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EFFECT OF DIFFERENT FERTILIZERS ON THE GROWTH OF *JATROPHA CURCAS SEEDLINGS*

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ABSTRACT

Use of NPK (17 : 17 : 17) fertilizer has significant position in effect on the growth characteristic in seedling of *Jatropha curcas*. Effect of different fertilizers on the growth and development of *Jatropha curcas* has been studied, NPK (17 : 17 : 17) show the effect on the growth and development of Jatropha plant; hence, controlled treatment has very gilt (i.e., height and girth) of *Jatropha curcas* plant. Hence NPK can be recommended for the growth of *Jatropha curcas* plant under the desired condition of pH, E.C., moisture and organic matter.

Key words: Jatropha, Growth improvement, Fertilizers.

INTRODUCTION

Jatropha curcas is an all-purpose zero waste perennial plant. It is considered as a potential source of non-edible fuel producing plant along with its different medicinal properties and grows well in the tropical and sub-tropical climate, like India.

The seed contain 4-40% viscous oil known as Curcas oil. The oil is high in octane value and can be used directly in diesel engines added to diesel fuel as an extender or transesterized to a biodiesel fuel. The oils clean fuel reducing green house gas emissions has greater lubricity and reduces engine loss. Pure Jatropha biodiesel is non-toxic in nature. This oil is strongly purging widely used as an antiseptic for cough, skin disease and as a pain reliever in rheumatism. Refining crude Jatropha oil into biofuel products produces glycerin as by product, which is an great demand as a raw material in cosmetic, medicine and food product industries. India has growing energy and transport fuel demand, where *Jatropha curcas* has a potential to become one of world key energy crop[1].

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The term "Jatropha" is usually used to refer to the species *Jatropha curcas*, which is a member of the family Euphorbiaceous, a large drought-resistant multipurpose shrub with several attributes and considerable potential[2]. It has been widely cultivated in central and south America, South-east Asia, India and Africa[3]. It is a multipurpose tree and can be grown in low to high rainfall areas either in farms as a commercial crop or as a hedge to protect field and prevent erosion. Its seed contain a high amount of oil[4], which is a good source of biodiesel after esterification. Its seed cake, which is a by-product from biodiesel production, contains high content of protein with a well-balanced amino acid composition according to the FAO/WHO reference pattern, except for lysine[5].

Due to gradual depletion of world petroleum reserves and the impact of environmental pollution, there is an urgent need for suitable alternative fuels for use in diesel engines. In view of this, vegetable oil is a promising alternative because it is renewable, environment-friendly and produced easily in rural areas, where there is an acute need for modern form of energy[6-10]. In recent years, systematic efforts have been made by several research workers to use vegetable oil as fuel in engines[11-14]. Seeing the cost and edible oils consumption, the use of non-edible oils compared to edible oils is very significant. Thus, Jatropha oil provides an alternative.

Jatropha curcas can be cultivated from seeds, seedling and curling. The host time for planting is the warm season before or at the met g the rains. In the former case nattering of a plants is required. The recommended spacing for plantation is 2 to 3 m by 1.5 to 3 m. The number of trees per hectare at plantation may range from 1100 to 3300. Plant growth is dependent on soil fertility and rainfall. A poor nutrient level will lead to creased failure of seed development; thus, it is important to maintain the soil fertility. Hence, the present study was made as an attempt to determine the effect of different fertilizers in the growth of *Jatropha curcas*.

EXPERIMENTAL

Methodology

Soil sampling and analysis

Soil sampling was carried out during the month of February 2012. Soil was sampled from Padilla Nursery near Jhansi. The word soil is derived from a Latin word 'solum' meaning earth material in which plant grow. The study of soil is known as soil

science or pedology. Soil may be defined as “the part of earth crust, in which humus is present and plant can grow”. Generally the soil may be collected from ploughed field and humus rich area.

Padilla nursery

Soil was sampled from Padilla nursery near Jhansi. We take plougher (khurpi) and move to agro-forestry site and dig out soil at a depth of approximate 30 cm and then collected the sample and filled it in the polybag. Then another sample was taken from the same site in random manner with the same process. We collect four different samples from the agro-forestry site and labelled them as A1, A2, A3 and A4.

