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Full Length Research Paper

Effect of farmyard manure and elemental sulfur on the growth and chemical characteristics of *Jatropha curcas* L. tree grown in Calcareous soil.

Mohamed Abd EL- Hady[1] and Nermeen T. Shanan [2]

[1]Water Relations and Field Irrigation Department, National Research Centre, El Behoos St.,Dokki, Cairo, Egypt
[2]Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, Egypt

Corresponding Author's E-mail**:** nermeenshanan77@gmail.com

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Expansion of biofuel cultivation and production has become an urgent issue in the case of depending on disposed sewage secondary treated water in irrigation, so it was necessary to focus on the soil management before planting to maximize plant growth and access to production quickly is needed. Therefore, this study was carried out on a loamy sandy soil at Suez Governorate on *Jatropha curcas* trees planted three years ago. Two types of amendments were applied regarding to organic and inorganic; farm yard manure, FYM (5 and 10 ton/fed.) and elemental sulfur (0.15 and 0.30 ton/fed) in addition to the untreated soil (control). This study aimed to evaluate the efficiency of organic and inorganic amendments on some growth characters and chemical constituents of *Jatropha curcas* plants. The results revealed that the *Jatropha* trees received 10 ton/fed FYM gave greatest values of most of the characters over the other treatment (5 ton/fed). These characters were plant height, total hull weight, flower diameter and (N, P and K %). The effects of both doses were nearly equal on total seed weight, total hull length and total hull diameter. Moreover, the effect of sulfur treatments on *Jatropha* tree was superior at 0.30 ton/fed overcome the control on total seed weight, total hull weight, flower diameter, oil and K contents. The *Jatropha* trees received FYM exhibited increment values in most studied characters more than those with Sulfur as on plant height, total seed weight, total hull weight, hull diameter, seed index, N and P contents. The comparison among the impact of the studied amendments on the main economical *Jatropha* plant characters revealed that FYM was superior in case of seed index, and content of N and P in leaves. Whereas sulfur had a promotive effect on the leaf K and oil content in seeds.

Keywords: Farm yard manure, jatropha tree, calcareous soil,

INTRODUCTION

Jatropha is a genus of flowering plants in the spurge family, Euphorbiaceae. It is native to the American tropics, most likely Mexico and Central America. It has been introduced to Africa and Asia and is now cultivated worldwide. It is cultivated in tropical and subtropical regions around the world, becoming naturalized in some areas, and adapted to arid and semi-arid conditions (Janick*et al.*, 2008). It contains approximately 170 species of succulent plants, shrubs and trees (some are deciduous, like *Jatropha curcas*). Most of these are native to the Americas, with 66 species found in the Old World (Heller, 1996).

Jatropha curcas is multipurpose species, small tree or large shrub. It is poisonous, semi-evergreen , reaching a height of 6 m (Janick *et al.*, 2008). It is resistant to a high degree of aridity, allowing it to be grown in deserts. The seeds contain 27-40% oil. Oil finds wide usage and has high economic potential for large scale industrial use (Achten *et al.*, 2007 and 2008) that can be processed to produce a high-quality biodiesel fuel, usable in a standard diesel engine.

Biodiesel is being eco-friendly, easy to produce raw material, easy oil extraction and trans–esterification (Kumar *et al.*, 2010 and Kumar and Satyawati, 2011).The residue oil cake generated during oil extraction biodiesel production can be used as fertilizer (Jayasigh, 2003). *Jatropha* oil cake is rich in nitrogen (3.2%), phosphorus (1.4%) and potassium (1.3%) and can be used as organic manure (Jayasigh, 2003 and Kumar and Sharma, 2008).The seeds are also a source of the highly poisonous toxalbumin curcin or jatrophin. As with many members of the family Euphorbiaceae, *Jatropha* contains compounds that are highly toxic. However, despite their abundance and use as oil and reclamation plants, none of the *Jatropha* species have been properly domesticated and, as a result, their productivity is variable, and the long-term impact of their large-scale use on soil quality and the environment is unknown (World Agroforestry Centre, 2007). Igbinosa and Colleagues (2009) demonstrated potential broad spectrum antimicrobial activity of *Jatropha curcas*. However, Adebowale and Adedire(2006) reported that *Jatropha* plant is used as a medicinal plant by using their seeds against constipation, the sap for wound healing and leaves as tea against malaria.

