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A Study on the Regular Water Supplementation for Seed Output in Physic Nut

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ABSTRACT: *Jatropha curcas* L. had been the choice of researchers as well as producers of bio-diesel replacing the energy crops due to its various benefits. However, inconsistencies in the growth and seed output were the main constraints faced by the cultivators.

In this regard, a field work has been conducted for a period of three years (2009-2012) selecting seven field stations to study the impact of the availability of water over the physical growth and the dry seed output. Different watering schedules viz. Drip irrigation, bore-well and rain-fed were adopted. In addition to the physical growth of the plant impact of water over the fruit quality was also studied. The study revealed that regular availability of water favoured the growth of the plant and also the fruit quality. Out of the seven field stations, drip irrigated sites have shown more number of seeds/1000 fruits where availability of water was regular and continuous. Results showed that the plant can survive without regular water supplementation but the physical growth as well as seed output were influenced by the availability of water. It was proved that the regular and continuous availability of water resulted in the high yield. Details of the study were discussed in the full paper.

KEYWORDS: *Bio-fuel, Conventional fuel, energy crops, Jatropha.*

I. INTRODUCTION

Rapid depletion of fossil fuel reserves and rising oil prices has led to the search for the alternatives. To protect the global environment and concerning long-term energy security, it becomes necessary to develop alternative fuels with properties comparable to petroleum based fuels. The difference between the consumption and availability can be partly met by substituting it through bio fuels (Rao Y V et al, 2008), chemically the mono alkyl esters of fatty acids which are produced by the transesterification with Methanol or ethanol (Knothe, G. et al, 2006). Therefore, in recent years several researches have been carried out to use vegetable oils as fuels in engines as biodiesel (Pramanik, K. 2003). Furthermore, the farmers would benefit by cultivating these crops in rural areas (Akbar E, et al. 2009).

In India, it can be seen in almost all the states and is generally grown as a live fence for the agricultural fields. It was also grown in waste lands or degraded lands to reclaim them. Government of India has launched Biodiesel Mission to cultivate this crop on large scale in such lands selecting some states like Andhra Pradesh, Gujarat,

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Tamilnadu etc. However, inconsistencies in the growth and seed output were the main constraints faced by the producers of biodiesel because the yield could not be predicted. Hence the research is going on to know the impacts of fertilizers, spacing, water availability etc., over the growth of *Jatropha*.

The objective of the present study was to record the growth consistency of *J. curcas* L. and the impact of availability of water over fruit and seed output and thus to find out the suitable conditions for its successful cultivation.

II. LITERATURE SURVEY

In recent years liquid biofuels have attracted the world due to their flexibility for storage and transportation. These biofuels could be produced from various sugar crops (Sugar cane, sugar beet, Sweet sorghum), starchy crops (Maize, Wheat, Barley, Rye, potatoes, Cassava) and cellulosic material (Switch grass, Mischantus, Willow, Poplar, Cropstover) for the production of ethanol: oil crops (rape seed, oil palm, soybean, sunflower, peanut, Pongamia, *Jatropha*) and algal biomass for the production of biodiesel (da Schio, B., 2010). Among all *Jatropha curcas* L. (Further referred as *Jatropha*), a small tropical tree produces fruits holding oil bearing seeds reached a special position. Drought resistance, non-palatability, suitability to various climatic and soil conditions, faster growth rate and perennial nature are the other preferable characters for the selection of *J. curcas* (Y. Takeda, 1982, G. Martin and A. Mayeux, 1984, S. Roy and A. Kumar, 1990, N. Jones and J. H. Miller, 1991, S. Roy, 1998, Openshaw, 2000), which brought to the miracle-tree status, hyped for its ability to simultaneously produce biodiesel, reclaim waste land and enhance socio-economic development (Francis et al. 2005). In addition, the oil is extractable with simple techniques and is easily convertible to biodiesel.

III. MATERIAL AND METHODS

The present field study has been carried out at Krishna district, of Andhra Pradesh for a period of 3 years, in various plots of *Jatropha*, selecting 1 year old saplings.