Then after moving to medicinal plant site, total three different samples were taken from it by digging out field, approximate to 30 cm and in random manner and these are name of as M1, M2, and M3.

There after, three samples were taken from near bed site by digging the field to 30 cm depth and these were filled in the polybag and named as NB1, NB2 and NB3.

Three more samples were taken from state forest site in the same manner and given the name StN1, StN2 and StN3.

Finally, small quantities of soil sample were mixed from each sample and named as mixed sample. It made a new sample.

Pretreatment

Drying

Soil sample was often dried by equilibrium at the atmosphere and room temperature (under certain circumstance). This may be raised to 30^{o}C for about 24 hrs under harsher conditions. The level of available nutrients may change and nitrogen containing compound interconvert.

Grinding

The drying process leaves the soil in large aggregates. This large aggregated soil was grinded by physical and mechanical methods. These soil samples were grinded so that the size may range from 20-2000 μm. During the grinding, soil sample was sieved two and three

times to remove the pebbles and other large particles. Now these soil samples were again filled in the labeled polybag for the further analysis of different soil parameters.

Analysis

The following parameters were analyzed:

(i) pH

(ii) Moisture

(iii) Electric conductance

(iv) Nitrogen

(v) Phosphorus

(vi) Potassium

(vii) Organic matter

(i) pH: pH can be defined as the negative logarithm of H^+ ion concentration to the base 10.

$$pH = -\log [H^+] = \log 1/[H^+]$$

The most reliable and convenient method for measuring pH of a given soil sample is pH meter. For measuring pH of given soil sample, an 100 mL empty beaker was weighed and then 20 g given soil sample was filled in it. Then 50 mL distilled water was poured in it and marked it as per the code of polybag.

This process was performed for every soil sample so that every 100 mL beaker would contain 20 g given soil sample and 50 mL distilled water and then it was kept for sometime in an undisturbed place.

Three standard solutions of pH 4.0, 7.0 and 9.0 were prepared using buffer capsules of respective pH. The pH meter was standardized using these buffer solutions.

The pH of the solution of each soil sample was measured with the help of pH meter. The electrode of pH meter was washed with distilled water after each measurement just to avoid any error in pH value measured. The recording of pH was done very carefully because there may be fluctuations in readings of pH meter. The stable value of pH was recorded.

(ii) Moisture: Moisture means the presence of water (soil water) in the soil in the small amount.

For the measurement of moisture, initially the dried petridishes were taken and weighted. Some amount of soil sample was taken in the petridishe and soil sample again was weighed to determine the moisture content before grinding (means in the form of small pieces of blocks). After weighting the marked petridishes as per as the polybag mark, coding was done for each soil sample.

After this, petridishes containing soil samples were kept in the hot oven at about 100°C for one hour. After one hour, sample was taken out from oven and again weighted. Then again, these soil samples were kept in the hot oven at 100°C. This process was repeated three to four times.

Finally, these samples were taken out from oven and weighed. The final weight of sample petridish was subtracted from the initial weight of sample taken out from oven and weight of sample with petridish from the initial weight of sample with petridish before putting it in oven.

Weight of petridish = X

Weight of soil sample + Petridish = Y

(Before keeping in oven)

Weight of soil sample + Petridish = Z

(After drying it in oven)

Moisture content = (Y – Z)

(iii) Electric conductance: 20 g sieve soil was taken in small beaker and then 50 mL distilled water was added in it. Then it was kept for one hour. 100 mL distilled water was taken in another beaker and the electrodes of E-C meter were washed by this distilled water. The reading of different soil sample were noted by conductivity meter at room temperature.

(iv) Organic matter

Reagent

(i) 0.1 N $K_2Cr_2O_7$

(ii) 0.5 N Ferrous ammonium sulphate (FAS)

(iii) Diphenylamine

(iv) o-Phosphoric acid

(v) Sodium fluoride

1 g sieved soil was weighed in 500 mL conical flask. 10 mL 0.1 N $K_2Cr_2O_7$ solution and 20 mL concentrated H_2SO_4 were added. Then 200 mL distilled water was added. The flask was kept aside for half an hour. 10 mL o-Phosphoric acid, 0.2 g NaF and 30 drops diphenylamine indicator were added and it was titrated against 0.5 N FAS solution. A color change from dark blue to green was noticed.

