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Biomass Production of *Jatropha curcas* L., a Comparison

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Abstract

Height, weight of wood, vegetative growth rates in field and pot condition and a comparison of biomass of *Jatropha curcas* L. by using fertilizer and without fertilizer were studied. Results showed that although survival rate in pot condition was higher (58.06%) than that of field condition (49.14%), other biomass parameters were better in field condition. Average biomass of plants (dry weight) in pot condition was 62.09 g, and it was 209.28 g in field condition after one year. Associations among the parameters of biomass growth of the plant also studied here to show how the rate of change of length and diameter of stem, number of branches are interrelated in overall vegetative growth. Fertilizers used in the process of cultivation of *J. curcas,* better yield in terms of biomass production could be obtained than the condition where no fertilizer was used. Here on an average biomass of plants was 291.25 g without fertilizer and it was 683.75 g when fertilizers had been used. The extent of differences in all conditions are analyzed in the paper. Analysis and findings of this study might help to get information on better cultivation of *J. curcas* for mass production of this plant.

Key words: *Jatropha curcas* L., Vegetative growth, Biomass production, Fertilizer

Introduction

Jatropha curcas L. (Fam. Euphorbiaceae) is a drought-resistant bush or small tree with spreading branches and stubby twigs that grows to 6 meter high under favorable conditions.

The wood and fruit of *Jatropha* can be used for numerous purposes including fuel. The seeds contain (50% by weight) viscous oil, which can be used for manufacturing of candles and soaps, in the cosmetics industry, for cooking and lighting by itself or as a diesel/paraffin substitute or extender. This latter use has important for meeting the demand for rural energy services and also exploring practical substitutes for fossil fuels to counter greenhouse gas accumulation in the atmosphere. Seed-cake or press-cake is a by-product of oil extraction. *Jatropha* seed-cake contains curcin, a highly toxic protein similar to ricin in Castor, making it unsuitable for animal feed (RF, 1998, Makkar *et al.*, 2001).

Cultivation of *Jatropha* appears viable in many countries in the world. *Jatropha* may not replace other important food crops since it is meant for flood free wastelands and unutilized fallow lands/less productive lands and in turn will not have a major impact on cropping pattern (Kochar *et al.,* 2005). Moreover, *Jatropha* adapts well to marginal as well as live fence, as farm animals do not brows it (Heller, 1996, Joker and Jepsen, 2003). In addition to that, it is predicted that the demand for biomass in developing countries will increase with population, although the proportion of energy provided by biomass may remain constraint on a global or even a country basis (Scurlock & Hall, 1990, Kenny *et al*, 1990).

Considering the huge potentials in energy sector and socio-economic and medicinal uses of *J. curcas,* the present research has been undertaken.

Materials and Methods

To compare biomass production of *J. curcas,* cultivation in (i) pot and field condition (experiment-1), and (ii) with and without utilization of fertilizers (experiment-2) was carried out.

Experiment - 1

Stem cuttings were collected from Chittagong, Jessore, Sylhet and Thakurgaon districts of Bangladesh. The cuttings were 200 - 300 mm long with a diameter of 13.00 - 20.50

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mm. A total of 196 cuttings were planted in the research field at Institute of Fuel Research and Development (IFRD) of Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka and 115 cuttings were sowed in earthen pot filled with soil. Stem cuttings used in the experiments were collected and planted in March, 2007. All together 311 cuttings were cultivated for comparing the biomass in two different conditions and to assess their variation.

Preparation of research field and sowing of stem cuttings

The soil of the experimental field was a clay loam pH with 6.58. Range of annual humidity and temperature were 53-92% and 14.5-35.0° C, respectively. The line to line distance was 1.5 m. Stem cuttings were sown in the soil at a depth of 4-6 cm and plant to plant spacing of plantation was 2 m. Watering was done four times per week in November to February and two times per week in March and April and no watering was done in May to October of the study period. Weeding and other cultural practices were done as and when necessary. Cuttings were observed regularly to find its bud initiation, growth rate and survival rate. After two years of plantation, data were collected on the basis of some important parameters like stem diameter, stem length, fresh weight of cuttings, dry weight, branch diameter, branch length and fresh weight and dry weight of branch cuttings from October, 2009.

