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Impact of seed weight and pre-sowing treatments on germination and seedling growth of *Jatropha curcas*

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ABSTRACT

The present investigation deals with seed size and pre-sowing treatments on the germination and seedling growth of *Jatropha curcas.* The medium sized seeds excelled over other seed grades with respect to germinability and growth attributes irrespective of the environmental conditions. Among the seventeen different pre-sowing treatments, the seeds treated with 200 ppm GA_3 registered the best germinability and seedling growth characters viz., seedling percent, shoot length, hypocotyls length, root length, dry matter production/seedling and vigour index followed by 100 and 300 ppm GA_3 under nursery conditions.

INTRODUCTION

Jatropha curcas Linn. commonly known as Ratanjot belongs to the family *Euphorbiaceae*. In the Forest Flora of the Bombay Presidency, *J. curcas* has been described as a small ever green nearly glabrous tree or soft wooded shrub 3 to 4 meters high (Anonymous. 1976). It is indigenous to America cultivated in most tropical parts of India, commonly in hedges. It is believed to be a native of South America and Africa spread to other continents of the world by the Portuguese. The Arabs have been using this plant for medicinal purposes (Liu et al. 1997).

The seeds of *J. curcas* yield an oil content of 30-40 percent (Dagar et. al. 2004). The oil can be combusted as fuel without being refined. It burns with clear smoke-free flame tested successfully as fuel for simple diesel engine. *J. curcas* holds immense opportunities for farmers and rural entrepreneurs to make money and also to replace diesel environmental friendly bio-diesel (Divya et al. 2006).

Seed fortification is the incorporation of required substances into the seed for invigorating the seed. In this physiological seed management technique the seeds are soaked in water or dilute solutions to obtain quality seedlings conditions. The choice of chemical and its concentration and duration of soaking vary with species, but these factors decide the success of the seed depending upon the initial seed quality character of the various factors influences the seed quality character at field and storage (Swarup, 2006).

J. curcas is one of the emerging seed oil crop of economic importance that is propagated through seeds. Studies on pre-sowing seed treatment to enhance the germination and vigour of seed raised at nursery are meager in this emerging multipurpose crop. Therefore, the present study was undertaken to find out the effect of seed size and pre-sowing treatments required for breaking dormancy of *Jatropha* seeds. Therefore, the

present study was undertaken to find out the effect of seed size and pre-sowing treatments on the germination and seedling growth of *Jatropha*.

MATERIALS AND METHODS

The experiment was conducted in the nursery of College of Forestry in green house during 2007. On an average the area receives an annual rainfall of 850 to 1000 mm, most of which is concentrated during monsoon season. The temperature during the study ranged between 25°C–35°C. The seeds were sown in a Randomized Block Design in four replications in the first week of March. Regular irrigation, weeding and hoeing were done as and when required. Germination data was recorded immediately after the emergence of seeds.

Bulk seeds obtained from the seed source Allahabad were graded for uniformity by eliminating the small seeds. The selected seeds were treated with bavistin @ 2g kg^{-1} and evaluated for the seed quality characters. The seeds were arbitrarily graded into three categories on weight basis, viz., large (> 0.75 g/seed), medium (0.55-0.75 g/seed) and small (<0.55 g/seed). The graded seeds were sown in polybags. The seeds were subjected to seventeen presowing treatments soaking in 100, 200, 300 ppm of IBA, BA, Kinetin, GA_3, Riboflavin, respectively and water soaked for 24 hours and control in distilled water. Observations were recorde for seed moisture content (%), germination (%), root length (cm), shoot length (cm), and dry matter production of seedlings (g). Vigour index values were also computed as per Abdul Baki and Anderson (1973) adopting the following formula

Vigour index = Germination (%) x Total seedling length (cm)

The data gathered were statistically scrutinized using F test for understanding the level of significance of seed and seedling quality characters. The germination counts were recorded daily for 20 days while the growth parameters were recorded after the completion of one growing season. Germination per cent was calculated as the number of seeds sown and the number of seeds germinated, expressed in percentage. Peak value was calculated as the maximum mean daily germination reached at any time during the period of the test as per Czabator (1962). Germination value is an index combining speed and completeness of seed germination. Daily germination counts were made and Germination Value was calculated as per Czabator (1962) using following formula:

$$GV = PV \times MDG$$

Where, PV was peak value of germination, and MDG, mean daily germination.