(i) Nitrogen

Reagent

(i) 0.32% $KMnO_4$

(ii) 2.5% NaOH

(iii) Boric acid

(iv) N/10 H_2SO_4.

(v) Mixed indicator

10 g soil was taken in 500 mL round bottom flask and 20 mL distilled water was added. Then 0.32% $KMnO_4$ and 100 mL 25% NaOH were added. Then distillation was carried out to absorb liberated ammonia in 10 mL boric acid, in 100 mL conical flask. Blue color was observed after titrating it with 0.1 NH_2SO_4.

(vi) Phosphorous

Reagent

1. 4 N HCl
2. 2,4- Dinitrophenol
3. 0.5 M $NaHCO_3$
4. Ammonium molybdate
5. Stannous chloride

2.5 g sieved soil sample was taken is 150 mL conical flask. 50 mL $NaHCO_3$ was added followed by pinch of charcoal and it was allowed to stand for 1 hr and then filtered.

5 mL filtrate was taken in 50 mL volumetric flask. 2-3 Drops of 2, 4-dinitrophenol indicator was added. Then 4 N HCl was added drop by drop to adjust the pH of solution till solution becomes colour less. 10 mL ammonium molybadate and 0.5 mL $SnCl_2$ were added and the volume was maked up to 50 mL with distilled water. The reading was taken on spectrophotometer at 660 mm.

(vii) Potassium

Reagent

1. 100 ppm K
2. Ammonium acetate

5 g soil sample was taken in 150 mL volumetric flask and add 25 mL ammonium acetate was added. It was shaken for 5-10 minutes and filtered with ordinary filter paper. Reading was taken were a flame photometer.

Methodology of randomized block design model of Jatropha plantation site

First of all a Jatropha plantation site was selected and one block was marked as control, in which no treatment was given. Three replications were made and each replica was divided into eight blocks. Four plants are taken from each block. So that 32 plants are present in each replica, so total 96 planted are treats with different fertilizers.

In first replica, approximate 10 g urea was used in first block, 10 g DAP in third block, 10 g SSP in fourth block, 10 g NPK (15 : 15 : 15) in fifth block, 10 g NPK (17 : 17 : 17) in sixth block, 10 g NPK(19 : 19 : 19) in seventh block and about 1 Kg compost in eighth block.

Similarly in second replica, approximate 1 Kg compost was used in first block, 10 g NPK (19 : 19 : 19) in second block, 10 g NPK (17 : 17 : 17) in third block 10 g NPK (15 : 15 : 15) in fourth block and 10 g SSP in fifth block, 10 g DAP in sixth block, 10 g MOP in seventh block, 10 g urea in eighth block. Again in third replica, approximate 10 g SSP was used in first block, 10 g DAP in second block, 10 g MOP in third block, 10 g urea in fourth block, 1 Kg compost in fifth block 10 g NPK (19 : 19 : 19) in sixth block, 10 g NPK (17 : 17 : 17) in seventh block and 10 g NPK (15 : 15 : 15) in eighth block. Proper irrigation was there at plantation site and different readings were taken at regular time period of three weeks.

Table 1: Treatment and composition of fertilizer

S. No.	Treatments	Fertilizer	Composition
1	Treatment-1	Urea	10 g
2	Treatment-2	MOP	10 g
3	Treatmens-3	DAP	10 g
4	Treatment-4	SSP	10 g
5	Treatment-5	NPK 15 : 15 : 15	10 g
6	Treatment-6	NPK 17 : 17 : 17	10 g
7	Treatment-7	NPK 19 : 19 : 19	10 g
8	Treatment-8	Compost	1 Kg
9	Treatment-9	Control	-

RESULTS AND DISCUSSION

Biofertilizer

After 84 days of study

The *Jatropha curcas* was treated with different fertilizers and growth parameters are given shown in Table 2 and soil parameter analysis reports in Table 3. NPK 17 : 17 : 17 fertilizer causes maximum increment in height (55.235 cm) of *Jatropha curcas* plant after 84 days where as NPK 19 : 19 : 19 fertilizer showed maximum increment of girth up to (1.96 cm) after 84 days. From the Table 2 it is clear that controlled treatment has least effect on the increment of height and girth of *jatropha curcas* plant, NPK 15 : 15 : 15 fertilizer has second maximum increment effect in height (about 50 cm) and DAP has second maximum effect in increment of girth 1.0 cm. Compost has second minimum increment effect on height 35 cm and girth 0.62 cm. while DAP 49.28 cm, SSP 47.34 cm, MOP 42.63 cm, and urea 42.71 cm shows moderate increment in height. Table 2 also indicates that NPK 19 : 19 : 19 shows maximum increment in girth up to 1.96 cm.

