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Impact of mineral and organic fertilizer on vegetative growth of *Jatropha curcas* L in sandy soil

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ABSTRACT
Organic agriculture, as an adaptation strategy to climate change, is a concrete and promising option for rural communities and has additional potential as a mitigation strategy. The management of soil organic matter is critical to maintain a sustainable productive organic farming system. They possess many desirable soil properties and exert beneficial effect on the soil physical, chemical and biological characteristics as well as a sink for carbon dioxide sequestration to mitigate the negative impacts of climate changes. In this regard, a field experiment was carried out in a private sandy soil farm in Manshyet El Gammal, Tamiah, Fayum. Egypt to evaluate the effect of mineral and organic fertilizer treatments on growth and some chemical constituent of *Jatropha curcas* L. The results revealed that there were significantly differences between the fertilization treatment with superiority to the treatment T_{11} (50% Mineral fertilizer dose + 50% Chicken manures dose + Inoculation with cerialene) which produced the highest values for all the studied vegetative growth parameters as well as photosynthetic pigments content (chlorophyll a, b and carotenoids) and macronutrients contents (nitrogen, phosphorus and potassium).

Introduction

Jatropha curcas L, a multipurpose, drought resistant, perennial plant belonging to Euphorbiaceae family is gaining lot of importance for the production of biodiesel. Jatropha has been promoted as a potential renewable energy source for many of its advantageous properties in comparison to other biomass feedstock, as a tropical woody perennial tree species (AIACC, 2006). Jatropha may survive under harsh climate and soil conditions. 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 (Adebowale and Adedire, 2006). As developing countries face increasing local demand for energy, they also must deal with both economic and environmental pressure on agricultural lands in general. The possibility of growing energy crops such as *Jatropha curcas* L. has the potential to enable some smallholder farmers, slow or reverse global warming by reducing greenhouse gas (GHG) emissions and sequester carbon to the soil (IPCC, 2006). In addition, biodiesel produces fewer particulates, hydrocarbons, nitrogen oxides and sulphur dioxides than mineral diesel and therefore reduces combustion and vehicle exhaust pollutants that are harmful to human health. (FAO, 2010).

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. Organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem, health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions and locally adapted systems. This is accomplished by using, where possible, agronomic, biological, and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system. Organic agriculture is a system that relies on ecosystem management rather than external agricultural inputs (Samman *et al.*, 2008). Moreover, use of soil microorganisms which can fix atmospheric nitrogen, synthesis of growth promoting substances or by enhancing the decomposition of plant residues to release vital nutrients and increase humic content of soils, will be environmentally benign approach for nutrient management and ecosystem function (Wu *et al.*, 2005 and Karmakar *et al.*, 2007) Application of biofertilizer 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). Soil microorganisms are important components in the natural soil sub-ecosystem because not only can they contribute to nutrient availability in the soil, but also bind soil particles into stable aggregates , which improve soil structure and reduce erosion potential (Shetty *et al.*, 1994). There are many research on organic agriculture discussing its role as a mitigation and adaptation strategy (Niggli et al. 2008 and IFOAM, 2008). Therefore, this investigation was undertaken to evaluate the efficiency of partially replacement of organic fertilizer instead of mineral ones on growth and some chemical constituents of Jatropha plants.

Material and methods

A field experiment was carried out at a private farm in Manshyet El Gammal, Tamiah district, Fayum Governorate at

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the summer season of 2011 to study the effect of effect of mineral and organic fertilizer treatments on growth , and some chemical constituent of (*Jatropha curcas* L). Seeds of Jatropha were sown at 17 March 2011 under drip irrigation system. Experiment was laid out in a completely randomized block (4x3 m distance between trees) i.e. 350 trees /fed., includes 11 fertilization treatments with four replicates as shown in Fig (1). The initial physical and chemical characteristics of the soil and chemical analysis of organic (cattle and chicken) manures were determined according to Klute (1986) and Page *et. al.*, (1982**)**, are shown in Tables (1 and 2). Nitrogen was applied in the form ammonium sulphate (20.5% N) at the rate of 400 g / tree Phosphorus fertilizers in the form of calcium super phosphate (37% P2O5) 200 g / tree and potassium as potassium sulphate (48% K2O) , 150 g / tree for 100% mineral fertilization treatment (all mineral fertilizer were added in 4 doses , at sowing and every 45 days later, while organic fertilizers were added as full dose before sowing at the rate of 5 kg/tree for 100% organic treatment. Seed inoculation was carried out before sowing, where jatropha seeds were inoculated with cerealine (nitrogen fixing bacteria include *Azospirilum sp* strains) at the rate of 0.25 g per kg seed. All agronomic practices were followed as recommended for jatropha production in this district. A representative vegetative plant sample was taken after 180 days from sowing for each treatment from four replicates for measuring plant height (cm.), number of leaves, leaf area (cm^2), stem diameter (cm) and root length (cm). The following physiochemical measurements were determined in the fresh leaves: chlorophyll a, chlorophyll b and crotenoids (mg/g fresh weight) according to von Wettstein (1957). Then the different parts of the plant were then dried to constant weight at 70° to determine the dry weight (g) of leaves, stem and root. The dried plants were then thoroughly ground to fine powder and total nitrogen percentage was determined according to the method described by A.O.A.C. (1975). The content of phosphorus and potassium were determined in the digested material using Jenway flame photometer as described by Eppendrof and Hing (1970). The obtained results were subjected to statistical analysis of variance according to method described by Snedecor and Cochran (1982)

