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Animesh Sinha
Forest Genetics and Plant Breeding Division, Institute of Forest Productivity (ICFRE) Gumla National Highway, Lalgutwa, Ranchi, Jharkhand, India

Jai Kumar
Forest Genetics and Plant Breeding Division, Institute of Forest Productivity (ICFRE) Gumla National Highway, Lalgutwa, Ranchi, Jharkhand, India

Diwakar Prasad Nirala
Forest Genetics and Plant Breeding Division, Institute of Forest Productivity (ICFRE) Gumla National Highway, Lalgutwa, Ranchi, Jharkhand, India

Nirbhay Ambasta
Upendra Nath Verma Inter College, Chatra, Jharkhand, India

Rajneesh Kumar
Forest Genetics and Plant Breeding Division, Institute of Forest Productivity (ICFRE) Gumla National Highway, Lalgutwa, Ranchi, Jharkhand, India

Phallo Kumari
PG Department of Botany, V.B.U. Hazaribagh, Jharkhand, India

Correspondence
Animesh Sinha
Forest Genetics and Plant Breeding Division, Institute of Forest Productivity (ICFRE) Gumla National Highway, Lalgutwa, Ranchi, Jharkhand, India

Fruit setting & their seed germination rate of half diallel crossed flower of eight best-selected *Jatropha curcus*

Animesh Sinha, Jai Kumar, Diwakar Prasad Nirala, Nirbhay Ambasta, Rajneesh Kumar and Phallo Kumari

Abstract
The present investigation was carried out for determining the rate of seed setting of half dialled cross flower of best *Jatropha* plant at Nagri field 7 km away from the Institute of Forest Productivity, Ranchi. The half diallel crossing was done among the eight best parents. Total of 28 different crosses was made. The highest seed setting was observed in cross 6 × 8 (79.61%) whereas the lowest seed setting was observed in cross 1 × 6 (45.81%). Matured fruits were collected during July – August 2015 and within a week of fruit collection; seeds were sown in open sand bed at the campus of Institute of Forest Productivity, Ranchi. The maximum (92.23%) and minimum (55.78%) seed germination was observed in cross 4× 6 and 3 × 8, respectively. It was observed that crossing did during April - May produced early fruit setting but later on, fruits were dried due to scorching in the month of May. The best time was during June-July for dial crossing in the agro climatic zone of Ranchi district. The seed germination was also depended upon climatic condition and season. The best time for seed germination was in the warm season before or at the onset of the rains.

Keywords: Dialled Crossing, Seeds, Germination, Flower, *Jatropha* etc

Introduction
Jatropha curcas is a perennial softwood shrub or small tree, originated from Central America. It belongs to family Euphorbiaceae that well established in most tropical and subtropical areas of the world. Recently, oil of jatropha seeds has been recognized for its suitability for conversion into biodiesel (Jun Wu, 2010) [6].

The first step of bio-diesel production is the cultivation of *Jatropha* trees for the production of oil-bearing fruits. *Jatropha* has high ecological adaptability (Heller, 1996) [5]. It can grow in a wide range of conditions. It can be cultivated in the areas having low to heavy rainfall, marginal to dry and hot conditions areas, where the most of the other crop species are not able to survive there (Francis *et al*., 2005) [3]. Leaves shed during the winter season. *Jatropha* can be grown in a wide range of soils. Well drained sandy or gravelly soils with good aeration are preferred (Foidl *et al.*, 1996; Heller 1996) [2, 5]. *Jatropha* plant can be established from seeds, seedlings and cuttings. The conventional method for propagation of *Jatropha* is limited by poor seed germination and vegetative cuttings (Openshaw, 2000; Purkayastha *et al*., 2010) [9, 10]. The seed germination and plantation depend upon climatic condition and season. The best time for seed germination and plantation is in the warm season before or at the onset of the rains. The spacing for plantation is 2-3 m by 1.5-3 m for plantations (Meena and Amarendra, 2010) [8]. The watering of the seedling plants is necessary for the dry season. The leaves and stems are toxic to the animal but the seeds and seed cake are used as an animal feed after the treatment (Makkar *et al*., 2001) [7].

Materials and Methods
The research work of diallel crossing was done on eight best-selected parents at Nagri field that was 7 km away from the Institute of Forest Productivity, Ranchi (Latitude: $23^0$21.388' N and Longitude: $85^0$14.661' E). The elevation height of experimental field is 685 meters from sea level. The field contains red acidic soil and the average annual rainfall is about 1200 mm. The experiment of the diallel crossing was done in a 5-year-old plant of *Jatropha curcas*.

Table 1 represents the eight parents that were selected on the basis of their high yield and superior growth performance. The half diallel crossing was done among the eight parents. The diallel crossing without reciprocal was made using these eight parents. So, a total of 28 different crosses were made as shown in Table 2.