The other fertilizer causing increment in girth were NPK 15 : 15 : 15 (0.71 cm). SSP (0.92) cm, MOP (0.79) cm and NPK 17 : 17 : 17 (0.83 cm).

The soil condition of the plantation and near plantation site were shown in Table 3. The pH of the agro-forestry site after the analysis is 6.70 that shows slightly acidic property, while the pH of the medicinal plant site is 7.43 showing alkaline properties, while the pH of nursery bed site is 7.15 and the pH of the state forest site is 7.12.

Table 2: Effect of different fertilizer on the growth of *Jatropha curcas*

S. No.	Treatments	Before the treatment		After 21 days of treatment (cm)		Increment after 21 days (cm)		After 42 days of treatment (cm)		Increment after 42 days (cm)		After 84 days of treatment (cm)		Increment after 84 days (cm)	
		Height	Girth												
1	Urea	81.29	12.75	91.58	12.83	10.29	0.08	104.33	13.08	23.04	0.33	124.00	13.54	42.71	0.79
2	MOP	81.62	13.00	91.91	13.16	10.29	0.16	104.91	13.41	23.29	0.41	124.25	13.78	42.63	0.78
3	DAP	78.08	12.95	94.66	13.16	16.58	0.21	106.97	13.75	28.89	0.03	127.36	13.95	49.28	1.00
4	SSP	68.16	12.45	80.25	12.66	12.09	0.21	94.00	12.91	25.84	0.46	115.50	13.37	47.34	0.92
5	NPK 15 : 15 : 15	74.58	12.91	95.25	13.16	20.67	0.26	106.25	13.41	31.67	0.50	124.58	13.62	50.0	0.71
6	NPK 17 : 17 : 17	72.17	13.29	96.50	13.58	23.80	0.29	106.00	13.75	37.64	0.79	127.41	14.12	55.25	0.83
7	NPK 19 : 19 : 19	91.16	12.58	100.75	13.91	9.59	1.33	111.08	14.08	19.92	1.5	127.68	14.54	36.52	1.96
8	Compost	86.83	12.66	97.5	12.75	10.92	0.09	106.08	12.91	19.75	0.25	121.83	13.28	35.00	0.62
9	Control	91.83	14.16	102.38	14.20	10.55	0.04	111.16	14.14	19.33	0.24	121.65	14.82	29.82	0.66

Table 3: Soil analysis

S. No.	Site	pH	Mean	E.C	Mean	Moisture	Mean	Organic matter	Mean	Phosphorus	Mean
1	A-1	645		0.1		1.01		0.64		24.98	
2	A-2	6.70	6.70	0.2	0.22	1.12	1.33	0.66	0.63	24.92	24.97
3	A-3	6.68		0.3		1.72		0.64		25.12	
4	A-4	6.82		0.3		1.49		0.60		24.84	
5	M-1	7.35	7.43	0.2	0.20	1.09	1.90	0.66	0.66	56.5	56.3
6	M-2	7.45		0.2		3.30		0.68		56.2	
7	M-3	7.50		0.2		1.33		0.66		56.4	
8	NB-1	7.00	7.15	0.1	0.20	1.45	1.41	0.82	0.84	26.3	26.4
9	NB-2	7.15		0.3		1.10		0.85		26.8	
10	NB3	7.30		0.2		1.68		0.86		26.2	
11	ST.N-1	7.05		0.1		1.86		0.84		47.34	
12	ST.N-2	7.08	7.12	0.1	0.13	1.31	1.44	0.88	0.86	48.12	47.66
13	ST.N-3	7.20		0.2		1.15		0.88		47.52	
14	Mixed	7.20	7.20	0.1	0.1	1.24	1.24	0.74	0.74	38.24	38.24

Where, A = Agro forestry site, B = Medicinal plant bed site, NB = Nursery bed site, St. N = State forest nursery site

The E.C. of the agro-forestry site is 0.22, while the E.C of the medicinal plant site is 0.02, while the E.C of the Nursery bed site is also 0.20 and the E.C of the state forest site is 0.13.

