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Abstract

The present study was conducted to determine the variation in yield and oil content by taking composite sample of six *Jatropha* trees selected randomly from two cultural site conditions *viz.* arable (T1), non-arable (T2) and three altitudinal ranges E1 (400-600m)), E2 (600-800m) and E3 (800-1000 m) in Himachal Pradesh. The oil was extracted from the dried seed using steam distillation method of oil extraction. The highest oil was recovered in T2 E2 (non-arable site with low altitude) various morphological and yield attribute like number of fruits/branches, number of fruits/tree, number of seeds/tree were also studied. Arable site with high altitude (T1E3) recorded the highest value for these parameters.

Keywords: Biodiesel, energy demand, yield attributes, growth pattern, pollution reduction.

Introduction

The developing world in today encountered with near crisis situation both economic and environmental. This region with barely 56 per cent of the land area has to support around 77 % of the total population at the global level. India consumes about 111 millions tons of petroleum products annually. About 33 million tons in produced in the country as crude oil meeting less than 30 per cent of the needs. India ranks sixth in the world in term of energy demand. Accounting for 3.5 percent of the world commercial energy demand in 2001. India is witnessing a serious threat at of its resources as well as various concomitant environmental disasters. The impacts of degradation are though visible in all renewable and non-renewable resources at the forest and the lands which are very vital for sustenance have been previously affected. The largest resource liability for India lies in its input of petroleum product. These are essential to maintain the tempo of the high growth rate of Indian economy. Both transport and industry consume million tons of diesel every year, which is produced from crude oil. Reserves of crude oil rapidly diminishing and the reliability and security of oil supplies has been of global concern since the energy crisis of the 1970. Depleting reserves of fossil fuels and increasing effects of pollution from these fuel demand eco-friendly alternatives, which can supplement or replace fossil fuels: In recent years research has been directed to explore biofuels -plant based fuel sources as a supplement or substitute of fossil fuel. Biofuels are renewable and environmentally safe. Biodiesel is fatty acid ethyl or methyl ester made from virgin or used vegetable oils (both edible and non edible) and animals fats. The main commodity source for biodiesel in India can be non- edible oils obtained from plant species such as *Jatropha curcas* (Ratanjyot), *Pongamia pinnata* (Karanj), *Calophyllum inophyllum*, *Hevea brasilensis* etc. Biodiesel contains no petroleum, but it can be blended at any level with petroleum diesel to create a biodiesel blend or can be used in its pure form. Just like petroleum diesel, biodiesel operates in compression ignition engine which essentially require very little or no engine modification, because biodiesel has properties similar to petroleum diesel fuels. Biodiesel is considered clean fuel since it has almost no sulphur, no aromatics and has about 10 percent built -in- oxygen which helps into burn fully. Among the oil seeds of forest origin *Jatropha curcas* popularly known as Ratanjayot have an immense potential for producing oil, which finds large scale industrial uses. *Jatropha curcas* is a large soft wooded, deciduous, multipurpose tree of 47-meter height, which belongs to the family Euphorbiaceae. Plant display vigorous growth in early periods. Plants from seed develop a taproot and four lateral roots where as cutting do not develop a tap root (Heller, 1996). It flowers in hot and rainy season and set fruits in winter. In field condition this may produce the seed yield as high as 12th/ha/year after five year of plantation (Jones and Miller, 1992), while 0.8 to 1.0 Kg of seed per meter of live fence can be obtained if it is planted for hedge (Henning, 1996). Flower and seed production positively to rainfall/moisture and fertility of soil. The oil content of seeds represents a reasonable opportunity for renewable fuel Schultz and Morgan, 1985; Princen, 1983) and (Harrington, 1986). A study on energy yield from different plants in terms of the liquid fuel / acre/year inch of water among many processes under test (Calvin, 1987). The seed of Jatropha contains about 38-40 per cent non-edible oil. Curcas oil contains a fatly acid and one of its profitable uses is as raw material for making soap. Oil is also used for manufacturing candles and varnishes.

Materials and Methods

The experiment was conducted in the laboratory of department of Silviculture and Agroforestry, Dr. Y.S. Parmar university of Horticulture and Forestry Nauni, Solan, H.P. India. Oil content variation studies were under taken according to distribution ranges of the species and cultural conditions (arable & non- arable). The whole distributional range of the species divided in to three elevation i.e. E1 (400-600 m), E2 (600-800 m) and E3 (800-1000m). The seeds collected from all the three altitudinal ranges and two sites were processed for oil content variation. Generally three seeds were obtained from single fruit. Simultaneously morphological parameter like number of branches/trees, number of fruits/branch, number of fruits/tree (number of fruits/tree was approximately calculated by multiplying the total number of branches and number of fruits/branch) and number of seeds/tree (calculated by multiplying the total number of fruits/tree by number of seeds/fruit) were recorded.
The shade-dried seeds (100 g) from each sample were taken and kernels were separated manually. The separated kernels were crushed in pressler mortar. After crushing a composite sample of 30gm weighed in thimble then soxhlet extracted on a heating mantle.
The oil from the sample was extracted by using soxhlet apparatus. The prepared sample is put in to soxhlet appratus. The prepared sample is put in to soxhlet apparatus places over heating mantle. The oil was extracted from sample with the help of petroleum either followed by continuous distilling for 4 hours. The oil was recovered by complete distilling of most of the solvent on a heating mantle. The oil is then transferred to measuring cylinder. The measuring cylinder is then placed over water bath for complete evaporation of solvent for about 2-3 hrs and volume of oil was recorded and expressed as oil content (%) as follow

