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Effect of Fertilizers on Agronomy Practices for Optimizing Jatropha Seed Production

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ABSTRACT

One of the best attribute pertaining to Jatropha is its ability to grow in low fertile marginal soil as envisaged in this experiment. The present study deals with agronomic trials with the aim to find out best agronomy practices with respect to irrigation and fertilizer for optimizing Jatropha seed production. Plots were laid out in split-plot design and treated with urea 12 gm/plant, MoP 20 gm/plant, DAP 20gm/plant, Sulphur 5gm/plant, Azotobactor 2.78gm/plant, Trichoderma 2.78gm/plant, PSB 2.78gm/plant, either alone or in combination. Three times fertilizer application added with Sulphur was found the best treatment for higher production. The maximum height, diameter, branches, crown length & breadth observed in Jatropha plant due to three times application of fertilizer (Urea, DAP, MoP) with sulphur. Fertilizer application rendered great role in the seed production of Jatropha.

Key words: *Jatropha curcas, Fertilizers, Bio-fertilizers, Irrigation, Height, collar diameter, Branches, Flowering branches.*

INTRODUCTION

The call for alternative source of energy such as bio-energy felt intensely in recent years due to the current global crisis of energy production and the pressure to cut Co_2 emissions. Due to the green energy strategies together with the blending requirement of diesel adopted by many countries, much attention has been laid on plant-based feedstock for biodiesel production[1]. Since the flow of interest in recent years is to look for alternatives to liquid fossil fuels, concentration has been focused on the possibility of growing *Jatropha curcas* L., for the purpose of producing oil to be used as biofuel. *Jatropha curcas* L., in last few decades has received considerable interest of the policy makers and scientists all over the globe as a potential source of non-edible vegetable oil. It has become a prospective candidate for large scale plantation on poor marginal lands due to its diverse benefits, as a source of soil ameliorator as well as green manure, for its medicinal properties for human and veterinary ailments[2,3&4], plant protectant being insecticidal properties[5,6,7&8], raw material for dye[9], one of its non toxic variety as human food[10,11,12,13&14],

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oil for soap making[15], seed cake as manure[16,17,18,19&20] and its tremendous possibility to advance rural economy by generating enormous working days for employment during different stages of its cultivation and downstream processing for obtaining vegetable oil to be used as biofuel[21,22,23,24,25,26&27].

It produces seeds upto 50 years with a high oil content of about 37% or more[28]. However, the current seed biomass output of Jatropha for production of biofuels is inadequate to completely replace fossil fuels[29].

Jatropha is often described as having a low nutrient requirement because it is adapted to grow in poor soils. The potential of *Jatropha curcas* to survive on marginal lands offers it a great competitive ability over other bio-energy crops[30].

A majority of work has been done on Jatropha on its germplasm evaluation and there is insufficient data on jatropha responses to fertilizer under different growing conditions. It is to be noted that favourable environmental conditions that affect its production are yet to be known[31].

Present investigation finds out best Agronomy practices with respect to irrigation and fertilizer for obtaining maximum height, maximum collar diameter, maximum number of branches etc. for optimizing Jatropha fruit production.

METERIALS AND METHODS

The Study Site

The field lay out of the experiment was established at Nagri, Ranchi, Jharkhand, India (Latitude: $23^0$21.388' N, Longitude: $85^0$14.661' E). The area has the geography of medium elevation plateau with sub-tropical and sub-humid climate with an altitude of 685 meters and has dry-deciduous forest Vegetation. Ranchi receives an average rainfall of 1423.9mm, receiving rains about two and a half months (73 days of a year) with 19 % coefficient of variation. The experimental area receives 82% of the rainfall within the four months of Monsoon ranging from June to September with the summer and post Monsoon rains adding about 8% and 7% respectively. Least rainfall occurs in winter with 3% rainfall[32].

The temperature recorded during the peak period of this experiment i.e. during 2012 ranged from highs of 42.2 °C to lows of 4.7 °C[33]. The mean monthly temperature of the area varies between 23°C and 33°C with lowest in December and highest in May or June.