The moisture of the agro-forestry site is 1.33 (very low), while the moisture of the medicinal plant site is 1.90, which is more than the agro-forestry site, the moisture of nursery bed site is 1.41 and the moisture of the state forest site is 1.44.

The organic matter of the agro-forestry site is 0.63, while the organic matter of the medicinal plant site is 0.66, while the organic matter of the nursery bed site is 0.84, and the organic matter of the state forest site is 0.86.

The phosphorous of the agro forestry site is 24.97, while the phosphorous of the medicinal plant site is 56.3, Nursery bed site is 26.4 and state forest site is 47.66.

Role of nitrogen, phosphorous and potassium in physiology of *Jatropha curcas*

Nitrogen: Nitrogen, an essential plant nutrient, is frequently in short supply in cultivated soils. Its role is connected with vigorous vegetable growth. Soil nitrogen is absorbed as ammonium and Nitrate forms. Nitrogen in organic from is unavailable to plant; it is converted in inorganic form as bacteria decompose organic compounds. Indian soils are generally nitrogen deficient. Nitrogen deficiency in plant results in stunted growth and chlorotic appearance. Conventional nitrogen fertilizer are ammoniacal, nitrates, nitrates combined ammoniaum nitrates and amide fertilizer, Non-conventional nitrogenous fertilizers include liquid nitrogen fertilizer anhydrous ammonia, aqua ammonia, nitrogen solutions etc., slow release nitrogen fertilizers (coating of urea with insoluble material or chemically converting the fertilizer into less soluble from or by incorporating urease and nitrification inhibitors).

Phosphorous: Phosphorous, a plant macronutrient is present in soil in varying degrees, usually high in virgin soil. Phosphorus concentration in plants is one-tenth of nitrogen. Its storage in seeds prepares them for germination. Soil phosphorus exists in three froms i.e.

(1) Inorganic compounds

(2) Organic compounds

(3) Soil solution

Soil solution is the actual sources of phosphorus for plants. Weathering reaction

results in releasing of phosphate anions in soil solution from other forms of soluble compounds. Soil solution at any one time is extremely small. Soil pH, temperature, soil organic matter, moisture, surface area of organic minerals etc. are the conditions that influences the release of phosphorus to soil solution. Immobilization of phosphorus reduces its availability to plants. Consumption of conventional phosphatic fertilizers forces India to import the phosphatic fertilizers and raw material for indigenous manufacturers of conventional fertilizers. Non-conventional phosphatic fertilizers e.g. low-grade rock phosphate can be directly used in acidic soils as a cheap alternative.

Potassium: Potassium is one of the three macronutrients for plants. The potassium content of fertilizer is given in terms of K_2O. It plays an important role in plant physiology and improves yield. Large proportions of the Indian soils contain potassium; however, it can be classified as relatively unavailable from, slowly available form or readily available form; In clay soils, there are no leaching losses of potassium whereas in sandy and organic soils, such losses occur.

It is important that there should be continuous supply of potash from sowing until harvest. Abundant K supply reduces bacterial population in general in root zone including denitrifying bacterial. K-Fertilizers should be applied after soil tests/plant analyses before any symptoms appear on plants. Calcareous soil/recently limed soils having large number of calcium caption, higher level of K is required.