Germination Speed was worked out as per method prescribed by Maguire (1962).

$$GS = S\left(\frac{n}{t}\right)$$

Where, 'n' was number of daily germinated seeds, and 't' total number of days from sowing to germination.

RESULTS AND DISCUSSION

It is evident from Table 1 that there is a strong relationship between the seed size and the germination and seedling growth characters. The medium sized seeds resulted in maximum germination (90.20%) followed by large sized seeds and the lowest germination (62.50 %) occurred in small sized seeds. Similarly the seedling growth parameters viz., plant height (32.74 cm), collar diameter (2.92 cm), shoot root ratio (4.36) and total fresh biomass (7.64 g) was recorded in seedlings raised from medium sized seeds. Similar results have been reported by Sharma and Sood (1990) for *Leucaena leucocephala* and Singh et al. (1995) for *Quercus leucotrichophora* where they ascribed highest germinability of seeds to medium sized seeds followed by large and small sized seeds.

The seeds of *Jatropha* derived from the same lot responded differently to different seed treatments under nursery conditions (Table 2). Of the seventeen pre-sowing treatments, soaking of seeds in 200 ppm GA_3 for 24 hours recorded the highest germination per cent (95.00 %) and was followed by soaking in 100 ppm GA_3 for 24 hours. However, minimum was recorded for control.

The increase in seed germination by the application of gibberellic acid has also been reported by many workers in different species. Singh (1989) found an increase of 19 per cent

Table 1: Effect of seed size on germination and seedling growth of *J. curcas*

Seed Weight	Germination (per cent)	Plant height (cm)	Collar diameter (cm)	Shoot root ratio	Total fresh biomass (g)
Large (>0.75 g/seed)	75.22	23.48	2.53	3.75	5.42
Medium(0.55-0.75 g/seed)	90.20	32.74	2.92	4.36	7.64
Small (<0.55 g/seed)	62.50	19.11	1.58	2.12	3.14
$CD_{0.05}$	0.40	0.19	0.09	0.21	0.17

Table 2: Effect of different pre-sowing treatments on germination of *J. curcas*

Growth hormones (ppm)	Germination (%)	Germination speed/day	Germination Value/day	Peak Value/day
IBA 100	70.00	0.23	39.12	7.41
200	71.00	0.23	32.59	6.68
300	69.00	0.22	37.79	7.23
BA 100	65.00	0.21	29.63	6.39
200	45.00	0.15	14.97	4.86
300	70.00	0.23	36.01	7.34
Kinetin 100	65.00	0.23	34.77	6.79
200	70.00	0.25	50.83	9.38
300	80.00	0.26	50.85	8.95
GA_3 100	92.00	0.30	61.87	9.72
200	95.00	0.31	68.07	10.87
300	90.00	0.28	59.56	9.78
Riboflavin 100	80.00	0.26	55.00	9.80
200	75.00	0.25	41.67	8.00
300	80.00	0.26	40.21	6.88
Water soaked	75.00	0.25	33.97	6.65
Control	55.00	0.09	9.24	3.65
SEd	13.90	0.05	14.62	1.61
CD (P=0.05)	27.93	0.09	29.38	3.23

germination over control by the application of $288x10^{-5}$M solution of GA_3 after 24 hours of soaking the seeds of *Picea smithiana*. Similar increase in seed germination in different species after the application of gibberellic acid in different concentrations has been reported by Omran et al. (1990), Bahuguna et al. (1988), Pitel and Wang (1988), Verma and Tondon (1988), Schwintzer and Ostrofosky (1989) and Dagar et. al. (1977).

