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Oil content analysis of *Jatropha curcas* L. seeds under agronomical treatment with N, P, K and Gypsum

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Abstract
Jatropha curcas L. has the potential to become one of the world's key energy crops. Present study deals with agronomic trials pertaining to find out best agronomy practices with respect to irrigation and fertilizer for optimizing *Jatropha* seed production and their oil percentage. The experiment was conducted at Nagri field 7 Km away from IFP, Lalgutwa. Oil was extracted from the seeds which are obtained from 3 years old plant. Three times fertilizer application added with sulphur was screened out as best treatment for higher production of seeds of *Jatropha*. Solvent extraction techniques were used for oil extraction. Sulphur containing gypsum played an important role in increasing the yield and oil percentage in seeds of T_5 treatment which is in conformity with the results of earlier works. The effect of sulphur on number of fruits plant^{-1}and number of seeds fruit^{-1} was found significant when gypsum was applied.

Keywords: *Jatropha curcas*, oil percentage, sulphur

Introduction
Jatropha curcas L. is a member of the spurge family, Euphorbiaceae. A native to the American tropics, most likely Mexico and Central America, it has been introduced to Africa and Asia and is now under cultivation in tropical and subtropical regions through the world, and adapted to arid and semi-arid conditions (Janick *et al.*, 2008). *Jatropha curcus*, one of the prospective of non-edible fuel-producing crops is commonly called 'Ratanjyot'. It is a small tree or large shrub, which starts bearing fruits from the 2nd years. It is multipurpose plant valued not only for its medicinal properties and resistant to various stresses but also for its use as oil seed crop (Heller 1996, Staubmann 1999, Openshaw 2000). It can be grown on a wide range of soil types including wasteland and in gravelly, sandy, degraded or acidic soil (Openshaw, 2000) and over a diverse range of agro-climatic conditions. It has low requirements of fertilization and can grow under low rainfall conditions.

The seeds contain 4–40% viscous oil. The oil is a clean fuel, reducing greenhouse gas emissions, has greater lubricity and reduces engine wear. Fruits are produced in winter or throughout the year depending on temperature and soil moisture. *Jatropha* fruit contains 37.5% shell and 62.5% seed. Seeds have 42% husk and 58% kernel (Singh *et al*., 2007).

The productivity of *Jatropha* depends on proper fertilizer management practices. Type of Fertilizer determines the yield of seeds and percentage of oil in *Jatropha* and hence the aim of this experiment was.

Materials and Methods
Study site
Field experiment performed at Nagri research field, situated 7 Km west of the Institute of Forest Productivity, Ranchi (Latitude: 23^{0}21.3' N, Longitude: 85^{0}14.6' E and altitude 685 m). The experimental site was flat wasteland having low fertile red lateritic acidic soil with moram and gravels and with medium natural drainage. The area has a Sub-tropical and sub-humid climate with dry-deciduous vegetation type. The annual temperature is 27.5°C, reaching maximum up to 34.9°C and minimum up to 18.5°C. The relative humidity of the site averages 76%. The average annual rainfall is 1423.9 mm. The major rainy months are June to September contributing 82% of the rainfall with the summer and post Monsoon rains adding about 8% and 7% respectively (Wadood *et al*., 2009).

Experimental Design
Agronomy trial was established in February 2012 with four replications in split-plot design of the experiment. In the main plot, 7 treatments of fertilizer were applied.

In each treatment (the sub-plot), 20 accessions of *Jatropha* were planted at a rate of 9 plants per accessions at enspacement of 3m×3m. The details of treatments are given in Table 1. The amount of oil from the seeds obtained from the three-year-old plants was calculated as percentage of total oil present in kernel part of seeds. It has been found that treatment T_5 was best with respect to fruit yield than the rest of the treatments. The data of oil content obtained were subjected to statistical analysis.

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
T_1	No Fertilizer	Fertilizer (per plant)- Urea 12g, DAP 20g, MOP 20g
T_2	Fertilizer I (One time in a year) January	
T_3	Fertilizer II (Two times in a year) January and May	
T_4	Fertilizer III (Three times in a year) January, May and Sepember	Biofertilizer (per plant)- Vermicompost 1kg, Azotobacter 2.78g, Tricoderma 2.78g, Gypsum 5g per plant
T_5	Fertilizers III (Three times in a year) with Gypsum (January, May and Sepember)	
T_6	Biofertilizers I (One time in a year), Vermicompost I (One time in a year) January	
T_7	Biofertilizers II (Two times in a year), Vermicompost II (Two times in a year) January and May	

Determination of oil percentage

The oil percentage was calculated by the formula.

$$\text{Oil percentage} = (M_o/M_k) \times 100$$

Where M_o = Mass of oil in gram, M_k = Mass of kernel in gram

Results and Discussion

Table 2 shows that three times fertilizer application added with Gypsum is the best treatment so far for higher production of fruits and seeds in *Jatropha* are concerned. Sulphur containing gypsum played an important role in increasing the oil percentage in seeds of T_5 treatment which is in conformity with the results of earlier works. The effect of sulphur on a number of fruits plant^{-1}and number of seeds fruit-1 was found significant when gypsum was applied. Sulphur plays an important role for enhancing the reproductive growth with a positive effect on the proportion of tissues of the reproductive organs (inflorescence and capsules) (Grath and Zhao, 1996). Further, sulphur increases leaf area and chlorophyll content of leaves resulting in higher photosynthesis and assimilation, metabolic activities ultimately lead to overall improvement in vigour and yield attributes and finally seed yield (Chaubey and Dwivedi, 1995). Sulfur is the fourth major plant nutrient after nitrogen, phosphorus and potassium and contributes a important role in the synthesis of the amino acids like *cystine, cysteine* and *methionine*, a component of vitamin A and also activates certain enzyme systems in plants (Havlin *et al.,*2004). Sulphur improves the efficiency of applied NPK fertilizers (Ahmad *et al.*, 1994).

