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RESEARCH ARTICLE

STUDY ON THE GROWTH RESPONSE OF PHYSIC NUT TO VARIOUS SOIL TYPES.

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Abstract

A field work has been conducted to study the impact of soil over the growth and seed output of Jatropha (Physic nut) for a period of three years at Krishna district of Andhra Pradesh selecting different Jatropha plantations. Various parameters like mean height, mean girth, average number of branches per plant were observed along with the phenological output with a regular interval in the study sites to compare the growth of *Jatropha* in varied soil conditions.Results revealed that both the physical growth and fruit yield were recorded comparatively high in the black gravel soils among all the field stations. Details of the study were mentioned here in the full paper.

Introduction:-

Jatropha curcas L. is a small tree, belonging to the family Euphorbiaceae and is a native of tropical America, but now thrives in many parts of the tropics and sub-tropics in Africa and Asia (Heller, 1996 and Gubitz et al., 1999). Due to its various advantages like 30-40% oil content in seeds useful as biodiesel and also useful as illuminant, lubricant and manufacturing of soap and candle making (Wani et al., 2006). It can grow in waste lands, poor soils (Francis et al., 2005, Jingura, 2011 and Harika et al., 2014) and tolerate wide range of rain fall between 200 mm-1200mm (Kheira et al., 2009). All these special characteristics, Jatrophahas dragged the attention of the many countries to reclaim the waste lands (Kumar et al., 2011).

Though the potentiality is high, still the research and knowledge on *Jatropha* cultivation is in its infancy as there are limitations for its large scale cultivation. Overall difficulty in yield –prediction is the major constraint (Prasad andWegstein, 2011) which in turn influenced by various parameters like nutrients, spacing effect, soil type, temperature etc. In India, *J. curcas* is found in almost all the states and is generally grown, as a live fence for protection of agricultural fields as cattle or goats do not eat it since it is not edible.

The objective of our study was to record the growth consistency of *J. curcas* L. in different soil types and to find out which soil conditions are viable for successful cultivation.

Material and methods:-

The present study has been carried out establishing 7 field stations at 5 mandals in Krishna district of Andhra Pradesh for about three years. Six natural plantations of *Jatropha* were selected from 4 mandals of Krishna district

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viz., Mylavaram, Agiripalli, G.Konduru and Nandigama. In addition, one control site was also maintained at Chandarlapadu mandal to compare the growth. The details of the study stations were mentioned below:

Stations of Mylavaram Mandal :
Morusumilli and Pulluru

Stations of G. Konduru Mandal :
Kuntamukkala

Stations of Agiripalli Mandal:
Rajavaram and Nekkalam

Stations of Nandigama Mandal:
Nandigama

Chandarlapadu Mandal:
Experimental site (Chandarlapadu)

Study area:
Krishna district is located between 16^0 10 N and 81^0 08 E and the total area was 8,727 Km^2. The average temperature of the region was 45^0C in summer and 21^0 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.

Nutrients:
Gypsum was added in Nandigama and Chandarlapadu sites @60kg/ha. NPK and Super Phosphate were added at 6 months interval to the Chandarlapadu plantation (control site) @ 60 Kg/ha and 150 Kg/ha respectively to study the impact of nutrients on growth, flowering, fruiting and seed output (yield). Neither manure nor nutrients were supplemented externally for the remaining field stations.

Watering schedule:
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 internal irrigation canals at Morusumilli and Pulluru plots 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 Chandarlapadu. In the drip irrigated plots water was supplied in alternate days in winter and regularly during summer, to avoid water logging condition.

Type of plantation and Density of the plants at different spacings:
Out of the seven selected field stations three were having *Jatropha* as Block plantation (mono crop) viz, Rajavaram, Nandigama and Chandarlapadu and in the remaining four stations viz, Kuntamukkala, Morusumilli, Pulluru and Nekkalam it was grown as a boundary crop (fence).

Different plant spacings were maintained at various study sites as follows:
Kuntamukkala:
It was a boundary crop in 13 acres. The plant spacing was maintained as 3×3 m.

Morusumilli:
It was a boundary crop in 12 acres. The plant spacing was maintained as 3×3 m.

Pulluru: It was a boundary crop in 11 acres. The plant spacing was maintained as 3×3 m.

Rajavaram:
This plantation was a block plantation in 5 acres with 3×3 m spacing.

Nekkalam:
Nekkalam plantation was a boundary crop in 10 acres with 2×2 m spacing (2500 plants/ha).