Preparation of earthen pots and sowing of stem cuttings

The experiment was carried out in the earthen pot at IFRD, BCSIR, Dhaka. Air-dried soil with pH 6.40 was used in the earthen pot. Stem cuttings were sown in the soil at a depth of 6 cm in each earthen pot. Afterwards, the cuttings were examined daily for its bud initiation, growth rate and survival rate. Watering, weeding and data collection were done similarly to the field experiment as mentioned earlier.

Finally, 32 plants from each of field and pot cultures were cut down for measuring length, diameter, fresh weight and dry weight.

Experiment - 2

Field preparation, stem cutting and sowing, watering and weeding and all other cultivation procedures were performed in the same way as in the first experiment, but the study period was different. Here cuttings were collected and sowed in March, 2010 and after seven months of cultivation they were cut down, processed and data were collected in October, 2010.

In this experiment, two different fields 50×60 m were used. In one field no fertilizers were used and in another field root hormone (3G)-3 kg/acre, Magnesium Sulphate (Follymag)-6 kg/acre, Borne-3.6 kg/acre, TSP, Urea and MP each 120 kg/acre were used.

The collected data were analyzed statistically and mean, standard deviation and other calculations were evaluated considering 5% level of significance by SPSS (Statistical Package for Social Science), version 12.

Results and Discussion

Data on stem length, stem diameter, dry weight, and number of branches were measured and the results have been presented separately.

Experiment - 1

Stem diameter varied 14.70 - 64.41 mm with mean 25.97 ± 9.35 mm. However, a vast fluctuation in stem length was noticed which ranged from 13 - 250 cm with an average 93.98 ± 308.9 cm. Similarly, fresh weight of plants also varied significantly from 50 - 4450 g, and its mean was 434.84 g. Average dry weight of plants was 175.69 g with a large standard deviation, and it varied from 27 - 1700 g. Maximum number of branches was five with an average of 1.58 branches per plant. Among the plants under study 34.4% had no branch,1.6 percent plants had one branch and 40.6% plants had 2 branches and 20.3% had 3 branches, 1.6 percent plants had 4 branches and 1.6 percent plants had 5 branches.

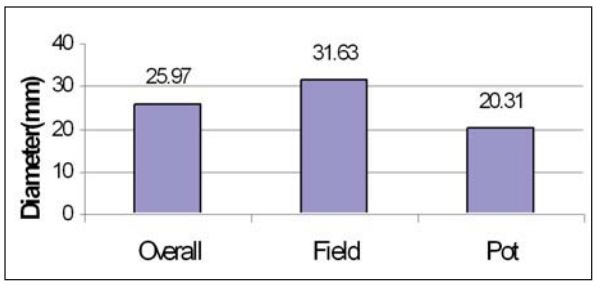

Fig. 1: Diameter (mm) of plants in field and pot condition

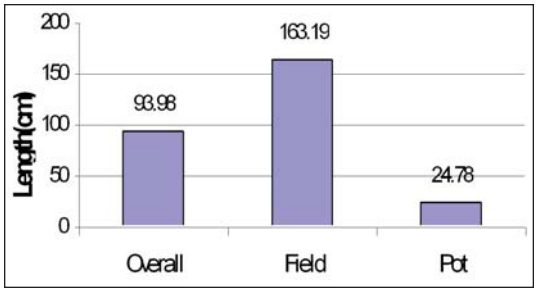

Fig. 2: Length (cm) of stem in field and pot condition

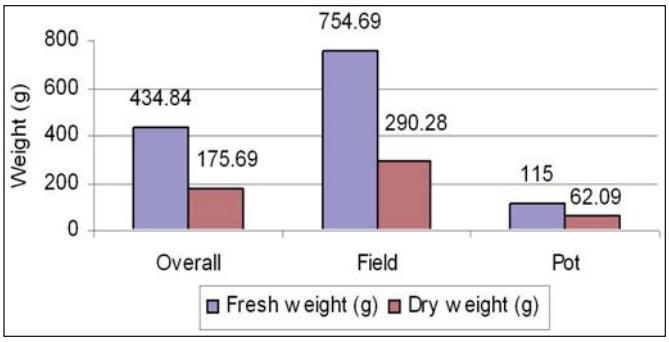

Fig. 3: Fresh and dry weight of plants

Although survival rate is higher in pot condition than that of field condition (58.06% vs 49.14%), all parameters of vegetative growth of *J. curcas* were better in field condition than pot condition. However, the extent of betterment is assessed in the present study. Stem diameter in field condition is 57% more than that of pot condition. More than six times better growth of stems can be observed in field condition than pot condition. Similarly, five times more dry weight is noticed among the plants which were cultivated in the field than that of the pot condition. Number of branch is also double in the field than pot cultivation. For comparing the means, F-test was performed, which prevails that values of parameters of growth are significantly higher ($p<0.05$) in field cultivation than that of pot cultivation.