The area has higher average humidity during the rainy season from July to September (82.93, 84.50 and 81.66% respectively) [34].

The experimental plot was a wasteland in nature, having low fertile red lateritic acidic soil. The surface of the field contained moram and gravels with medium natural drainage. While some part of the replications was over the subtle slope, the majority of the replication was planted on a levelled surface. The soils collected from the experimental site during June, 2012 were sent to NBRI, Lucknow for soil characteristic analysis that revealed following characteristics.

Range of different Soil parameters for the trial plot

Parameter	Range
pH	5.63-6.53
EC(µS)	9.18-22.17
Available Nitrogen (%)	0.03-0.04
Available Phosphorus(mg/g)	0.004
Available Potassium(mg/g)	0.03
TOC (%)	0.86-0.90

Experimental Design

Agronomy trial was established in February, 2011 with four replications in Split-plot design of the experiment. In the main plot, 7 treatments of fertilizer were applied. In the sub-plot, 20 accessions of Jatropha cuttings

were planted at a rate of 9 plants per accessions at an enspacement of 3m×3m. The details of treatments and origin of accessions are given hereunder in Table 1A and 1B.

Table 1: The details of main plot treatments (fertilizer treatments) in January, May and December of every year

Fertilizer treatments	Treatment details	Quantity of treatment
T1	No Fertilizer	Fertilizer (Per plant)- Urea 12g, DAP 20g, MOP 20g Biofertilizer (Per plant)- Vermicompost 1kg, Azotobacter 2.78g, Tricoderma 2.78g, PSB 2.78g
T2	Fertilizer I (One time in a year) January	
T3	Fertilizer II (Two times in a year) January and May	
T4	Fertilizer III (Three times in a year) January, May and September	
T5	Fertilizers III (Three times in a year) with Sulphur (January, May and September)	
T6	Biofertilizers I (One time in a year), Vermicompost I (One time in a year) January	
T7	Biofertilizers II (Two times in a year), Vermicompost II (Two times in a year) January and May	

Table 1B: The details of 20 accessions of Jatropha for the experiment

Sl. No.	Indigenous collection (IC) number of the Accession	Source of origin of the Accession
1	IC 555379	Nandan, Hyderabad
2	IC 555383	Nandan, Hyderabad
3	IC 555381	Nandan, Hyderabad
4	IC 555380	Nandan, Hyderabad
5	IC 555382	Nandan, Hyderabad
6	IC 564010	Nandan, Hyderabad
7	IC 566603	Ruchi, Indore
8	IC 566612	Ruchi, Indore
9	IC 566602	Ruchi, Indore
10	IC 569131	Ruchi, Indore
11	IC 558210	Ruchi, Indore
12	IC 471359	Biotech Park, Lucknow
13	IC 471358	Biotech Park, Lucknow
14	IC 471344	Biotech Park, Lucknow
15	IC 468909	Biotech Park, Lucknow
16	IC 553592	Biotech Park, Lucknow
17	IC 550449	Biotech Park, Lucknow
18	IC 560620	Biotech Park, Lucknow
19	IC 560627	Biotech Park, Lucknow
20	IC 560653	Biotech Park, Lucknow

Measurements

Following measurements, among others, were made: plant height, collar diameter, number of branches per plant, number of flowering bunches per plant, fruit number; seed number, seed weight and other remarkable feature like disease susceptibility etc. were recorded.

Data analysis

The data obtained were subjected to statistical analysis, employing analysis of variance (ANOVA), *'F'*-test for significance at $P \leq 0.05$ and computing LSD values to separate means in different statistical groups using statistical software SPSS version 18.

RESULTS AND DISCUSSION

As shown in Table-4, Effect of fertilizer on three quantitative traits viz., collar diameter, number of branches and number of fruits were found significant. Application of fertilizer by three times in a year with or without sulphur was found best for collar diameter and number

of branches. One time or two times application of biofertilizer and vermicompost produced a better production of fruits than one or two-time application of fertilizer in a year. Whereas, application of fertilizer by three times without sulphur was recorded maximum fruit production after 1.5 years of plantation followed by three times application of fertilizer with sulphur. Interestingly, in the next year, the maximum fruit production was found in the application of fertilizer with sulphur by three times in a year. The effect of sulphur was found significant for fruit production in Jatropha.