Andhra Pradesh state is situated on the eastern coast of India. Six natural plantations of *Jatropha* were selected from 4 mandals of Krishna district viz., Mylavaram, Agiripalli, G. Konduru and Nandigama. In addition, one control site was also maintained at Chandarlapadu mandal to compare the growth. The impact of regular availability of water was studied in the present work by employing different watering modes in all the 7 field sites.

Study area:

Krishna district is located between 16° 10' N and 81° 08' E and the total area was 8,727 Km². The average temperature of the region was 45°C in summer and 21° C in winter. Black cotton (57.6%) and red (19.4%) soils were dominant here. The major source for cultivation was monsoon based rainfall and the average rainfall of the district was 1135.26 mm/ yr during the study period.

Description of field stations:

Different conditions were maintained in terms of spacing, nutrients, mode of watering etc. in all these study stations. In Mylavaram mandal three different plantations were observed viz., Kuntamukkala, Morusumilli and Pulluru. *Jatropha* has been cultivated as a boundary crop in 13 acres, 12 acres and 11 acres respectively in these three study sites. The plant spacing was maintained as 3m in all these sites. Out of these, red rocky soil was present in Kuntamukkala with a pH of 7.8 and black cotton soils were prevailing in the other two sites viz., Morusumilli and Pulluru with a pH of 8.

Rajavaram and Nekkalam plantations were identified from Nuzvid mandal. Rajavaram plantation was a block plantation in 5 acres with 3×3m (1110 plants/ha) spacing and the soil was red rocky with a pH 7.5. Nekkalam plantation was a boundary crop in 10 acres with 2m spacing. The soil here was black with a pH 8. The plantations of Nandigama mandal viz., Nandigama plot and the Chandarlapadu (experimental) plots were having black gravel soil and the pH of the soil was 8.14. Nandigama plantation was a block plantation (mono culture) of 10 acres with a spacing of 2×2m (2500 plants/ha). The Chandarlapadu plantation was the control site of one acre mono culture. Minimum

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spacings were maintained here as 1×1m (10,000 plants/ha) and 1.5×1.5m (4444 plants/ha) to compare the growth conditions with the natural plantations.

Table-1: Mode & Schedule of watering at different field stations

Name of the plot	Rajavaram	Nekkalam	Morusumilli	Pulluru	Kuntamukkala	Nandigama	Chandarlapadu
Type of Soil	Red	Black Cotton			Red, Rocky in some part	Black Gravel	
pH	7.5	7.8	8	8	7.8	8.14	8.14
Spacing	3x3m	2m	3m	3m	3m	2x2m	1x1m and 1.5x1.5m
Mode of watering	Rain fed	Rain fed	Bore well	Bore well	Drip	Drip	Drip
Schedule of watering	Rain fall dependant		15 days in summer and one month in the remaining period		Daily in summer and alternate days in the remaining period		
Availability of water	Irregular &		Regular &		Regular &		
	Not uniform		Uniform		Uniform		

Mode of Watering:

Different watering modes were adopted in the study sites and with different intervals. The main sources were bore well irrigation canals and drip irrigation. Water supply was provided through bore well irrigation canals at Morusumilli, Pulluru stations whereas Rajavaram and Nekkalam were rain fed plantations and there was no other specific mode of watering. Drip irrigation was provided for the other three sites viz., Kuntamukkala, Nandigama and the control site at Chandarlapadu. In the bore well irrigated plantations watering was done by digging grooves from one plant to the other so as to receive by each and every plant, right from the first plant.

Schedule of Watering:

Interval of water supplementation also varied from one station to the other, depending up on the mode of watering. Water was supplied through drip irrigation plots in alternate days in winter and daily during summer season. For bore well irrigated plantations, watering was done with an interval of 15 days in summer and one month during the remaining period of the year. Hence, in these plots, there was uniformity in the availability of the water for the plant because watering was done at a regular interval. The remaining two field stations viz., Nekkalam and Rajavaram were rain-fed plantations and were pure rain dependants. Here, watering was not regular and there was no uniformity in the water availability as the number of rainy days and the quantity of water received were unpredictable (Table-1).

Sample fruit collection:

The harvested fruits were separately kept in the paper boxes and a total number of mature fruits derived from 10 selected plants per acre within each plot was noted. They were summed together at the end of the harvesting season. The number of fruits was recorded in fruits per plant per year, and then converted into fruits per hectare per year. Seeds

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removed from fruit hulls were sun dried for 3 days to approximately 12% moisture content before storing in paper bags. They were weighed by using an electronic weighing machine (sensitivity of 0.01gm).