Highly significant correlation between stem diameter and their fresh and dry weight were obtained. Stem length and their fresh and dry weights were also correlated significantly. But a moderately positive correlation between stem length and diameter was noticed among plants under study both in the field as well as pot conditions.

Table I: Comparison of parameters of biomass growth of *Jatropha curcas* in field and pot cultivation

Parameter	Field cultivation			Pot cultivation		
	Range	Mean	SD	Range	Mean	SD
Stem diameter (mm)	20.12-64.41	31.63	10.23	14.70-24.50	20.31	2.62
Stem length (cm)	34.0-2500.0	163.19	428.96	13.0-34.0	24.78	50.08
Dry weight (g)	42.0-1700.0	290.28	350.71	27.0-95.0	61.09	20.51
Fresh weight (g)	100.0-4450	754.69	920.50	50.0-200.0	115.0	40.24
Number of branch per plant	0-5	2.09	1.33	0-2	1.06	1.01

Table II: Correlation among measurements of parameters of plants

		Stem diameter (mm)	Stem length (cm)	Fresh weight (g)	Dry weight (g)
Stem diameter (mm)	Pearson Correlation	1	.627(**)	.929(**)	.925(**)
	Sig. (2-tailed)	.	.000	.000	.000
	N	64	64	64	64
Stem length (cm)	Pearson Correlation	.627(**)	1	.795(**)	.797(**)
	Sig. (2-tailed)	.000	.	.000	.000
	N	64	64	64	64
Fresh weight (g)	Pearson Correlation	.929(**)	.795(**)	1	.998(**)
	Sig. (2-tailed)	.000	.000	.	.000
	N	64	64	64	64
Dry weight (g)	Pearson Correlation	.925(**)	.797(**)	.998(**)	1
	Sig. (2-tailed)	.000	.000	.000	.
	N	64	64	64	64