Table 4: Mean sum of squares for three quantitative traits after 1.5 - 2 years of plantation

Source of variation	df	Mean sum of square		
		collar diameter (mm)	number of branches	Number of fruits
Replication	3	2102.78	104.912	141.676*
Fertilizer	6	3345.77*	107.742*	107.121*
Main plot Error (Rep * Fer)	18	773.97	33.775	35.002
Accession	19	263.06**	23.624**	8.773**
Accession x Fertilizer Interaction	114	66.43 NS	4.197 NS	2.410 NS
Sub-plot Error	399	54.76	3.558	2.680

*, ** Significant at the 0.05 and 0.01 probability levels, respectively

Table 5: Mean and Standard Error of Mean for two quantitative traits under fertilizer treatments (after 1.5 to 2 years of plantation)

Fertilizer treatments	**Treatment details**	**Collar diameter (mm)**	**number of branches**
T1	No Fertilizer	33.206a	3.987
T2	Fertilizer I	44.749b	4.943
T3	Fertilizer II	47.914c	6.362
T4	Fertilizer III	**52.251d**	**7.112**
T5	Fertilizers III with Sulphur	**51.723d**	**7.689**
T6	Biofertilizers I, Vermicompost I	43.404b	5.308
T7	Biofertilizers II, Vermicompost II	43.200b	5.352
SE		4.4	1.55
CD		7.61	2.68

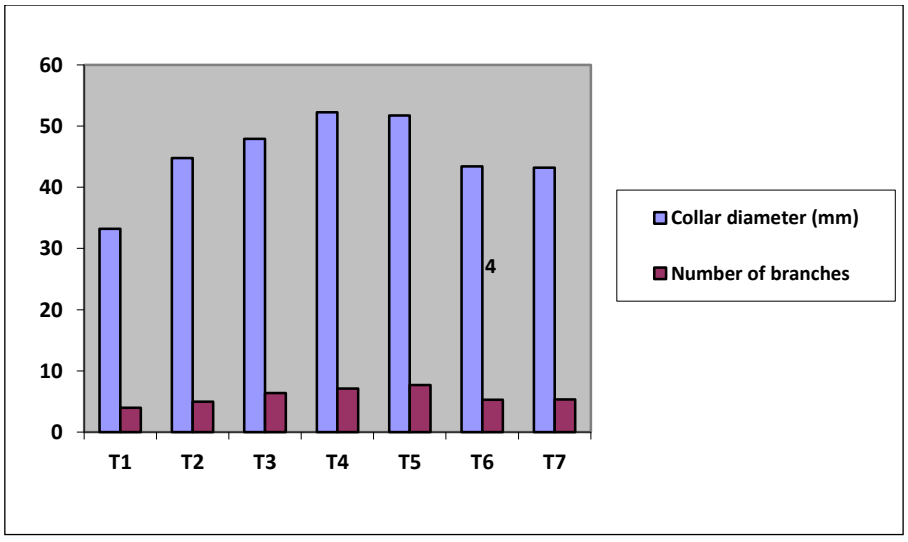


Fig. I: Shows the Collar diameter and number of branches in seven treatments (After 1.5 to 2 years of plantation)