During the past few decades, intensive agriculture has led to heavy withdrawal of nutrients from the soil. Generally, excessive amounts of inorganic fertilizers are applied to plants in order to achieve a higher yield (Stewart *et al.*, 2005). Bokhtiar *et al.*, (2008) reported that organic manures, when applied with chemical fertilizers produce better yield than individual ones.

Application of bio-fertilizer is considered today to limit the use of mineral fertilizers and supports an effective tool for desert development under less polluted environments, decreasing agricultural costs, maximizing crop yield due to providing them with an available nutritive elements and growth promoting substances (Metin *et al.*, 2010). On calcareous soils, sulfur may be added to furnish calcium indirectly (Balbaa,1995) that oxidized to sulfuric acid, which reacts with the calcium carbonate to form gypsum ($CaSO_4$-$2H_2O$) that consider the cheapest, soluble calcium source (Abd El-Hady and Shaaban, 2010). Water movement in soil was improved under acidification treatment except under increase salinity water. Abdelhamid *et al.,* (2013) found that values of soil EC, pH and $CaCO_3$ were improved as a result of S application and a gradual reduction of the previous characters comparing with untreated plot. Application of sulfur enhancement water content under investigated soil water constant compared to the control. Content of N, P and K increased in plant by about 118.8%, 132.8% and 62.2% as above the control one, respectively. Qadir *et al.,* (2000) mentioned that due to salts affect many processes such as: i) crop growth, ii) soil physical properties, and iii) sufficiency and toxicity of nutrients. Also, they added that amelioration of these types of soils mainly depends on the water flow through soil profile to leach excess salts. Therefore, this investigation was undertaken to evaluate the efficiency of organic and inorganic amendments on some growth characters and chemical constituents of *Jatropha curcas* plants.

MATERIALS AND METHODS

Experimental site

The experimental site Suez Farm is located about 6 km south Suez Sewage Plant (29^o $52^\backslash$ N, 32^o $28^\backslash$E).The regional climate in this area is very hot with highly relative humidity most of the year (65 to 87 %). Rainfall is rarely and low amount was recorded (< 25 mm/year in two or three events) in last decades and normally occurs between January to April. Temperature values up to 30°C months a year. Dry period occurs between May to October and shows highly insulation and evaporation rates. Also the wind has a seasonal pattern, with the strongest winds occurring during the dry season, and more moderate winds occurring along the summer season.

Table 1 represented the properties of the soil area. The soil is sandy loamy in texture which determined after (Gee and Bauder, 1986). The main soil properties were measured (by Hanna Instruments HI 2550 pH/ORP/EC/TDS/NaCl Benchtop Meter). Soil $CaCO_3$ content was measured by Calcimeter after Soil Survey Division Staff (1993) and organic matter was determined after Rebecca (2004). Water contents in soil at saturation percentage, field capacity, wilting point and soil available water were measured after Klute (1982).

Plant materials

Jatropha trees were planted three years ago (at September 2013) in a ditcher. Plot consisted of 14 lateral lines at side, 30 m long, 4 m between the rows and 1.25 m between two successive trees and two drippers for each tree (8 l/h per dripper).Two types of manures were applied; the organic manure (farm yard) at rates of 5 and 10 ton/fed and inorganic manure (elemental sulfur) at rates of 0.15 and 0.30 ton/fed, in addition to the untreated plot (control).The chemical analysis of farm yard manure is represented in Table 2.

Irrigation system

Jatropha plants were irrigated by drip irrigation system. Irrigation process was carried out daily with total amount ranged from 16 to 40 liter/day by treated waste water from Suiz Sewage Plant. The descriptive analysis of the characteristics of waste water (four samples during the growing season, April, June, July and September) were presented in (Table 3). Fertilizer

Table 1: Soil mechanical, chemical and hydrophysical characteristics of the experimental site.

