thesis Fac. Of Agric. Minia Univ. Egypt.

Lu, W.G., Q.W. Huang and Q.R. Shen, 2005. The effect of organic fertilizer and organic-inorganic fertilizer application on soil enzymes activities during watermelon growing period. Journal of Nanjing Agricultural University, 28: 68-71.

Mouftah, R.T., 2007. Response of Taimour and Zebda mango trees to application of organic and biofertilization along with seaweed extract. Ph. D. Thesis, Fac. of Agric., Minia Univ., Egypt.

Omar A.E.Kh., and E.B.A. Belal, 2007. Effect of organic, inorganic and bio-fertilizer application on fruit yield and quality of mango trees (*Mangifera indica* L. cv."Sukari") in Balteem, Kafr El-Sheikh, Egypt. Agric. Res., Kafrelsheikh Univ., 33 (4): 857-872.

Russo, R.O. and G.P. Berlyn, 1990. The use of organic biostimulants to help low input sustainable agriculture. J. Sus. Agric., 1 (2): 9-42.

Santos, B.M., 2007. Effects of adding compost to fertilization programs on 'Keiit' mango. Journal of Agronomy, 6: 382-234.

Shivakumar, B.S., R.T. Dharmatti, and H.T. Channal, 2012. Effect of organic cultivation of papaya on yield, economics and soil nutrient status. Karnataka Journal of Agricultural Sciences, 25 (4): 488-492.

Sau, S., P. Mandal, T. Sarkar, K. Das and P. Datta, 2017. Influence of bio-fertilizer and liquid organic manures on growth, fruit quality and leaf mineral content of mango Cv. Himsagar. Journal of Crop and Weed, 13(1): 132-136.

Snedecor, G.W. and W.G. Cochran, 1990. Statistical Methods.7th Ed., Iowa State University Press, Ames Iowa, USA. 593.

Sun, R.L., B.Q. Zhao and L.S. Zhu, 2003. Effects of long-term fertilization on soil enzyme activities and its role in adjusting- controlling soil fertility. Plant Nutrition and Fertilizer Science 9: 406-410.

Wilde, S.A., R.B. Corey, J.G. Layer, and G.K. Voigt, 1985. Soil and plant analysis for tree culture. Published by Mohan Primlani, Oxford, IBH, Publishing Co., New Delhi, 1-142.

Zang, X.P., X.E. Lin, Z. X. Zhou, L. Tan, Y. Ge, M.J. Dai, and W.H. Ma, 2015. Effects of different fertilization treatments on quality of mango fruit and soil fertility. Subtropical Plant Science, 44: 146-149.