Nandigama:
Nandigama plantation was a block plantation (mono culture) of 10 acres with a mixed spacing of 2×2 m (2500 plants/ha) and 3×3 m (1110 plants/ha).

Chandarlapadu (Here after referred as control site):
The Chandarlapadu plantation was the control site of one acre mono culture. Minimum spacings were maintained here as 1×1 m (10,000 plants/ha) and 1.5×1.5 m (4444 plants/ha) to compare the growth conditions with the natural plantations.

Pruning:
To enhance the number of branches, all these plantations were pruned once except the control site, which was pruned twice. Out of the seven study sites, three viz,. Rajavaram, Nekkalam, Nandigama sites were pruned in November-2009 and the four sites viz., Kuntamukkala, Morusumilli and Pulluru were pruned in Novemeber-2010. The experimental site at Chandarlapadu site was pruned twice i.e. Oct-2009 and Nov-2010.

Type of soil:
Different soils were prevailing in different field stations like red, black cotton and black gravel. Red soils were present in Kuntamukkala and Rajavaram stations. Black cotton soils were prevailing in Morusumilli, Pulluru and Nekkalam stations where as black gravel soils were present in the other two field stations viz., Nandigama and Chandarlapadu (Table-1).

pH of the soil:
The soil in all the seven field stations was near neutral value and slightly alkaline in nature. The pH of the soils in the present study ranged between 7.5 and 8.14 showing a minor difference of 0.64.

Fruit quality:
The fruits were allowed to dry on the plant itself and the dried fruits were collected to separate the seeds. The mean seed length was reported in between 1.5 cm to 1.8 cm. Number of seeds per fruits was also noticed as 2-3. Fruit coat to seed ratio, on dry weight basis from a sample of one thousand dry fruits from each field station was calculated.

Results and discussion:-

Soil is the major influencing factor in plant's life. Type of soil, availability of various nutrients in soil, water holding nature etc. are influencing the soil over the physical growth as well as fruiting and seed yield. *Jatropha* can survive in any type of soil but the phenological growth varies under different soil conditions.

Effect of Soil type over growth :
Red soil:
By the end of the study the height of the plant was reached to 9.5ft and 11.1ft at Rajavaram and Kuntamukkala, respectively where red soils were prevailing. The girth was noted as 8.3inches and 8.8 inches, and the number of branches was identified as 20 and 22, respectively.

Flowering was measured as 40% and 60%, fruiting was measured as 30% and 39% by these two sites whereas 23.6% and 30% dry seed output was recorded.

Black cotton soil:
Black cotton soils were existing at Morusumilli, Pulluru and Nekkalam plantations where the height of the plant was recorded as 12.5ft, 11.9ft and 10ft, girth was recorded as 9.5inches, 9.6inches and 8.5 inches showing 29, 25 and 23, respectively.

30.5% flowering, 15.5% fruiting and 10.2% seed yield were recorded at Morusumilli, 30% flowering, 15% fruiting and 10% seed yield were recorded at Pulluru and 43.6% flowering, 33.7% fruiting and 26% seed yield were recorded at Nekkalam,

Black gravel:
At Chandarlapadu and Nandigama plantations black gravel soils were present in which the height was noted as 14.5ft and 15ft whereas the girth was measured as 10.5inches and 10.8inches, respectively showing 30 branches at each site.

72% flowering, 61.1% fruiting and 51.2% seed yield were recorded at Chandarlapadu whereas 69% flowering, 50.2% fruiting and 40% seed yield were recorded at Nandigama plantation.

Comparison of growth among the study sites:
The mean height of the plant was highest recorded at the plantations with black gravel soil such as 15ft at Nandigama and 14.5ft at Chandarlapadu. Moderate height as 10- 12.5ft was recorded in the black cotton soils as 10ft at Nekkalam, 11.9ft at Pulluru and 12.5ft at Morusumilli. Lower height was recorded in the red soils as 9.5ft and 11.1ft in Rajavaram and Kuntamukkala stations. Minimum height was observed at Rajavaram (9.5ft) and in the rocky part of Kuntamukkala plantation while in the non-rocky part better height was observed.

The mean girth of the plant was also recorded as maximum among the field stations in black gravel soils (10.8 inches at Nandigama and 10.5inches at Chandarlapadu), followed by black soils (9.6 inches at Pulluru, 9.5 inches at Morusumilli and 8.5 inches at Nekkalam plantation). Least mean girth was recorded in the red soils as 9.8 inches by Kuntamukkala plantation and only 8.3 inches by Rajavaram plantation.