Characters	Values	Characters	Values
Sand %	65	$CaCO_3$%	10.75
Silt %	23	pH	8.35
Clay %	12	EC (dSm^{-1})	9.45
Texture	Loamy sand	Organic matter %	0.56
Water content %	23.0	Wilting point	6.4%
Field capacity%	15.6	soil available water	9.2%

Table 2: Chemical analysis of the organic manure (farmyard).

pH 1:10	EC 1:10 (dSm^{-1})	C/N ratio	Organic carbon	Organic matter	K	P	N
			%				
1.1	1.4	2.3	7.87	14.32	14.5	3.24	5.82

Table 3: The characteristics of irrigation waste water

Comparison parameter	EC dSm^{-1}	pH	$NO^{=}_3$ Ppm	Soluble cations and anions (meq/L)							SAR
				$Ca^{+}Mg$	Na^{+}	K^{+}	CO^{-}_3	HCO^{-}_3	Cl^{-}	SO^{-}_4	
Maximum	3.42	7.84	28.3	21.53	32.43	0.21	0.0	4.31	36.8	13.11	9.88
Minimum	2.84	7.61	37.1	15.91	22.45	0.13	0.0	2.83	25.72	9.87	7.96
Standard Deviation	±0.14	±0.03	±2.4	±0.11	±0.05	±0.07	0.0	±0.56	±1.13	±0.12	±0.63

program has not taken place except phosphoric acid was injected at 1 liter weekly.

Data recorded

At full mature stage of *Jatropha* tree the following characters were recorded: plant height (cm), total seed weight (g/tree), total hull weight (g/tree), total hull length (cm), total hull diameter (cm), flower diameter (mm), seed index (g), seed oil (%), macronutrients (N, P and K%) in leaves.

Statistical analysis

The data were subjected to the analysis of variance (ANOVA) appropriate to the randomized complete block design according, in factorial (two treatments as main factor, FYM and sulfur and application rates as sub main factors) to Dospekhov (1984). The significant differences (LSD) between treatments were compared with the critical difference at 5% probability level.

RESULTS AND DISCUSSION

Effect of organic manure treatments

Concerning the effect of organic amendment**,** farmyard manure (FYM) treatments on *Jatropha* tree at both doses; 5 and 10 ton/fed comparing to the control one, data in Table 4 and Figures (1a,b and c) showed that, both treatments outweigh that of the control. Moreover, the *Jatropha* trees received 10 ton/fed gave greatest values of most studied characters over the other treatment. Once these values were one and half times more as in plant height (31.8 vs 18.2 cm), total hull weight (62.1 vs 36.4 g), flower diameter (76.1 vs 50 mm) and N% (41.4 vs 28.7%), or these values were two-fold or more as in leaf content of potassium (91.8 vs 52.9%) and P (84.6 vs 30.8%), respectively. The effects of both doses were nearly equal in some characters of *Jatropha* tree as in total seed weight (59.7 vs 66.0 g/tree), in total hull length (4.1 vs 5.1 cm) andin total hull diameter (1.9 vs 1.9 cm).

Table 4: Effect of soil management by organic and inorganic amendments on the characters of *Jatropha* trees.

Treatments	Application rates	plant height	Total seeds weight	Total hull weight	Total hull length.	Total hull diameter	Flowers diameter
	ton/fed	Cm	g/tree	G	cm	cm	mm
Organic amendments (farmyard manure)	0	2.2	56.8	55.2	9.8	10.3	36.8
	5	2.6	90.7	75.3	10.2	10.5	55.2
	10	2.9	94.3	89.5	10.3	10.5	64.8
	Mean	2.6	80.6	73.3	10.1	10.4	52.27
Inorganic amendment (sulfur)	0	2.1	55.4	54.7	10.1	10.2	36.2
	0.15	2.4	67.5	73.8	10.2	10.5	56.2
	0.3	2.6	81.2	85.2	10.2	10.4	65.8
	Mean	2.4	68.0	71.2	10.2	10.4	52.73
LSD at 5%	Amendments	0.2	3.1	1.2	0.13	ns	ns
	Rates	0.1	2.6	0.8	0.07	ns	ns
	Interaction	0.1	2.4	0.7	0.07	ns	ns

Table 5: Effect of soil management by organic and inorganic amendments on the seed index, Oil content, N, P and K in leaves of *Jatropha* trees.