Oilseed plants have a high sulfur need (Aulakh & Pasricha, 1988; Tandon, 1986; Kanwar & Mudahar 1985). Sulfur fertilization has been used to increase the oil content in seeds of groundnut (Singh, 1986), rapeseed-mustard (Aulakh *et. al.*, 1980), sunflower (Singh & Sahu, 1986) and sesame (Gaur, 1980).

Table 2: Effect of fertilization on fruit production (after 3 years)

Fertilizer treatments	Treatment details	Number of fruits/ treatment (after 1.5 to 2 years)	Fruits/ plants (after 3 years)
T_1	No Fertilizer	11.57	0.39
T_2	Fertilizer I	14.51	4.98
T_3	Fertilizer II	16.38	6.35
T_4	Fertilizer III	45.02	17.00
T_5	Fertilizers III with Gypsum	33.30	27.72
T_6	Biofertilizers I, Vermicompost I	19.24	7.40
T_7	Biofertilizers II, Vermicompost II	20.84	6.20
S.E. (m)		1.58	
C.D.5%		2.73	

Among the seven treatments of this experiment, treatment five (T_5) was selected for calculation of oil percentage since the rest of the treatment were not economical in terms of fruit yield. Table 3 shows the data of oil percentage of 20 accessions of T_5 (best treatment of *Jatropha* plant in terms of a number of fruits per plant). It ranged from 19.92% to 43.2%. The accession, IC 560620 produced the maximum percentage of seed oil (43.2 %) in T_5 of agronomy trial plot. The maximum seed oil was found in IC 560620 (43.2%) followed by IC 553592 (35.81%), IC 555383 (35.66%), IC 564010 (33.28%), IC 555380 (32.87%), IC 555382 (32.6%), IC 471358 (32.55%), IC 566603 (32.44%), IC 569131 (31.4%), IC 555381 (31.15%), IC 471344 (31.12%), IC 471359 (29.68%), IC 550449 (29.05%), IC 566602 (28.47%), IC 555379 (27.29%), IC 560627 (25.33%), IC 468909 (24.88%), IC 560653 (23.23%), IC 558210 (20.21%) and least in IC 566612 (19.92%).

Table 3: Seed oil (%) of 20 accessions raised in trial plots

Code	Accession	Average seed oil (%)	Code	Accession	Average seed oil (%)
1	IC 555379	27.29	11	IC 558210	20.21
2	IC 555383	35.66	12	IC 471359	29.68
3	IC 555381	31.15	13	IC 471358	32.55
4	IC 555380	32.87	14	IC 471344	31.12
5	IC 555382	32.60	15	IC 468909	24.88
6	IC 564010	33.28	16	IC 553592	35.81
7	IC 566603	32.44	17	IC 550449	29.05
8	IC 566612	19.92	18	IC 560620	43.20
9	IC 566602	28.47	19	IC 560627	25.33
10	IC 569131	31.40	20	IC 560653	23.23

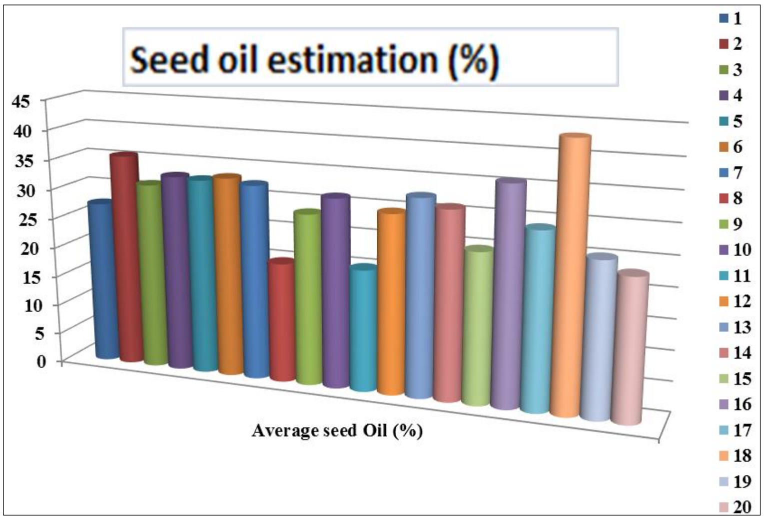

Fig 1: Oil percentage in 20 accessions of T_5 of trial plot

Table 4 shows that there are correlation between fruits production and oil percentage in most of the accession. Higher the fruits production per plant in each accession with higher percentage oil content in that accession.

Table 4: Oil percentage in top ten accessions on the basis of fruit production in T_5 of trial plots (after 3 years)

Accession	Fruits / plant	Average seed oil (%)	Accession	Fruits / plant	Average seed oil (%)
IC 550449	28.96	29.05	IC 555379	19.22	27.29
IC 560620	28.35	43.20	IC 553592	17.56	35.81
IC 566603	24.06	32.44	IC 555383	17.20	35.66
IC 471358	22.97	32.55	IC 558210	16.55	20.21
IC 471344	22.21	31.12	IC 468909	16.45	24.88

Conclusions

The productivity of *Jatropha* depends on proper fertilizer management practices. Type of fertilizer determines the yield of seeds in *Jatropha*. In present experiment, control produces 1 fruits/plant whereas in T_5 treatment (3 times fertilizer with gypsum) produces more than about 28 fruits/plant on three years old *Jatropha* plants. It shows the enhancing role of sulphur containing gypsum on productivity and oil percentage of *Jatropha*.

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