Plant roots absorb most of required potassium through soil moisture. Inadequate soil moisture may result in poor absorption of K-nutrient by plant. Reduced soil temperature and liming results in low amount of potassium in soil solution. Poor soil aeration also reduces potassium uptake by plants. Conventional K-fertilizers are muriate of potash (KCl) and sulphate of potash (K_2SO_4). Non-conventional K-sources include glauconitic a slow release fertilizer. In our opinion, NPK 17 : 17 : 17 was the better fertilizer recommended for the growth of *Jatropha curcas* plant under the analyzed condition of pH, E.C, moisture, organic matter and phosphorous (From Table 3) present in the soil and it is very helpful in the vegetative growth of *jatropha curcas* plant. However, NPK 15 : 15 : 15 shows second priority under such condition of soil parameterts while the other treatments show moderate effect on the growth of *Jatropha curcas* plant. Under this soil condition NPK 17 : 17 : 17 shows better result by increasing the property of mineral uptake by roots of *Jatropha curcas* plant and this fertilizer can easily flow and move in whole plant body by which plant grows rapidly. Fig. 1 shows increment in girth after 21 days, Fig. 2 shows increment in height after 21 days. Fig. 3 shows increment in girth after 42 days, Fig. 4 shows increment in height after 42 days, Fig. 5 shows increment in girth after 84 days and Fig. 6 shows increment in height after 84 days.