Treatments	Seed index	Seed oil	N	P	K
			In leaves		
		%			
Organic amendments (farmyard manure)	32.64	16.8	0.87	0.26	0.85
	41.25	23.4	1.12	0.34	1.30
	45.32	28.3	1.23	0.48	1.63
	39.74	22.83	1.07	0.36	1.26
Inorganic amendment (sulfur)	32.08	16.1	0.79	0.25	1.01
	38.64	26.4	1.05	0.29	1.46
	40.26	31.2	1.12	0.31	1.84
	36.99	24.57	0.99	0.28	1.44
LSD at 5%	1.4	1.3	0.4	0.17	0.24
	1.1	0.9	0.3	0.13	0.19
	0.9	0.8	0.3	0.12	0.17

Effect of inorganic amendment (sulfur)

Concerning the effect of sulfur as inorganic amendment on *Jatropha* tree at both doses; 0.15 and 0.30ton/fed comparing to the control tree, data in Table (4; 5) and Figures (1, 2; 3) showed that, both treatments, with superiority for 0.30 ton/fed, overcome that of the control. The increment values were obvious in; total seed weight (46.6%), total hull weight (55.8%), flower diameter (81.8%), oil content (93.8%) and K content (82.2%). While in the other characters, the values obtained from both doses of sulfur were quite equal to some extent.

Effect of organic vs inorganic amendments

Data in Tables (4;5) and Figures (1:4) revealed that, the *Jatropha* trees received organic manure treatments exhibited increment values in most studied characters more than those with inorganic one as in plant height (8.5%), total seed weight (18.5%), total hull

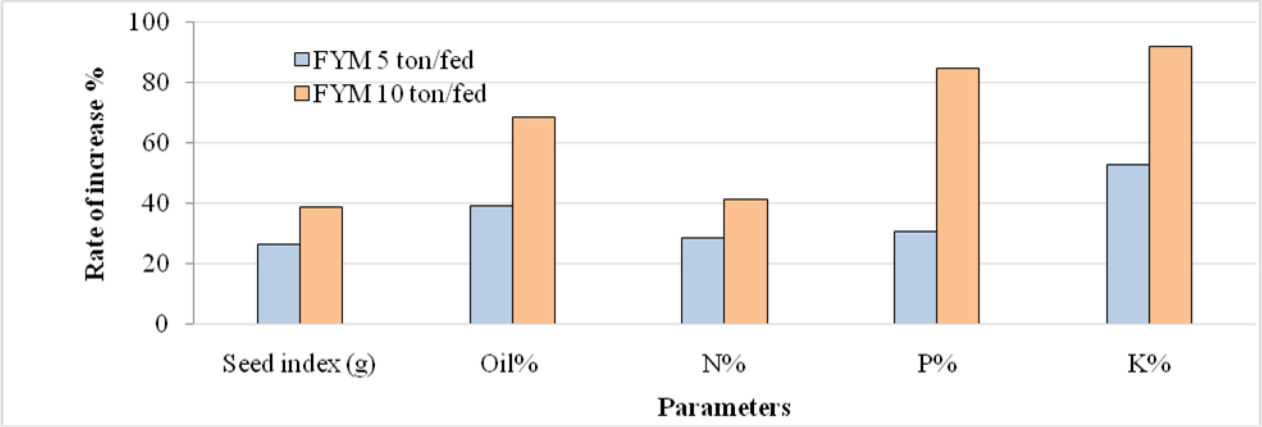

Figure 1: Effect of farmyard manure application on the percentage of change in seed index, the leaf content of macronutrients (N, P and K %) and oil % comparing with control.