The diallel cross refers to the mating of selected parents in all possible combinations and evaluation of a set of diallel crosses with parents is known as diallel cross analysis. Diallel crosses, excluding reciprocals, would be made in this experiment.

Table 1: Characteristics of Parents

Parent Code	IC number of accessions	Oil (%) in passport data	Oil (%) at our trial	Growth & yield Characteristics
1	555383	31.27	35.66	Highest collar dia. (60 mm), higher yield (1.1 kg/ plant)
2	566603	36.40	36.11	Seed yield (1.3 kg/ plant)
3	471344	37.20	31.12	Higher seed yield (1.1 kg/ plant), high primary and secondary branch number (8 & 26, respectively)
4	553592	36.10	35.81	Seed yield (1 kg/ plant)
5	550449	40.29	34.84	Seed yield (0.9kg/ plant)
6	560620	38.82	43.20	survival (89%), highest yield (1.4 kg/ plant)
7	468908	33.88	44.42	Highest seed oil (44.42 %)
8	468907	33.98	24.29	Highest plant height (150.35 cm), collar dia. (54.9 mm) & survival (100%)

Around 20-30 inflorescences per plant of 10-15 plants per parent were emasculated during April-June 2015. The inflorescences were emasculated by removing male flowers with the help of scissors before anthesis and covered with butter paper bags having 1-10 female flowers. In the morning (6AM-9AM), opened female flowers were crossed by rubbing the anthers (freshly collected) of the male parent against the stigma of female parent of another accession and the flowers were bagged again. The bags were removed after four days of pollination. The fruits were established after 15 to 25 days from a dusting of pollen (Pollination) and mature in 20 to 30 days that become at the stage of harvesting. The seeds were separated from the fruits and shown in nursery bed of sandy soil. For the calculation of seed germination rate, number of seeds which were shown in a nursery bed was recorded. After some time, the number of seeds that were germinated in the nursery bed was also recorded to calculate germination percentage by adopting the formula.

Percentage of seed germination = Seeds germinated/Total seeds x 100

Results and Discussions

It was observed that crossing did during April - May produced early fruit setting but later on, fruits were dried due to scorching in the month of May. Irrigation was applied, but very fewer seeds could be harvested. In the 3rd week of May, temperature crossed 41°C. Therefore, drying problem of flowers & fruits and non-availability of pollen was observed. After the rain, new flower buds were targeted for crossing work during June - July and more fruits could be harvested. The highest fruit setting was observed in cross 6 × 8 (79.61 %), followed by 4 × 6 (78.17%), 4 × 5 (77.03%), 2 × 8 (72.30%), 4 × 8 (72.02%), 3 × 6 (69.74%), 3 × 5 (67.42%), 5 × 6 (66.15%), 3 × 7 (66.05%), 2 × 4 (65.26%), 1 × 3 (63.81%), 1 × 2 (62.01%), 5 × 7 (61.90%), 6 × 7 (61.46%), 2 × 5 and 1 × 8 (61.06%). All parents of these cross were the better performance of growth and yield. However, the average fruit setting was observed in cross 3 × 8 (59.93%), 7 × 8 (56.96%), 3 × 4 (56.30%), 5 × 8 (56.00%), 1 × 4 (55.88%), 1 × 5 (54.73%), 2 × 3 (53.93%), 2 × 6 (50.94%) 1 × 7 (49.04%), 4 × 7 (48.57%) and 2 × 7 (48.21%) whereas the lowest fruit setting was observed in cross 1 × 6 (45.81 %) as shown in Table 2. The most of the crosses were showed the better seed setting due to the all eight parent having good yield and growth behavior.

Table 2: Fruit setting (%) after one month of half diallel crosses.

S.N.	Cross	Fruit setting (%)	S.N.	Cross	Fruit setting (%)	S.N.	Cross	Fruit setting (%)	S.N.	Cross	Fruit setting (%)
1	1 × 2	62.01	8	2 × 3	53.93	15	3 × 5	67.42	22	4 × 8	72.02
2	1 × 3	63.81	9	2 × 4	65.26	16	3 × 6	69.74	23	5 × 6	66.15
3	1 × 4	55.88	10	2 × 5	61.06	17	3 × 7	66.05	24	5 × 7	61.90
4	1 × 5	54.73	11	2 × 6	50.94	18	3 × 8	59.93	25	5 × 8	56.00
5	1 × 6	45.81	12	2 × 7	48.21	19	4 × 5	77.03	26	6 × 7	61.46
6	1 × 7	49.04	13	2 × 8	72.30	20	4× 6	78.17	27	6 × 8	79.61
7	1 × 8	61.06	14	3 × 4	56.30	21	4 × 7	48.57	28	7 × 8	56.96