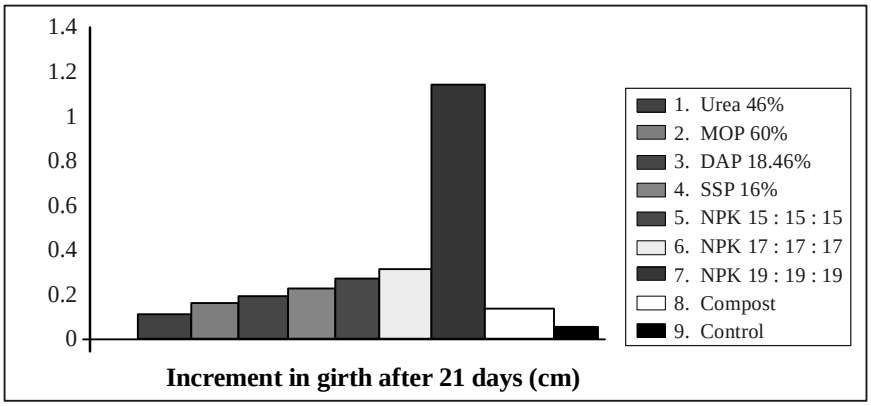

Fig. 1: Increment in girth after 21 days

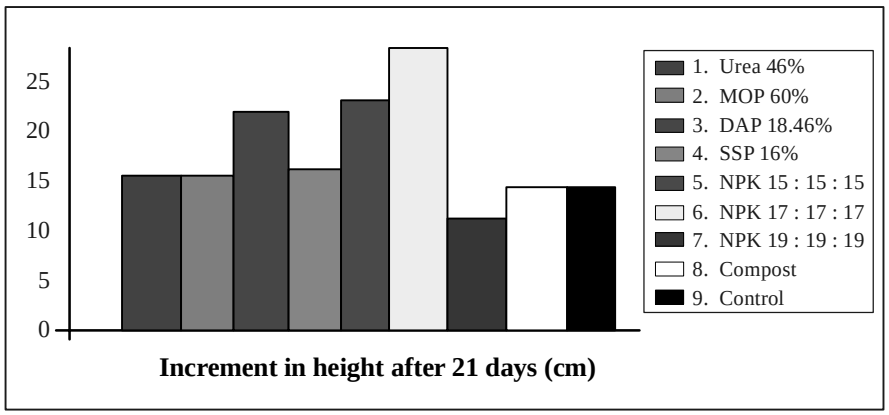

Fig. 2: Increment in height after 21 days

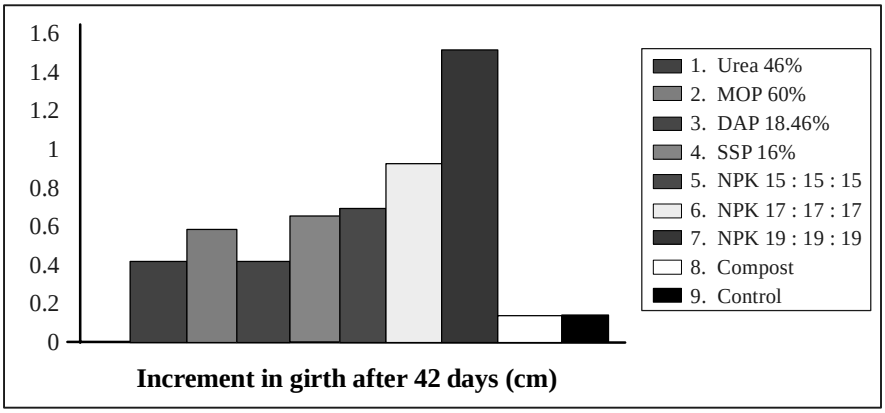

Fig. 3: Increment in girth after 42 days

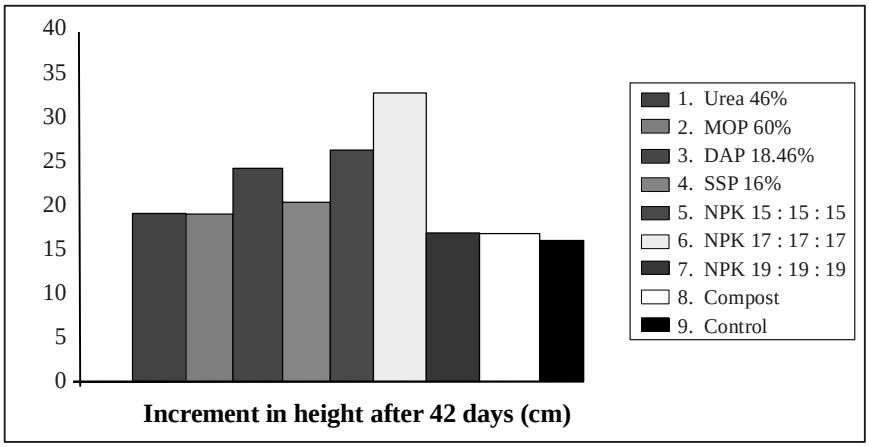

Fig. 4: Increment in height after 42 days

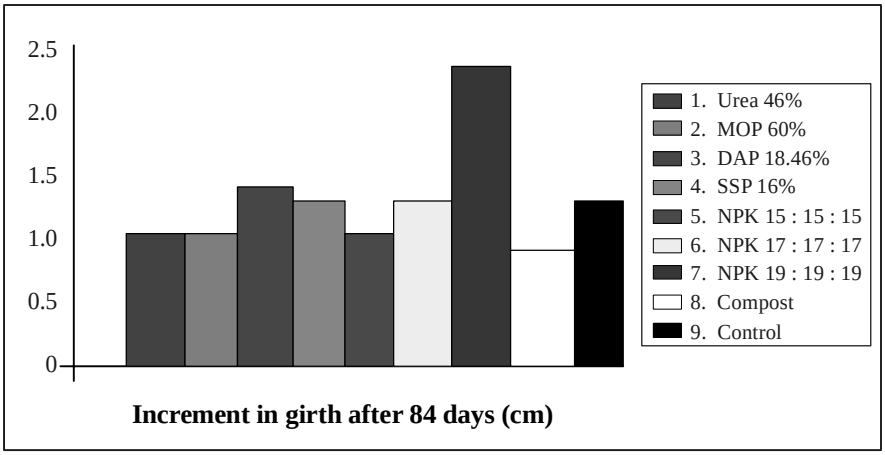

Fig. 5 Increment in girth after 84 days

CONCLUSION

This is possible only, when some fertilizer treatments are applied the *Jatropha curcas* plant for their early and better growth from biodiesel may be extracted and it may solve a great problem of energy source in india.

On the basis of this work, it may be conclused that *jatropha curcas* is a multiuse plant and has various impertinences in the various filed such as biofencing, reclamation of wasteland agro-forestry, medicine, raw material and most important biofertilizer and producing biodiesel. Biofertilizer is the major product obtained from the *jatropha curcas*

plant. The economy of developing countries mainly depends on the renewable energy resources. So *jatropha curcas* plant came in front as a green manure for crop production. Tender branches and leaves of *jatropha curcas* are used as green manure for coconut trees. Jatropha oil cake can hopefully replace chemical fertilizers. The leaves may provide possible plentiful organic matter and increase microbial activity of site improvement. *Jatropha carcus* can play significant role in meeting fertilizer need and enhance agricultural production without the use of polluting chemicals. Jatropha oil cake is also an organic fertilizer.

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