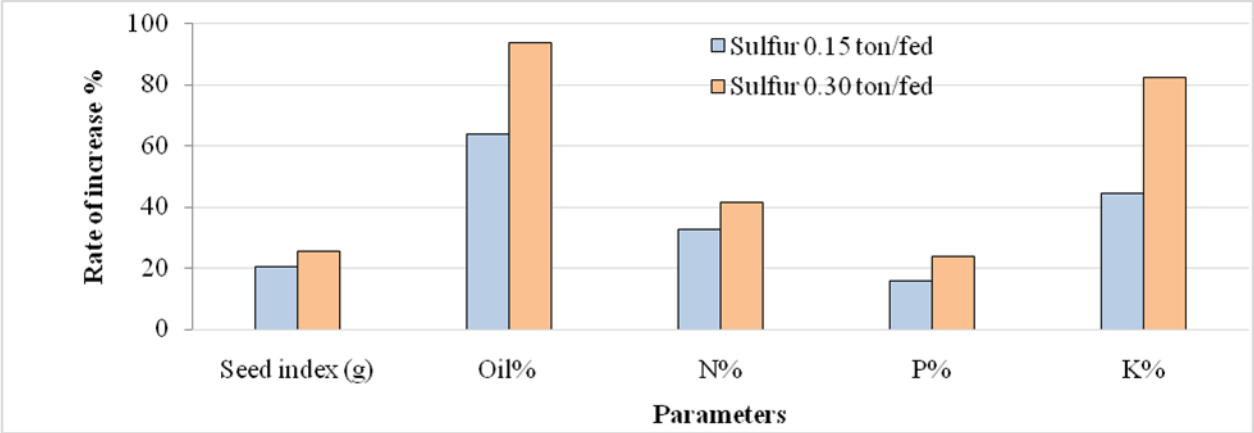

Figure 2: Effect of sulfur application on the percentage of change in seed index, the leaf content of macronutrients (N, P and K %)and oil % comparing with control.

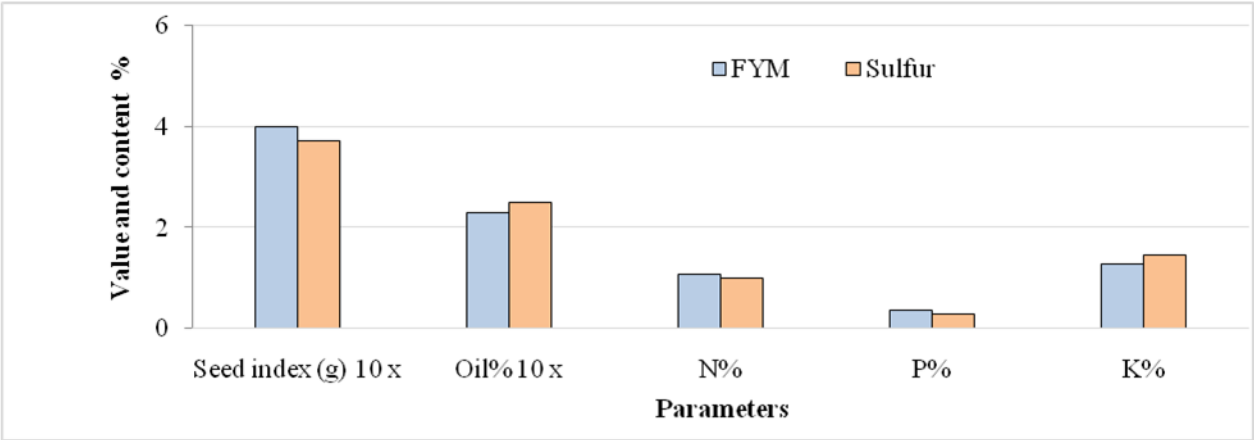

Figure 3: Effect of farmyard manure and sulfur application on the seed index, the leaf content of macronutrients (N, P and K %) and oil % comparing with control.