Matured fruits were collected during July – August 2015 and seeds were sown in open sand bed within a week of fruit collection. The cold water treatment showed 72% germination while pre-treatment using hot water or H_2SO4 (0.5 M) do not enhance germination (Brahmam, 2007) [7]. The direct seed showing is recommended at the beginning of the rainy season, after the first rains when the soil is wet, it helps to develop a healthy taproot system (Gour, 2006) [4]. Recording of data of seed germination was done periodically. Percentage of seed germination of crosses is given in Table 3. All cross of eight parents represented the high percentage of seed germination that was more than 50%. The maximum (92.23 %) and minimum (55.78%) seed germination was observed in cross 4× 6 and 3 × 8, respectively. More than 50% cross showed more than 80% seed germination rate. The crop shows high initial establishment success and survival (Zahawi, 2005) [12]. Seedlings with two cotyledonary leaves were uprooted from sand bed and planted in polybags containing sand, soil, and FYM (1:1:1). Singh *et al.*, (2006) [11] also reported that polybags containing sand, soil, farm yard manure in the ratio of 1:1:1 in case of more heavy soils.

Table 3: Germination (%) of F_1 seeds of *Jatropha curcas*

Cross	Seed germination (%)	Cross	Seed germination (%)	Cross	Seed germination (%)	Cross	Seed germination (%)
1 × 2	82.13	2 × 3	67.35	3 × 5	91.89	4 × 8	84.06
1 × 3	85.71	2 × 4	86.25	3 × 6	73.08	5 × 6	89.66
1 × 4	61.03	2 × 5	74.47	3 × 7	59.67	5 × 7	62.75
1 × 5	81.63	2 × 6	70.05	3 × 8	55.78	5 × 8	80.67
1 × 6	73.77	2 × 7	84.33	4 × 5	87.80	6 × 7	84.24
1 × 7	73.71	2 × 8	73.20	4× 6	92.23	6 × 8	83.14
1 × 8	86.86	3 × 4	82.93	4 × 7	77.56	7 × 8	83.53

Field preparation has been done with removal of lantana and leveling by JCB in the rocky moram soil. Total 36 populations (8 parents + 28 F_1 progenies) will be planted for evaluation. We have planted the plant 9 seedlings per replication in each cross as well as parents with a total of 5 replications in RBD fashion during the month of October 2015 with 2m x 2m spacing.

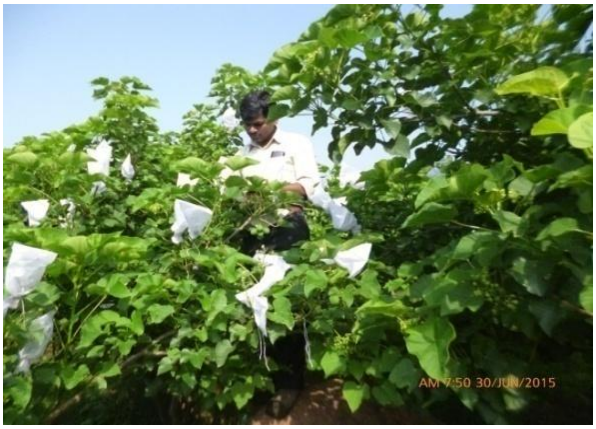

Fig 1: Bagging after emasculation/crossing

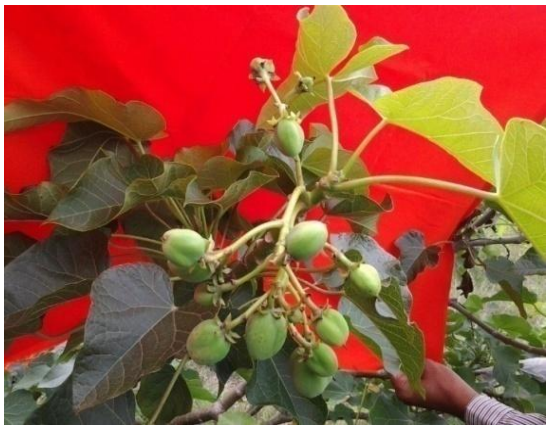

Fig 2: Fruit setting after crossing of one month

Fig 3: Seed germination on sand bed

Fig 4: Jatropha seedlings in polybags

Conclusions

From the above result, it can be concluded that the highest seed setting was observed in cross 6 × 8 (79.61 %) whereas the lowest seed setting was observed in cross 1 × 6 (45.81 %). The maximum (92.23%) and minimum (55.78%) seed germination was observed in cross 4× 6 and 3 × 8, respectively. More than 50% cross showed more than 80% seed germination rate. The best time for dial crossing was during June-July while for the seed germination was during July-August in agroclimatic zone of Ranchi district of Jharkhand.

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