The increase in seed germination by optimum concentrations of gibberellic acid may probably be due to enhancement of hydrolase (especially and amylase) synthesis as stated by Amen (1968) and Galston and Davies (1969).

Table 3: Effect of seed fortification treatment with growth regulators on seedling quality characters at nursery

Growth hormones & their conc. (ppm)	Seedling percent (%)	Shoot length (cm)	Hypocotyl length (cm)	Root length (cm)	Dry matter production seedling^{-1} (g)	Vigour Index
IBA 100	77 (62.73)	31.3	14.7	17	14.5	3128
200	79 (63.43)	28.0	13.8	16.5	15	3331
300	64 (54.33)	30.2	16	14	17.17	2604
BA 100	79 (63.43)	28.0	14.7	15.5	13.17	3235
200	75 (61.00)	31.0	15	19	17.33	3608
300	69 (57.10)	30.2	16.8	15.5	16.33	2882
Kinetin 100	78 (63.79)	29.3	15.7	19	14	3490
200	79 (63.43)	28.0	15.2	16.5	13.83	3186
300	73 (59.34)	31.7	16.2	21	15.83	3707
GA_3 100	85 (69.02)	30.2	15.5	21	15.33	3503
200	92 (72.26)	31.8	17.2	21	17	4056
300	83 (65.13)	28.5	15.5	17.5	14	2854
Riboflavin 100	65 (54.94)	25.7	14.4	16.5	16.17	2679
200	69 (57.41)	26.0	14	19	15.5	3124
300	65 (56.17)	24.7	13.6	16	13.83	2625
Water soaked	67 (56.17)	27.9	14	14.8	13.37	2592
Control	54 (47.19)	20.2	9.2	11.6	10.2	1957
Mean	74.18 (60.70)	28.91	15.14	17.49	15.15	3162.75
SEd	(0.22)	1.07	0.17	0.32	0.18	157.49
CD (P=0.05)	(0.44)	2.14	0.34	0.64	0.36	328.24

Alternatively it may be first initiating the embryo growth as a result of which more gibberellic acid is synthesized by the growing embryo and then the gibberellic acid induces hydrolase synthesis as suggested by Chen and Varner (1973).

Perusal of the data in Table 3 revealed that among the treatments, the seeds soaked in 200 ppm GA_3 recorded the highest values for seedling emergence percent, shoot length, hypocotyls length, root length, dry matter production/seedling and vigour index followed by 100 and 300 ppm GA_3. However 100 ppm IBA, 200 ppm Kinetin, 100 ppm BA showed non significant difference with each other and showed better growth of seedlings for all the traits.

All the evaluated growth regulators at higher concentrations and longer hours of duration reduced the germination, due to the supra optimal level of growth regulating substance which normally influences the seed quality factors adversely (Jerlin et al. 1999). The vigour parameters, studied through root length, shoot length, hypocotyls length, dry matter production and vigour index values expressed a consistent response with the evaluated growth regulators compared to control and water soaking stressing the need of the treatments for enhancing the growth of the seedling

Bahuguna et al. (1988) also attained maximum germination in *Michelia champaca* seeds due to GA_3 application, while, Verma and Tondon (1988) reported that all growth regulators

(GA_3, IBA and IAA) increased the germination and speed of germination in *Pinus kesiya* and *Schima khasiana* which was in accordance with the present results, where all the growth regulators enhanced the germination and vigour compared to the unsoaked control seeds for the possible causes discussed before. Thus, the present study on evaluation of presowing seed treatment for seedling emergence expressed that the enhancement of germination and vigour parameters was made possible due to the softening of the seed and the differential conducive osmatic pressure created by those solution on soaking the seeds in the specific solution. The other possible reason might be the antagonistic effect of growth regulating substances on the growth inhibiting substances present in the seeds and the enhancement in the rate of germination metabolism (Hilhorst 1995). Thus the study expressed that seed fortification with 100 ppm GA_3 has enhanced the seed and seedling quality characters of *Jatropha* at nursery for effective in promoting germination.

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