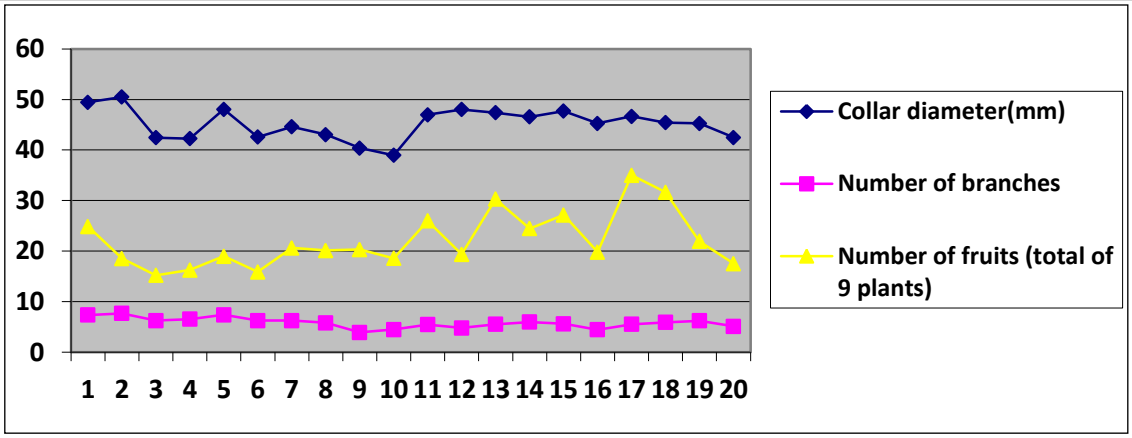


Fig. II: Shows the Collar diameter number of branches and number of fruits in 20 accessions

Table 6: Effect of Accessions on three quantitative traits (after 1.5 to 2 years of plantation)

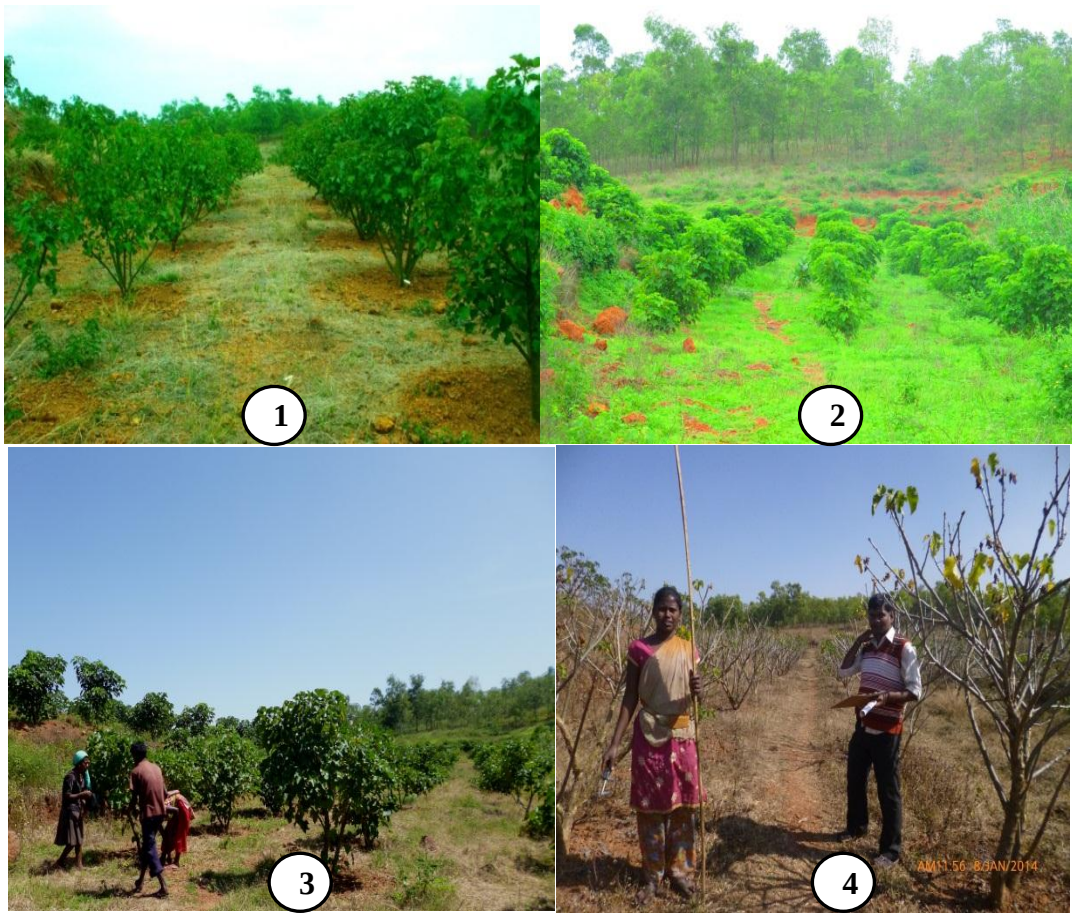
Code	Accessions	Collar diameter (mm)	Number of branches	Number of fruits (total of 9 plants)
1	IC 555379	**49.453**	**7.363**	**24.871**
2	IC 555383	**50.502**	**7.689**	**18.527**
3	IC 555381	**42.444**	**6.261**	**15.213**
4	IC 555380	**42.253**	**6.532**	**16.269**
5	IC 555382	**48.067**	**7.402**	**18.975**
6	IC 564010	**42.574**	**6.250**	**15.870**
7	IC 566603	**44.611**	**6.236**	**20.632**
8	IC 566612	**43.048**	**5.797**	**20.121**
9	IC 566602	**40.396**	**3.892**	**20.312**
10	IC 569131	**38.961**	**4.489**	**18.571**
11	IC 558210	**46.998**	**5.453**	**25.992**
12	IC 471359	**48.036**	**4.798**	**19.365**
13	IC 471358	**47.406**	**5.523**	**30.303**
14	IC 471344	**46.561**	**5.969**	**24.460**
15	IC 468909	**47.704**	**5.604**	**27.147**
16	IC 553592	**45.264**	**4.459**	**19.804**
17	IC 550449	**46.672**	**5.513**	**35.022**
18	IC 560620	**45.443**	**5.899**	**31.660**
19	IC 560627	**45.266**	**6.205**	**21.939**
20	IC 560653	**42.472**	**5.102**	**17.537**
	SE	1.98	0.504	0.438
	CD	3.25	0.828	0.718