A sample of fruits was randomly collected from each plot to compare the seed quality. Dry weight of the fruits, fruit coat, seeds and length of the seeds were measured. Fruit coat to seed ratio was also noticed.

IV. RESULTS AND DISCUSSION

Quality of the fruit was also important in deciding the oil content of the seed. At Chandarlapadu station for the sample of 1000 fruits 2550 seeds were observed, weighed about 1145 g contributing a percentage of 70.67 to the total dry fruit weight. At Nandigama station 2430 seeds were counted for 1000 fruits weighing around 1082 g i.e. 70.25 % of the total dry fruit weight. At the third station viz., Kuntamukkala for a sample of 1000 fruits of weight 1445g, 2022 seeds were noticed of weight 1012g which is equal to 70.03% of the total weight.

Considerably more number of seeds were recorded in the above mentioned three stations followed by Rajavaram station where the sample dry fruit weight was noticed as 1450g, out of which 68.96% was contributed by 2400 seeds weighing around 1000g, leaving a shell weight of 450gms (31.03%). Nekkalam station showed 2100 seeds for 1000 fruits. The total dry weight of the fruits was 1390g, in which the contribution of the seeds was 958g (68.92%).

Among all the two bore-well irrigated stations showed least results in terms of number of seeds and the dry weight as 1960 seeds (925g & 68.52%) at Morusumilli station and 1972 seeds (1365g, 68.49%) at Pulluru station.

Comparing the seed output among all the seven study stations it was evident that more number of seeds per 1000 fruits were recorded at two drip irrigated sites viz., Chandarlapadu and Nandigama as 2550, 2430 followed by the two rain fed plantations viz., Rajavaram and Nekkalam as 2400 and 2100, respectively. The other drip irrigated site viz, Kuntamukkala showed slight decrease as 2022 due to rocky surface. Less number of seeds were observed at the bore well irrigated plots viz, Morusumilli, Pulluru and Mylavaram as 1960, 1972 and 1760. Similar trend was observed in case of dry weight of the fruit and seed.

Irregular availability of water was the reason for the low flowering and low seed output in the plantations of Morusumilli and Pulluru. The availability of the moisture in the atmosphere and the availability of water through rainfall during the flowering season might be the reasons for the better flowering and fruiting at Nekkalam and Rajavaram even though they were rain fed plantations where an annual rain fall of 1135 mm/Yr was recorded during the study period. Supplementation of water throughout the year at regular intervals through drip was added to the best quality of the fruit in terms of more number of seeds/ 1000 fruit, dry weight of fruit and seed at Chandarlapadu and Nandigama sites. This has helped to overcome the crowding effect due to minimal spacings of 1x1m, 1.5x1.5m and 2x2m (Table-2).

Table-2: Fruit quality (Seed to Shell ratio-dry weight basis) /1000 fruits

Name of the plantation	CHANDARLAPADU	NANDIGAMA	KUNTAMUKKALA	RAJAVARAM	NEKKALAM	MORUSUMILLI	PULLURU
Number of seeds	2550	2430	2022	2400	2100	1960	1972
Fruit dry weight (g)	1620	1540	1445	1450	1390	1350	1365
Seed dry weight (g)	1145	1082	1012	1000	958	925	935
% of shell weight	29.32	29.75	29.96	31.03	31.07	31.48	31.5
% of seed weight	70.67	70.25	70.03	68.96	68.92	68.52	68.5

