STUDIES ON THE IMPACT OF AVAILABILITY OF WATER OVER THE GROWTH OF JATROPHA

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Abstract: Biofuel has been regarded as potential alternative for the conventional fuels and a large scale research work is going on in this area. In this context Jatropha has dragged the attention of the cultivators around the world to replace the energy crops due to its various benefits. In this regard, a field work has been started in Jan 2009 and continued for a period of three years to study the impact of the availability of water over the growth performance of *J. curcas* L. grown under varied conditions like soil type, mode of watering, type of plantation, supplementation of nutrients etc., The study revealed that drip irrigation appeared to be viable and economical in cultivating Jatropha.

Keywords: Biofuel, Conventional fuel, energy crops, Jatropha.

Introduction: Over the last few years *Jatropha curcas* L. (here after referred as *Jatropha*) has attracted the attention of the researchers in the field of bio-energy. *Jatropha curcas* (Linnaeus) belongs to the family Euphorbiaceae and there are more than 200 different names for its great significance to man and the various possibilities of its uses. The plant is regarded as a perennial shrub or a small tree. It is believed to be the native of tropical America, but now thrives in many parts of tropics and sub-tropics in Africa and Asia [1]. It can grow in waste lands, poor soils [2], [3] and tolerate wide range of rain fall [4], [5].The drought resistance, non-palatability, suitability to various climatic and soil conditions, faster growth rate and perennial nature are the other preferable characteristics for the selection of the species *J.curcas* as a potential biofuels crop [6], [7], [8], [9], [10], [11].

In India, it can be seen in almost all the states and is generally grown as a live fence for the agricultural fields. It can also be grown in waste lands or degraded lands to reclaim them. Nowadays the research is going on to know the impacts of fertilizers, spacing, water availability etc., over the growth of *Jatropha*. The objective of present study was to record the impact of the availability of water over the growth in various block and boundary plantations of *Jatropha*.

Material and Methods: The present field study has been started in Jan-2009 and carried out for a period of 3 years. The work was conducted at Krishna district, of Andhra Pradesh, in various plots of Jatropha, selecting 1 year old saplings with various distances under different environmental conditions to study the impact of availability water on the physical growth as well as flowering, fruiting and seed output.

Study areas of Krishna district: Krishna district was located between 16^0 10 N and 81^0 08 E. The average temperature of the region was 45^0C in summer and 21^0 C in winter and the average rainfall was 1028 mm/ yr. Study has been conducted in 8 plantations of Jatropha from 3 mandals of Krishna district of Andhra Pradesh, as follows:

Mylavaram Mandal	Nuzvid Mandal	Nandigama Mandal
Mylavaram	Rajavaram	Nandigama
Kuntamukkala	Nekkalam	Chandarlapadu (Experimental site)
Orusumilli	--	--
Pulluru	--	--

Different conditions were maintained in terms of spacing, nutrients, mode of watering etc. in all these study stations.

In Mylavaram mandal four different plantations were observed viz., Mylavaram, Kuntamukkala, Orusumilli and Pulluru. Jatropha has been cultivated as a block plantation in the first mentioned study site i.e, Mylavaram in 10 acres whereas it was a boundary crop in, 13 acres, 12 acres and 11 acres respectively in the remaining three study sites viz, Kuntamukkala, Orusumilli and Pulluru. The plant spacing was maintained as 3×3m (1110 plants/ha) in all these four sites. Out of these four sites, two were having red rocky soil viz., Mylavaram and Kuntamukkala with a pH of 7.8 and black cotton soils were prevailing in the other two sites viz., Orusumilli 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 2×2m spacing (2500 plants/ha). The soil here was black with a pH 8.

The plantations of Nandigama mandal viz, Nandigama plot and the

Chandarlapadu (experimental) plot 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 mixed spacing of 2×2m (2500 plants/ha) and 3×3m (1110 plants/ha). The Chandarlapadu plantation was the control site of one acre mono culture. Minimum 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.

Mode of watering: Watering was done by different modes for different plantations. The main sources were bore well, irrigation canals and drip irrigation. Water supply was provided through bore well as well as irrigation canals at Orusumilli, Pulluru and Mylavaram plots and drip irrigation was provided for the three sites viz., Kuntamukkala, Nandigama and Chandarlapadu. The other two viz., Rajavaram and Nekkalam were rain fed plantations and there was no other specific mode of watering. In the drip irrigated plots water was supplied in alternate days in winter and regularly during summer, to avoid water logging condition.

Soil type and nutrients: All these sites were alkaline in nature. However, Gypsum was added at Nandigama and Chandarlapadu sites to neutralise the soils. In addition, NPK and Super Phosphate were added at regular intervals to the Chandarlapadu plantation (Control site @ 60 Kg/ha and 150 Kg/ha respectively to study the impact of nutrients.