Three times fertilizer application added with sulphur is the best treatment so far for higher production of fruits and seeds in Jatropha. Best performer accessions on the basis of collar diameter or number of branches are not producing higher number of fruits or seed weight except IC 468909 and IC 566603. Four accessions out of top five accessions in Agronomy trial in the production of seeds in the first year are continuing in their performance in the next year also.

Table 7: Effect of fertilization on fruit production (after 3 years of plantation)

		(after 1.5 to 2 years of plantation)	**(after 3 years of plantation)**	
Fertilizer treatments	Treatment details	Number of fruits/ treatment	Fruits/ 9plants	Fruits/ plants
T1	No Fertilizer	11.569	3.50	0.39
T2	Fertilizer I	14.508	44.79	4.98
T3	Fertilizer II	16.376	57.11	6.35
T4	Fertilizer III	45.022	153.01	17.00
T5	Fertilizers III with Sulphur	33.303	249.46	27.72
T6	Biofertilizers I, Vermicompost I	19.240	66.58	7.40
T7	Biofertilizers II, Vermicompost II	20.844	70.66	8.10
SE		1.58		
CD		2.73		

Fertilizer application has a great role in the seed production of Jatropha. In control, after 3 years of the plantation, it produces 0.39 fruits/plant whereas in T5 treatment (3 times fertilizer with sulphur) produces more than 27 fruits/plant. Again if we go for a selection of good accessions, the production would be more than double. The average production of top five accessions in T5 treatment is 77 fruits/ plant.