** Correlation is significant at the 0.01 level (2-tailed).

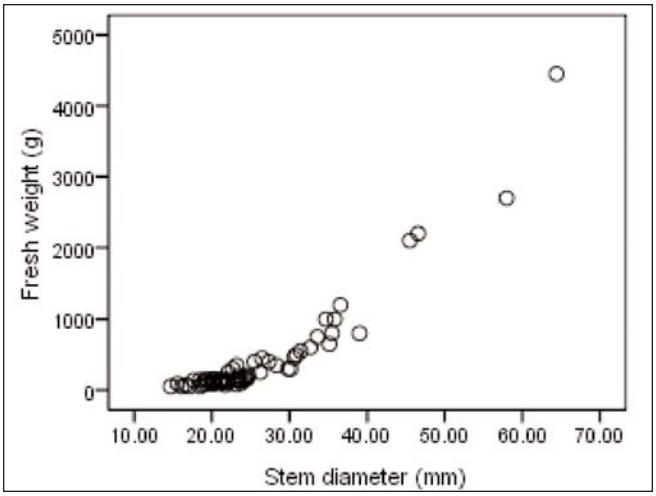

Fig. 4: Association of fresh weight with stem diameter

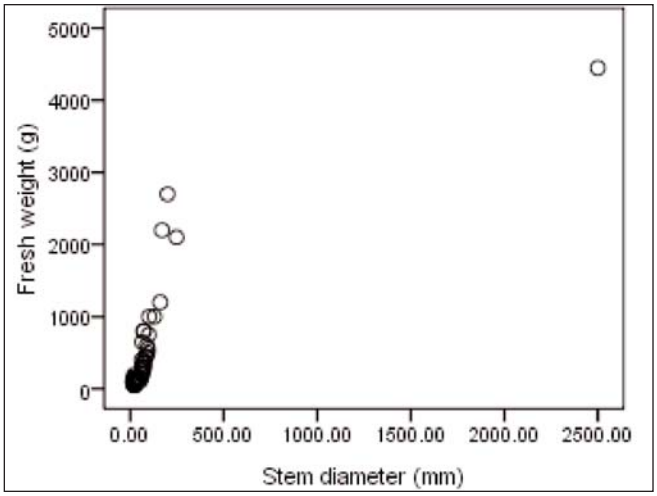

Fig. 5: Association of fresh weight with stem length

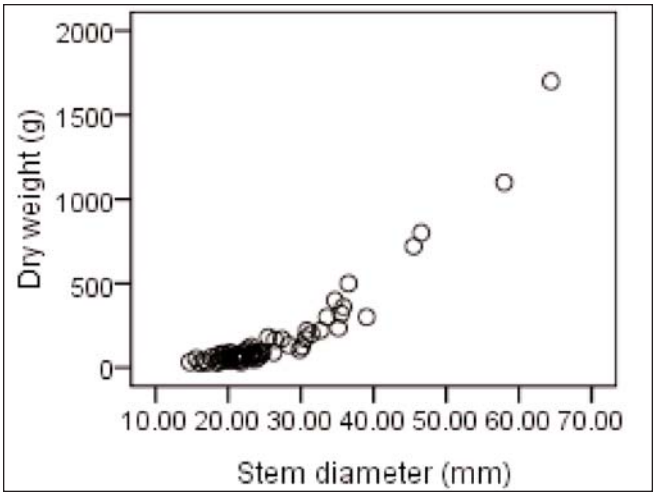

Fig. 6: Association of dry weight with stem diameter

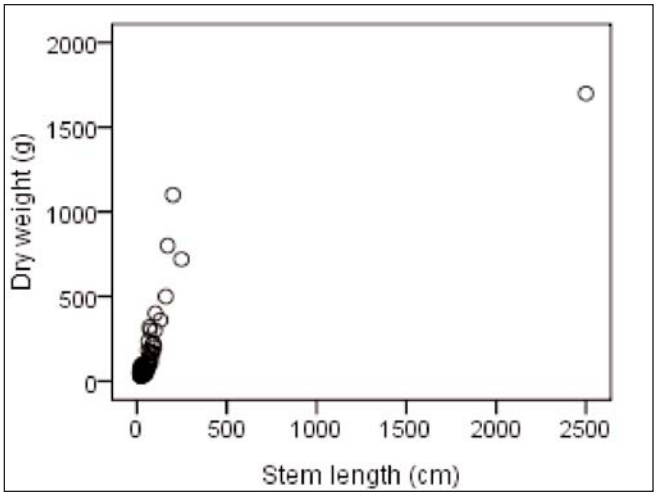

Fig. 7: Association of dry weight with stem length

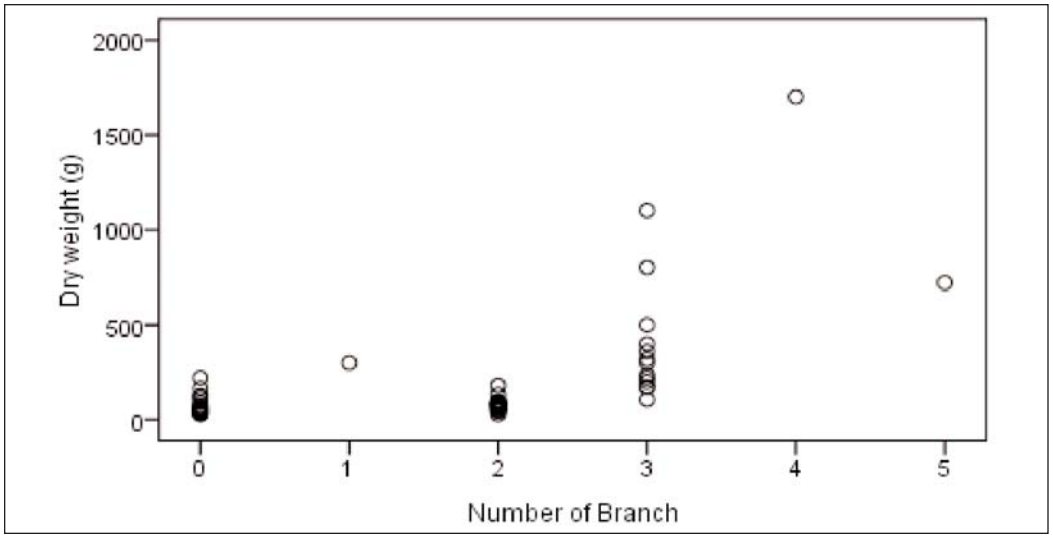

Fig. 8: Association of stem diameter with number of branches

Results show, in a population of tall plants scope exists for a further selection of plants with height, large stem diameter and high branch number which could give rise to a further improvement of the overall biomass production.