Physical growth of the plant was measured by counting the number of branches, height of the plant in feet and girth in inches. The percentage of flowering and fruiting were also estimated to the total plants. The yield of the plant was measured in terms of dry seed output (Kg/plant) and compared in terms of percentage. The growth of ***J.curcas*** in various plantations was compared by t-test.

The changes of the variables were recorded every day. Fruit maturity stages were predetermined as stage 1(small young immature fruit), stage 2(mature green), stage 3 (mature yellow fruit), stage 4 (black wet fruit/ semi dried) and stage 5 (black dry fruit/fully dried).

Results and discussion: 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 [12]. It is supported to know few pests and diseases but this may change when it is grown in commercial plantations with regular irrigation and fertilization [13]. 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.

Being a xerophytic succulent, its water requirement is extremely low and it can stand long periods of drought by shredding leaves to reduce the transpiration loss and in winter months (Nov- Feb). Based on the observations made 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.

At the end of the 4^{th} year of the plant, in the three drip irrigated plots viz, Nandigama, Chandarlapadu and Kuntamukkala more number of branches were identified like 26, 26 and 23 respectively compared to the other plots in which number of branches were confined to 21(in Pulluru, Orusumilli and Nekkalam) and 20(in Mylavaram and Rajavaram).

Water is the important mineral in deciding the plant growth. This was proved by the variations in the average height of the plant in various plantations. The average height of the plant was maximum reported in Nandigama plot and Chandarlapadu plots as 13ft, followed by Kuntamukkala with an average height of 12 ft and 10 ft in Orusumilli, Nekkalam and Pulluru plots. Minimum height was reported in Mylavaram site as 8ft, followed by Rajavaram plot (9 ft).

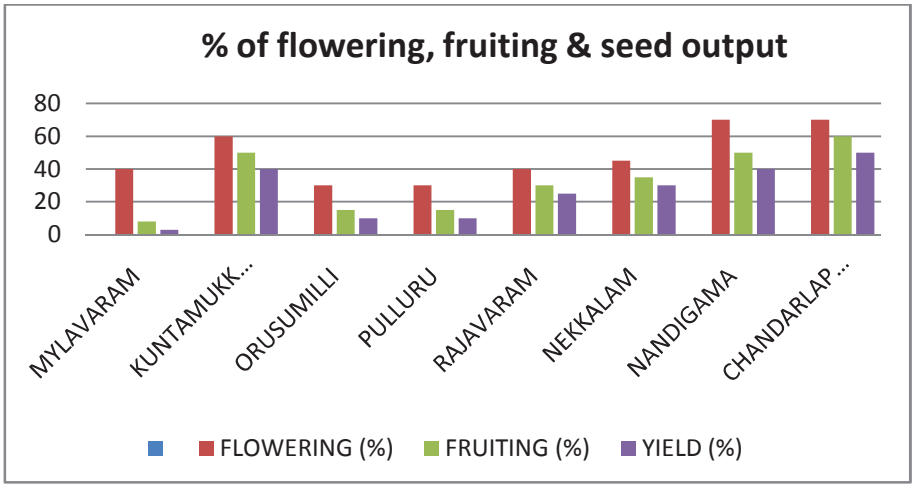
The addition of the nutrients might be the reason in addition to the water supplementation by drip for the maximum height in the Nandigama and Chandarlapadu plots. Effect of collar rot disease might be the reason for the poor growth in the Mylavaram site, though it was a drip irrigated plot. Poor growth was observed due to the irregularity in the availability of the water content for the growth of the plant though the Rajavaram and Nekkalam plots were receiving an annual rain fall of 1028 mm/Yr.

Highest % of flowering i.e., up to 70% was reported in Nandigama and Chandarlapadu plots, followed by Kuntamukkala (60%), Nekkalam (45%), Mylavaram and Rajavaram (40%) and only 30% was reported in Orusumilli and Pulluru plots. This was in conformity with earlier studies by [14], [15] that the application of nutrients and water in soils increase the production of *Jatropha*. % of Flowering, Fruiting & Seed output

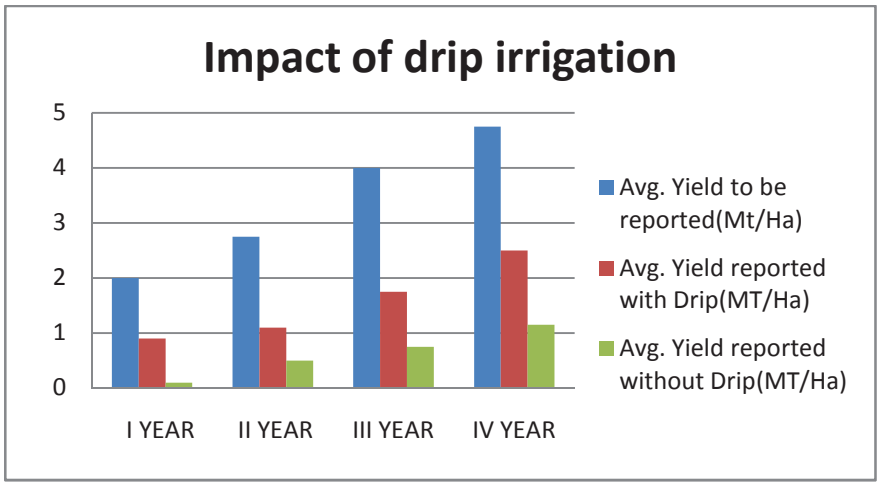
Similar results were observed in the case of fruiting and seed output like flowering. Comparatively maximum fruiting and seed output were recorded in the drip irrigated sites. This clearly indicates that availability of water regularly will influence the physical growth as well as the seed