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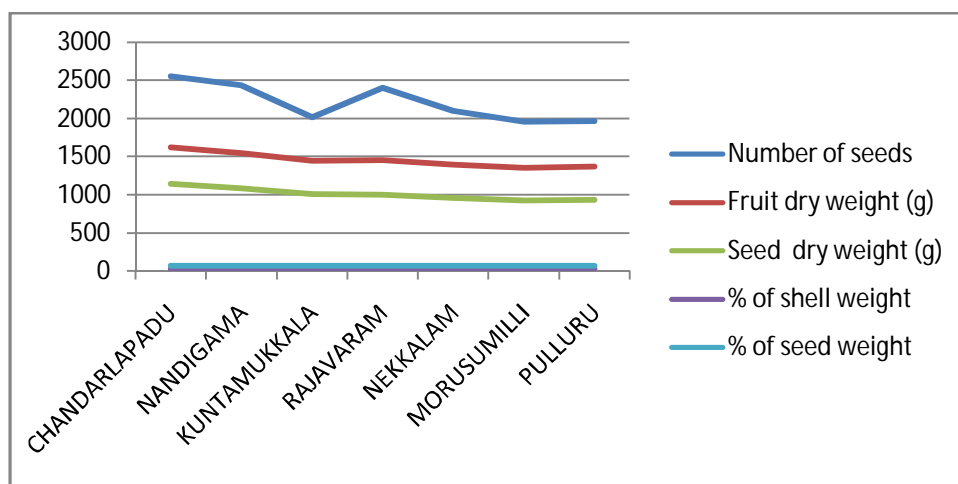


Figure: Line Diagram showing Number and Weight of seeds per 1000 fruits

Effect of watering:

One of *Jatropha*'s main mentioned advantages is its resistance to drought and its low water requirements. *Jatropha* is still a wild plant, which can grow without irrigation in a broad spectrum of rainfall regimes, from 250 up to 3000 mm/Yr (Foidl et al., 1996). The stem remains photosynthetically active, and in this state the plant can survive without rain for over a year. There are other reports also in conformity with the above statement by The Biomass Project, (2000) and Fact (2009). The present observations were in conformity with the results of Wahl et al, (2009) Harika et al, (2014) and Montobbio et al, (2010) that continuous irrigation favours the high productivity and also the number of nuts per plant. The number of seeds per plant was almost double in the irrigated plants when compared to the non-irrigated rain-fed plants.

Montobbio et al., (2010) reported that irrigation influences the seed yield and in their study they have noticed that only one tenth of the expected yield was obtained under irrigated conditions. He also noticed that the average number of nuts per plant was twice as high in irrigated plots as compared to rain fed ones and the survival percentage was significantly higher in irrigated plots.

Prajapati and Prajapati (2005) estimated *Jatropha* yields in rain-fed and irrigated conditions in India. After 5 years, the production per tree ranged from 1.2 kilograms under rain-fed conditions to 3.2 kilograms under irrigated conditions. The yield in rain-fed conditions is around 40% as high as under irrigation, implying that *Jatropha* can be grown in semi-arid lands but requires certain level of rainfall to produce high yields.

Several other also reported (Kheira and Atta, 2009 and Achten et al, 2010) that drought induced reductions in growth and yield of *Jatropha* under various growing conditions. Deficit irrigation decreased the growth and development of *Jatropha* plants but the plants continued to grow even irrigated with as low as 30% daily water use.

Francis et al., (2005) and Chaudhury et al., (2007) reported that yield varies significantly depending on the water input, which determines the number of fruiting period per year, which can vary from one to three and the application of nutrients and water in poor soils increase the production. Maes et al (2009) also revealed that *Jatropha* is not common in regions with arid and semi-arid climates and does not naturally occur in regions with the rainfall of less

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than 944 mm per year. The result of the study demonstrated that plantations in arid or semi-arid regions may show a low productivity or need additional irrigation.

Similar observations were made in the present study also. The availability of water plays an important role in growth of the plant. However, schedule and mode of water application influences the growth in different places.

Based on the results noticed in this study, the drip irrigation was proved to be more positive, compared to bore well and irrigation because minimum water could be made available regularly. Another advantage of drip irrigation is there will be no wastage of water. Thus, the soil moisture content could be managed uniformly which helped the growth of the plant.

V. CONCLUSION

Based on the observations made in this study, the drip irrigation was proved to be more growth supportive, compared to rain-fed irrigation and bore well since minimum water could be made available regularly in the drip irrigated sites. Another advantage of drip irrigation is there will be no wastage of water. Thus, the soil moisture content could be managed uniformly which helped the growth of the plant. It was proved that the regular and continuous availability of water resulted in the maximum seed output. For *Jatropha* cultivation on large scale for oil yielding purpose adaptation of regular water supplementation is required.

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