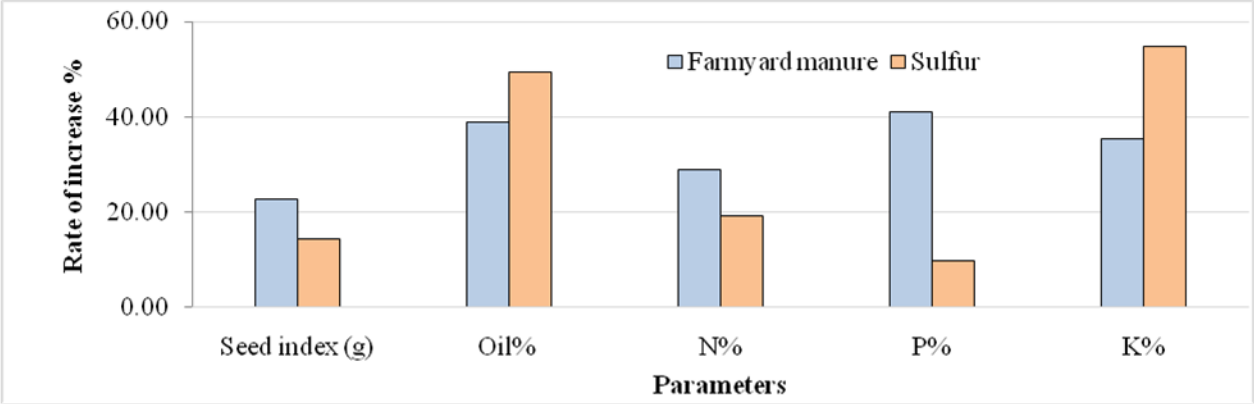

Figure 4: Effect of farmyard manure and sulfur application on the percentage of change in seed index, the leaf content of macronutrients (N, P and K) and oil %.

weight (2.9%), hull diameter (0.6%), seed index (7.4%), N content (8.8%) and P content (27.1%). Meanwhile, organic treatments were less than those of the inorganic one by 0.7% in hull length, 0.9 % in flower diameter, 7.1% in oil percentage and 12.3% in K content.

With respect to the seed index content in seeds, data pointed out that FYM application was more effective than sulfur under both used rates, 5 and 10 ton/fed, with values 38.8 and 26.4 % as compared with untreated one, respectively. The opposite was true in case of N, P and K content in leaves and the rate of increases were 28.7, 30.8, 52.9 % for the 1st rate of FYM and 41.4, 84.6, 91.8 % for the 2nd rate of FYM as compared with control, respectively. While Sulfur was more superior under both used rates to increase oil content in seeds of *Jatropha*with increasing rates 64.0 and 93.8 % above control (Table 5 and Figure 2).

Figure 4 illustrated the simple comparison among the impact of the studied amendments on the main economical jatropha plant characters. One can notice that FYM was superior in case of seed index, and content of N and P in leaves. Whereas sulfur had a promotive effect on the leaf K and oil content in seeds. This finding could attributed to the importance of the sulfur to oil composition process and help also in accumulate it in seeds, while it is reasonable that FYM encourage plant uptake from macro nutrients that exist in soil or in irrigation water. Also Hussein *et al.*, (2012) and kumar *et al.*, (2008) mentioned that the increasing occurred in growth characters could be due to that nitrogen sharing in building up and move carbohydrates from leaves to other part of the plant to improving the growth and yield characters. The reason for that is the organic fertilizer contains all the essential elements required for plant growth. In addition, Cassman *et al.*, (1995) stated that, application of organic fertilizer could enhance the soil properties, *i.e.* water holding capacity, water infiltration rate and soil fertility, moreover, reduce the soil erosion and nutrient leaching which will reflect on improving the growth and yield.

The efficiency of suitable quantity of organic fertilizer in soil increase the NPK content in leaves which hold nutrients and water on its surface to supply the plant with suitable amounts and release some nutrients such as Fe, Zn and Mn and makes these elements in available forms and in turn improves the growth (Adholeya and Prakash, 2004) or translocation of zinc and copper to plant to produce more hormones, vitamins and protein which enhanced the soil properties and increased the plant production (Aboshady *et al.*, 2009).

CONCLUSION

The study too up preceding evidence for different natural amendments before planting for growth enhancement and optimizing the yield and yield components especially seeds and oil %. The current study reflected the impact of pre-planting managements on the performance of *Jatropha* plant growth characters. However treated sewage water was used in irrigation process, soil management play an important role to improve characters of *Jatropha* tree under both organic and inorganic amendments, farmyard manure and sulfur, especially seed index, N, P, K, and oil content which enhanced to economic value for encourage planting this tree in future under fresh water crisis by maximizing utilization of sewage and/or brackish water under new reclaimed soil or soil close to Sewage Plant that suffered from high calcium carbonate .At the same time it could get benefits from its content from N, P, K and other plant nutrients and hence saving N, P and K fertilizers are expecting.

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