output.

Comparison of growth at various study sites								
NAME OF THE PLOT	MYLAVARAM	KUNTAMUKKALA	ORUSUMILLI	PULLURU	RAJAVARAM	NEKKALAM	NANDIGAMA	CHANDARLAPADU
Avg. No. Of Branches	20	23	21	21	20	21	26	26
Avg. Plant Height (Ft)	8	12	10	10	9	10	13	13
Flowering (%)	40	60	30	30	40	45	70	70
Fruiting (%)	8	50	15	15	30	35	50	60
Yield (%)	3	40	10	10	25	30	40	50



Age of the plantation	Avg. Yield to be reported (Mt/Ha)	Avg. Yield reported with Drip (MT/Ha)	Avg. Yield reported without Drip (MT/Ha)
I YEAR	2	0.9	0.1
II YEAR	2.75	1.1	0.5
III YEAR	4	1.75	0.75
IV YEAR	4.75	2.5	1.15



Impact of mode of watering at the age of 4 years								
Name of the plantation	**Rajavaram**	**Nekkalam**	**Mylavaram**	**Orusumilli**	**Pulluru**	**Kuntamukkala**	**Nandigama**	**Chandarlapadu**
Mode of watering	Rain fed	Rain fed	Bore well	Bore well	Bore well	Drip	Drip	Drip
Avg. No. of Branches	20	21	20	21	21	23	26	26
Avg. Plant Height (Ft)	9	9	8	11	11	11	13	13
Avg. plant girth (inches)	6.5	6.5	7.5	7.5	8	8	10	10
Flowering (%)	40	45	40	30	30	50	70	70
Fruiting (%)	30	35	8	15	15	40	50	50
Yield (%)	25	25	3	10	10	30	40	40

Physical growth: Height and plant girth (at 1 foot level from the ground) were also reported maximum in the drip irrigated plots, followed by bore well irrigated plots. Uniform and regular availability of the water might be

the reason for this growth in these plantations. Considerably least percentage of growth was observed in the rain fed plantations where uniform availability of water was not there.

Flowering: Flowering of 60%, 70% and 70% at Kuntamukkala, Nandigama and Chandarlapadu respectively and followed by 45% flowering at Nekkalam and 40% at Rajavaram and Mylavaram. Only 30% flowering was observed in the remaining two sites viz, Orusumilli and Pulluru. The effect of root rot, poor availability of water and soil nutrients were the reasons for the low flowering in the plantations of Orusumilli and Pulluru. Addition of nutrients in the form of NPK and Super phosphate and thus the nutrients were made available for the Chandarlapadu plantation in addition to the regular watering, especially Potassium, which was required by the plant during flowering. Thus, the addition of nutrients might have helped to overcome the effect of minimum spacing (1×1 m, 1.5×1.5 m).

Fruiting: In case of fruiting also, similar results have been obtained like flowering. Maximum fruiting was observed at the Chandarlapadu (60%) and Nandigama sites (50%), followed by 40% at Kuntamukkala plot, 35% at Nekkalam and 30% at Rajavaram. Only 15% was reported by Orusumilli and Pulluru plantations and comparatively less % of flowering i.e. only 3% was seen at Mylavaram plot. Effect of root rot might be the reason for the poor % of flowering at Mylavaram plot.

Seed output: The studies of [16], [17] have also revealed that the application of nutrients and water in poor soils increase the production. Similar results were obtained in the present study that addition of water and nutrient has resulted in the higher % of seed production (avg of 2-4 kg/plant) by the experimental site at Chandarlapadu and Nandigama site and in the remaining study sites comparatively less seed output was recorded where no nutrients were added.

Conclusion: With respect to the water balance, it is important that the availability of the water should be regular and continuous to increase the yield. Rain water harvesting and drip irrigation appeared to be economical and also useful. Fertigation through drip irrigation helps in minimizing the water and nutrient loss by allowing effective supplementation of nutrients through water. More hydrological research is essential in the coming days in this area as the water availability is a limiting factor for the growth of J curcas.

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