$$\text{Oil content (\%)} = \frac{\text{Oil weight}}{\text{Sample weight}} \times 100$$

Results

Numbers of branches/tree:
Maximum numbers of branches were recorded in T2 (8.59) and E2 (9.50) (Table1). However T1 & T2 are statically at par with each other. E1 and E3 significantly differ from E2. Among the treatment combination maximum number of branches were recorded in T2 E2 (10.83) and minimum in T1 E1 (7.00) whereas all the combination are at par with each other.
Number of Fruits/branch: -
Both altitude and site condition have a non-significant effect on number of fruits per branch however maximum number of fruits per branch were recorded in T2 (19.17) and E3 (27.17) and minimum in T1 (19.06) and E2 (14.25) (Table1). Among the treatment combinations maximum fruit per branch were recorded in T1E3 (19.06) and minimum in T1E2 (13.83).

Treatment / Elevation	No. of branches/tree			No. of Fruits/branch			No. of fruits/ tree			No. of seeds/ tree			oil content		
	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean	T_1	T_2	Mean
(E_1) 400-600	7.00	7.33	7.17	14.83	17.00	15.00	102.00	125.30	113.70	327.50	376.70	351.70	41.38	45.00	43.19
(E_2) 600-800	8.18	10.83	9.50	13.83	14.67	14.25	132.30	160.00	146.20	347.00	480.00	413.50	40.85	43.38	42.12
(E_3) 800-1000	7.50	8.50	8.00	28.50	25.83	27.17	217.00	215.80	216.40	651.00	647.50	649.20	22.68	38.63	30.66
Mean	7.56	8.59	8.23	19.06	19.17	19.12	150.40	167.10	158.75	441.80	501.20	471.50	34.97	42.34	38.66
CD 0.05															
Treatment		NS			NS			NS			NS			3.52	
Elevation		1.91			3.55			48.70			129.71			4.32	
T*E		NS			NS			NS			NS			6.10	

T_1: arable
T_2: Non-arable

Table1: - Effect of sites and elevation on yield and oil content from seed of *Jatropha*

Number of fruits/tree:-

The highest number of fruits/tree were recorded in T2 (167.10) and E3 (216.40) and minimum in T1 (150.40) and E3 (113.70). Among the altitudinal ranges, E3 registered significantly higher fruit yield per plant than E1 & E2 and among the treatment combinations fruit yield was recorded maximum in T1E3 (217) and minimum inT1E1(102.00) (Table 1).

Number of seeds/tree

It is evident from the data that elevation and site conditions had significant effect on number of seeds/tree. Maximum seed yield was recorded in T2 (501.20), E3 (649.20) and minimum in T1 (441.80) and E1 (351.70). Among the treatment combinations maximum seed yield was recorded inT1E3 (651.00) and minimum in T1E1 (327.5).

Oil contents %

Both elevation and site condition have significant effect on oil content. The maximum oil was recorded in T2 (42.34%) and E1 (43.19%) and minimum in T1 (34.97%) and E3 (30.66%). Among the treatment combination maximum oil yield was recorded in T2E1 (45.00%) and maximum in T1E3 (22.68%). However all the treatment combinations except T1E3 register significantly higher oil content.

Discussion

Elevations have a significant effect on all the yield attributes of *Jatropha curcas* growth table1. Maximum number of branches/tree, number of fruits/branch, number of fruits/tree was recorded maximum at higher elevations (800-1000m). Similar findings were reported by Manian and Gopalakrishan (1995) that at higher altitude there was a dominate utilization of the photo assimilation for growth as compared to production of oil. Maximum oil content (%) was recorded in T2 (Non arable lands) 45.00 % on kernel weight basis in lower altitudinal range of (400- 600m) whereas minimum was recorded in arable lands (22.68%) at higher altitudinal range (800-1000m). According to Tewari (1964), Diwaker (1993) *Jatropha curcas* is a well-suited species and wild growing hardy plant, well adapted to harsh condition of soil and climate whereas, the oil content variation with respect to soil site condition has not been reported so far and this variation might be because of edapho-climatic factors. The experimental results on oil content percent were also in context to the finding of Sehgal *et al* (1989) that the seed oil content of *Pinus roxburghii* yielded higher percentage of oil at lower altitude than at higher altitude.

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