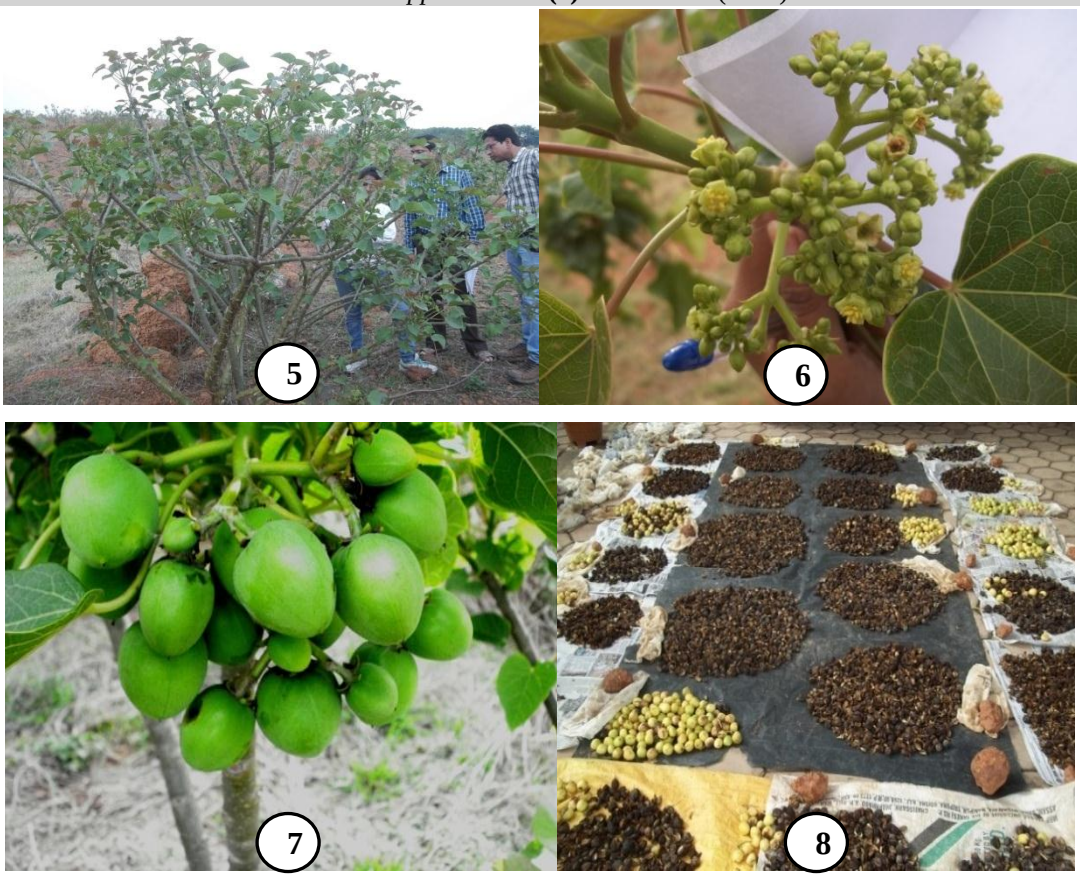


Fig. III: (1) Agronomy trial plot of August 2011 (2) Agronomy trial plot of September 2012 (3) Agronomy trial plot of Oct. 2013 (4) Agronomy trial plot of Feb. 2014 (5) Luxurious growth with higher branches (6) Flowering in Jatropha (7) Fruiting in Jatropha (8) Sun drying of fruits

Table 8: Top ten accessions on the basis of fruit production (after 3 years of plantation)

Accession	Fruits / plant	Source of origin of the Germplasm	Accession	Fruits / plant	Source of origin of the Germplasm
550449	28.96	Biotech Park, Lucknow	555379	19.22	Nandan, Hyderabad
560620	28.35	Biotech Park, Lucknow	553592	17.56	Biotech Park, Lucknow
566603	24.06	Ruchi, Indore	555383	17.20	Nandan, Hyderabad
471358	22.97	Biotech Park, Lucknow	558210	16.55	Ruchi, Indore
471344	22.21	Biotech Park, Lucknow	468909	16.45	Biotech Park, Lucknow

CONCLUSIONS

Fertilizer application had a great role in the seed production of Jatropha. Three times fertilizer application added with Sulphur was the best treatment for higher production. The effect of sulphur was found significant for fruit production in Jatropha.

Best performer accessions on the basis of collar diameter or number of branches are not producing a higher number of fruits or seed weight except IC 468909 and IC 566603. Top five accessions on the basis of yield were 550449, 560620, 566603, 471358, & 471344. Four accessions out of top five accessions in Agronomy trial in the production of seeds in the first year are continuing in their performance in the next year also.

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