Similar trend was seen even in the case of number of branches per plant, which were found to be more in black gravel soils as 30 at both Nandigama and Chandarlapadu plantations. Number of branches was found to be moderate in the black cotton soils ranging from 23 to 29 (23 in Nekkalam, 25 in Pulluru and 29 in Morusumilli plantation). Only 20 branches were recorded at Rajavaram station and 22 at Kuntamukkala station.

Considering the physical growth of the plant in terms of plant height, girth and number of branches it was found to be supported by black gravel soils followed by black cotton soils whereas red soils found to be less supportive when compared to the black gravel and black cotton soils. Among the three plantations of black cotton soils Nekkalam plantation showed least results in the physical growth. The rocky soils were found to be not growth promotive since in the red soils, the rocky part of (Kuntamukkala plantation) showed lower results compared to the non-rocky part of the plantation.

Not only the physical growth but also flowering, fruiting and seed output were recorded maximum among the field stations in the black gravel soils. Flowering was recorded as 72% at Chandarlapadu plantation and 69% at Nandigama plantation. Fruiting and seed output were recorded as 61.1% and 51.2% by Chandarlapadu plantation and 50.2% and 40% by Nandigama plantation.

Unlike the physical growth flowering, fruiting seed output were decreased in the black cotton soils when compared to red soils, except at Nekkalam plantation. Among the black soils, Nekkalam showed little higher percentages as 43.6% flowering, 33.7% fruiting and 26% seed output while the remaining two plantations viz, Pulluru and Morusumilli showed least percentages such as 30% and 30.5% flowering, 15% and 15.5% fruiting and 10% and 10.2% seed output, respectively. The two plantations with red soils viz., Rajavaram and Kuntamukkala showed 40% and 60% flowering, 30% and 39% fruiting and 23.6% and 30% seed output, respectively (Table-2).

The study confirmed the reports of earlier works by Barua, 2011 that the plant is undemanding in soil type as it grows everywhere, even on gravely, sandy, acidic and alkaline soils. But, there were significant differences in the growth performance of the plant to various soil types. Considering the physical growth of the plant in terms of plant height, girth and number of branches, it was supported by black gravel soils followed by black cotton soils whereas red soils found to be less supportive when compared to the black gravel and black cotton soils. Among the three plantations of black cotton soils Nekkalam plantation showed least results in the physical growth. The rocky soils were found to be not growth promotive since in the red soils, the rocky part of Kuntamukkala plantation showed lower results compared to the non-rocky part of the plantation. Not only the physical growth but also flowering, fruiting and seed output were recorded highest among the field stations in the black gravel soils (Harika Done, 2017).

The results were in conformity with the reports of Wiesenhuetter, 2003 that it can thrive even in the poorest rocky soils, but with reduced root formation.

Table 1:-Effect of soil type over the growth and seed out put

Name of the plantation	Rajavaram	Kuntamukkala	Nekkalam	Morusumilli	Pulluru	Nandigama	Chandarlapadu
Type of Soil	Red	Red, Rocky in some part	Black Cotton			Black Gravel	
pH	**7.5**	**7.8**	**7.8**	**8**	**8**	**8.14**	**8.14**
Mean Plant Height (ft)	9.5	11.1	10	12.5	11.9	15	14.5
Mean plant girth (inches)	8.3	8.8	8.5	9.5	9.6	10.8	10.5
No. of Branches	20	22	23	29	25	30	30
Flowering (%)	40	60	43.6	30.5	30	69	72
Fruiting (%)	30	39	33.7	15.5	15	50.2	61.1
Yield (%)	23.6	30	26	10.2	10	40	51.2
Number of seeds/1000 fruits	2400	2022	2100	1960	1972	2430	2550
Fruit dry weight (g)	1450	1445	1390	1350	1365	1540	1620
Seed dry weight (g)	1000	1012	958	925	935	1082	1145
% of shell weight	31.03	29.96	31.07	31.48	31.5	29.75	29.32
% of seed weight	68.96	70.03	68.92	68.52	68.5	70.25	70.67

ft= Feet, %= percentage

Conclusion:-

Based on the resultsin the present study it was confirmed that the plant could be successfully established in any soil and it undemands in soil type but, there were significant differences in the growth performance of the plant to various soil types related to the plant height, girth and branching. It was observed that soil alone is not having much influence over the growth and yield since it is influenced by some other factors like the availability of water and nutrients.

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