Experiment - 2

Stem diameters become 80 percent more if fertilizer is used, whereas stem lengths are one and half times more when fertilizers are used than they are not used. In case of fresh weight biomass growth is three times more than that of when fertilizers are used. Number of branches per plant also increases, although in significantly (0.43% more) for the utilization of certain amount of fertilizers in the field in the process of *J. curcas* cultivation. For comparing the means of parameters, F-test was performed, which reveals that values of parameters of growth are significantly better ($p<0.05$) when fertilizers are used than those when any type of fertilizer is not used.

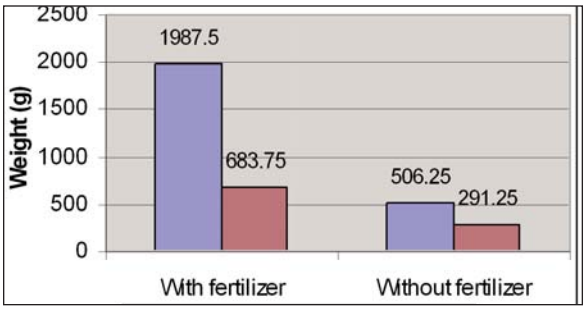

Fig. 11: Comparison of weight (g)

Table III: Parameters of biomass growth of *J. curcas* with and without the use of fertilizer

Parameter	With fertilizer			Without fertilizer		
	Range	Mean	SD	Range	Mean	SD
Stem diameter (mm)	30-50	39.50	7.36	15-30	22.5	4.66
Stem length (cm)	196-300	245.25	35.42	70-150	97.5	24.50
Fresh weight (g)	1400-2500	1987.5	321.55	250-800	506.25	184.08
Dry weight (g)	450-875	683.75	148.61	110-500	291.25	125.75
Number of branch per plant	3-4	3.75	0.46	2-3	2.62	0.52

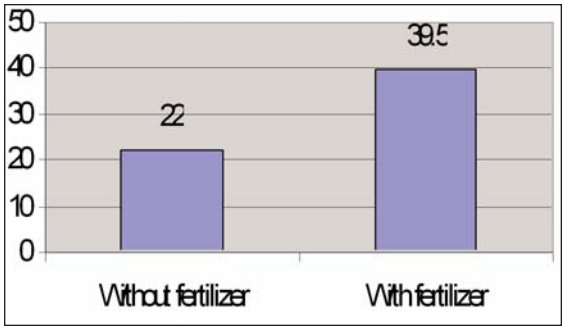

Fig. 9: Comparison of stem diameter (mm)

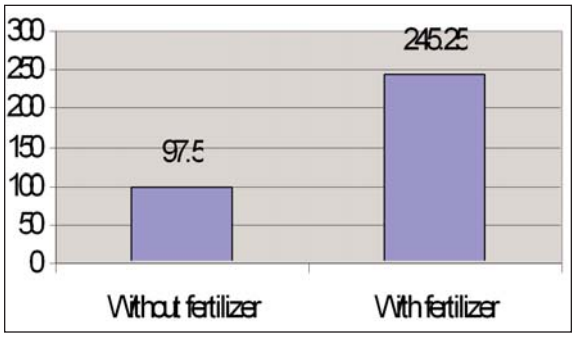

Fig. 10: Comparison of stem length (cm)

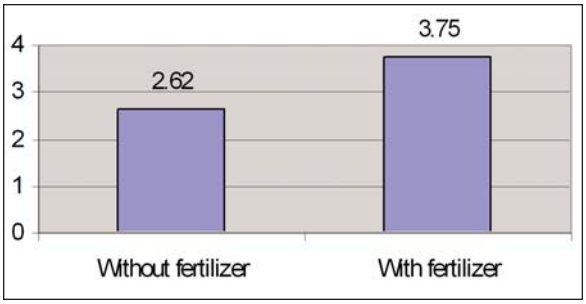

Fig. 12: Comparison of number of branch

Conclusion

From the present study it can be concluded that best growth performance of *J. curcas* in respect of vegetative and reproductive cultivation in field condition performed better than pot condition. It can also be concluded that the biomass growth of this plant is far more better if some fertilizers are being used in the field.

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