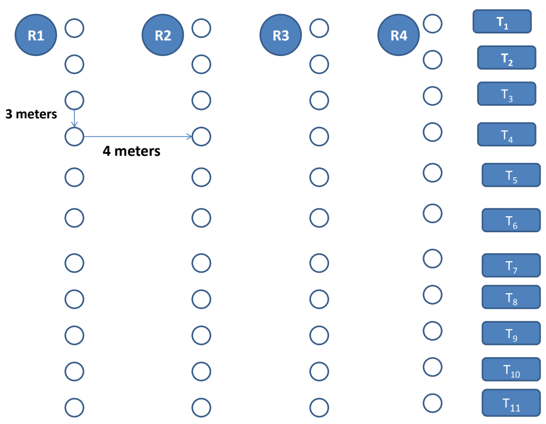

Fig (1) Experiment layout

T_1: Control (Without fertilizer)
T_2: 100% Cattle manures
T_3: 100% Chicken manures
T_4: 100% Mineral fertilizer
T_5: 50% Min. f + 50% Cattle manures
T_6: 50% Min. f + 50% Chicken manures
T_7: 100% Cattle manures + cerialene
T_8: 100% Chicken manures + cerialene
T_9: 100% Mineral + cerialene
T_{10}: 50% Min.f +50% Cattle manures + cerialene
T_{11}: 50% Min.f + 50% Chicken man. + cerialene

Results and discussion

Effect of mineral and organic fertilizer treatments on some growth parameters:

Data illustrated in Table (3) revealed significant positive impacts of the different fertilization treatments on the studied growth parameters, i.e., plant height (cm), number of leaves/plant, leaf area (cm^2), root length (cm) and stem diameter (cm) as well as the dry weight of leaves, stem and root (g) / plant with superiority for the T_{11} which produced the highest values for all the previous characters These findings are in harmony with those obtained by Kumar *et al*., (2008). The increase in growth parameters can be explained through the fact that nitrogen has a vital role in building up metabolites and carbohydrates which transferred from leaves to developing roots enhancing root length, diameter and weight as well as yield characters. The superiority of T_{10} and T_{11} could be because manure contains all the essential micro and macro elements required for plant growth. In this concern, Cassman *et al*., (1995) stated that, application of animal manure increases soil organic matter and improves a number of soil properties including water-holding capacity, oxygen content, and soil fertility. It also reduces soil erosion, improves solar heat absorption, increases water infiltration rates, reduces nutrient leaching, and increases crop growth and yields. The promoting effect of cerialene could be attributed to the biologically active substance produced by these biofertilizers such as auxins, gibberellins, cytokinins, amino acids and vitamins (Wu *et al*., 2005).

Effect of mineral and organic fertilizer treatments on photosynthetic pigments content:

Data presented in Figs (2) revealed that different fertilization treatments have significant results on the content of chl.a, b and carotenoids in the leaves of *Jatropha curcas* plants with superiority for the T_{11} which produced the highest values for the content of chl.a, b and carotenoids in jatropha leaves .Similar results were obtained by Maiti *et al*., (2000). Such increase in chlorophyll content in the leaves of plants may be attributed to the high rate of chlorophyll biosynthesis due to the enhancing effect of nitrogen on chlorophyll accumulation. Moreover, nitrogen is the main constituent of all amino acids in proteins and lipids that acting as a structural compounds of the chloroplast (Arisha and Bradisi, 1999).

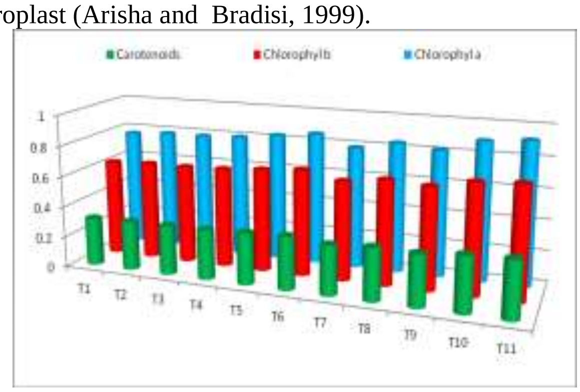

Fig (2) Effect of mineral and organic fertilizer treatments on chl. A, b and carotenoids (mg/g)

Effect of mineral and organic fertilizer treatments on macronutrients content:

From the data given in Fig (3), it can be concluded that the integrate application of mineral, organic and biofertilzer significantly and positively affected the content of micrountrients compared with the control plants. It is worthy to note also that highest values were recorded in jatropha plants treated with (50% Mineral fertilizer dose + 50% Chicken manures dose + Inoculation with cerialene). The obtained results are in agreement with the findings of Kumar *et al.,* (2008). The increment in N, P, K contents in the leaves of Jatropha plants may explain the efficiency of suitable quantity of organic fertilizers that can attract and hold nutrients and water on its surface to supply the plants with suitable amounts for a longer time and may be due to release of some nutrients; such as, Fe, Zn and Mn through the breakdown of organic manure in the soil and makes these elements in available forms and this in turn improves N, P, K and this reflects a beneficial effect on growth and dry weight (Adholeya and Prakash, 2004). Moreover, the increments in NPK as a result of organic fertilizers application may be attributed to their favorable effect on Jatropha vegetative growth (Table, 2) as mentioned earlier. Moreover, the relative positive effect of bio-fertilizer treatment on growth criteria may be attributed to their N_2-fixing activity and the production of plant growth promoting substances such as IAA, gibberellins and cytokinine-like substances (Wu *et al.*, 2005). Aboshady *et al*., (2009) added that, the increment in growth parameters may be due to the role of these microbes which help in fixing atmospheric nitrogen, solubilize and mobilize phosphorus, translocation of minor elements like zinc and copper to the plants, produce plant growth promoting hormones, vitamins and amino acids and control plant pathogenic fungi, thus helping to improve the soil health and increase crop production.

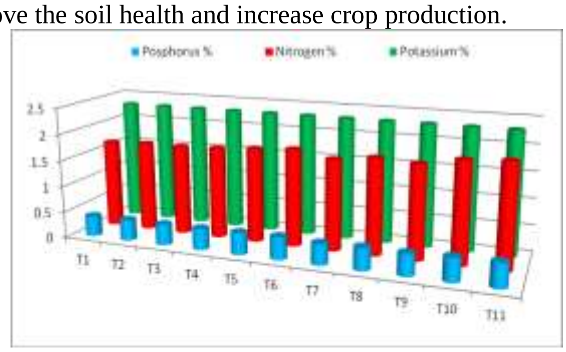

Fig (3) Effect of mineral and organic fertilizer treatments on nitrogen, phosphorus and potassium %

Conclusion

Nevertheless, the novel findings described here represent major steps forward in achieving the technically challenging goal of increasing jatropha productivity by reducing its dependence on the chemical fertilizer. Consequently, an alternate system of nutrient supply can replace the existing one through the integration of effective microorganisms inoculums along with organic / inorganic materials for optimum performance of jatropha should be encouraged as it is more valid for desert conditions. In conclusion the treatment T_{11}(50% Mineral + 50% Chicken manure + inoculation with cerialene) followed with T_{10} treatment (50% Mineral + 50% cattle manure + inoculation with cerialene) produced the highest values for all the growth parameters, the content of Chlorophyll a , b and carotenoids as well as the contents of nitrogen, phosphorus and potassium.

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Table (1) Soil mechanical and chemical analyses of the experimental sites

Sand %	89.13
Silt %	3.51
Clay %	7.36
Textural class	Sandy soil
Na^+ (mg/100 g)	35.25
pH	8.01
EC (mmohs/cm)	0.78
Organic matter %	0.82
Available N ppm	13.25
Available K ppm	26.54
Available P ppm	10.23

Table (2) Some chemical analysis of the used organic materials.

Organic manures	pH	EC (ds/m)	CaCO3%	Organic matter %	Organic carbon %	Nitogen %	Phosphorus %	Potassium %
Cattle manures	7.29	4.86	1.19	40.67	23.64	1.59	0.36	1.08
Chicken manures	7.96	3.37	2.43	46.37	26.95	2.17	0.85	1.48

T able (3) Effect of mineral and organic fertiliz on some growth parameter of *Jatropha cacus*.

Fertilizer treatments	Plant Height (cm)	Number of leaves/plant	Leaf area (cm^2)	Root length (cm)	Stem diameter (cm)	Dry weight (g)		
						leaves	stem	Root
T_1(control)	78.5	34.1	44.0	21.5	2.72	13.0	42.3	25.9
T_2	80.3	34.9	45.7	22.4	2.78	19.1	68.9	26.9
T_3	83.5	36.3	48.7	21.6	2.88	20.0	73.6	26.0
T_4	84	36.5	49.2	21.4	2.90	20.1	74.2	25.8
T_5	86.3	38.0	52.4	20.9	2.97	21.1	78.1	25.2
T_6	88.5	40.3	57.3	20.3	3.04	24.6	87.5	24.6
T_7	82	35.7	47.3	22.0	2.83	19.6	71.9	26.4
T_8	87	39.6	55.8	20.7	2.99	23.2	84.5	25.0
T_9	85.6	37.2	50.7	21.0	2.95	20.6	76.0	25.4
T_{10}	89	41.2	59.3	20.2	3.06	26.2	90.1	24.5
T_{11}	91	42.5	62.1	19.8	3.12	29.1	95.3	24.0
LSD 5%	4.68	1.99	2.97	0.98	0.15	1.13	4.65	1.15