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Research Article

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Seed Oil Content and Variability of Some Provenance of Jatropha Curcas Population in Ethiopia

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Abstract

Background

Jatropha curcas (L.) is drought resistant large shrub or small tree. It belongs to the genus Jatropha and the family Euphorbiaceae. It is native to tropical America, but now found abundantly in many tropical and sub-tropical regions. Jatropha curcas (L.) is one of the important species that bear seed containing oil with a potential use as biodiesel. The objective of this research is to estimate the seed oil content and variability for some tree morphological traits of Jatropha curcas population in Ethiopia.

Methodology

Fourteen Jatropha curcas populations were collected at different parts of Ethiopia. Sixteen plants per plot were planted at Shewarobit site in randomized complete block design with three replications. Data on survival rate, number of branches, seed yields and growth parameters were collected from those plants.

Results

The result showed that a survival rate of 85-100%, average root collar diameter was 11cm and plant height of 235 cm were recorded at the age of 39 months after planting. Different traits of Jatropha curcas indicated statistically no significant difference ($p>0.05$). However, slightly higher seed and oil yield (k.g/ha/year) 3016.0 & 111169.8, 2711.3 & 91235.25 were found from Chefa and R1-009 seed sources, respectively.

Conclusions

Even if, there was no significant difference observed among seed sources. Hence, Chefa and R1-009 collections have slightly greater yield both in seed and oil yields. So they should be chosen for future seed sources to produce crude oil due to their relative higher seed number and oil yield.

Keywords: Jatropha Curcas, Oil Content and Population.

Introduction

The increasing global demand for energy and recognition of limitations in the availability of the crude oil supply have resulted in a large increase in crude oil prices, and will continue to do so. Due to severe energy crisis and rising petroleum prices, developing alternate energy sources especially biodiesel is gained attention [1-3]. Jatropha or physic nut originated from Mexico and tropical America; it is cultivated in many other Latin America, Asian & African countries as a hedge [4]. The plant is widely cultivated in the tropics as a live fence in fields and settlements. This is mainly because it can be easily propagated by cuttings and the species is not browsed by cattle. Beside the live fence purpose, it has been used for various purposes including traditional medicine and the sap flowing from the stem is used to arrest bleeding of wounds Nath and Dutta, 1992.

Since the oil crisis of the 1970 and recognition of the limitation of the world oil resources and the increasing global warming, cultivation of oil crops including Jatropha curcas for energy purposes has received a special attention. Because, the atmosphere is not polluted by carbon dioxide, since when these are burned it has already been assimilated during the growth of these crops, it is drought resistant and can potentially be used to produce oil from marginal semi-arid lands, without competing with food crop production. In

addition, this fuel can be used partly to substitute costly oil imports for landlocked countries.

Despite the benefits that could be obtained from the proper development, management and utilization of Jatropha curcas, deliberate efforts towards production, including researches on cultivation techniques, breed improvement, management techniques and production technology are scanty in the Amhara region. Yet the performance and productivity of the different provenances of Jatropha curcas of the region have not been evaluated in the region. Thus, taking in to account all these gaps, this research project was initiated to address the development, management and utilization of Jatropha curcas. With this background, the objective of this research was to estimate the seed oil content of Jatropha curcas for selecting high seed yielder Jatropha curcas provenance as an oil crop in Ethiopia.

Material and Methods

Data Collection

Seeds were collected from Jatropha curcas populations growing area in Ethiopia. According to the study by Dereje Hailu , populations of Assossa, Chiro, Mersa, Jewuha and Cheffa had high oil content and seed yield among 18 different Jatropha populations [5]. Seed collections were also included from these superior populations. The collected seeds were sown at Shewarobit nursery site. The grown seedlings from these provenances were planted on a 6 m x 6 m plot of land during July 2009 using randomized complete block design with three replications at Shewarobit and Kemise. The spacing between trees were 2 m, between blocks and plots were 2 m and 3 m, respectively. Survival rate, seed yield, number of branches, 1000 seed weight and plant growth parameters such as height, root collar diameter were collected from non-boarder individuals.

Laboratory analysis

Oil quantity was measured by extraction method. Seed of each provenance from non-boarder individuals were collected separately and dried. From each provenance, 20 gm of seed was taken and their kernels were cracked, and their shells carefully removed manually following Pant K.et al., 2006 procedures. The separated kernels were crushed in pressure mortar. The crushed kernel was weighted in tumble and put in Soxhlet apparatus placed over heating mantel. The oil was extracted with the help of hexane followed by continuous distilling for one and a half hours. The oil was recovered by complete distilling of the solvent of a heating mental. The oil then transferred to measuring cylinder. The measuring cylinder were placed cover water both for complete evaporation of solvent for about one up to two hours and volume of oils were measured and expressed in percent [6].

Data analysis

A one-way analysis of variance (ANOVA) was performed through SAS to assess variations among provenances. Pearson correlation analysis was also used to relate oil yield with different parameters.

Result and Discussion

Survival rate

Except the two provenances, survival rate was higher (above 90%) for all provenances. Apart from Cheffa and R3-002, there was no mortality from the 21 months growing on wards (Figure 1). In overall, the survival rate ranges from 87.5% in Togo provenance to 100% in Cheffa and R2-004 provenances. Other study also showed that, Jatroha could be highly survived in tropical African's semi-arid regions where the climate is harsh and soils are relatively low physical and chemical quality [7]. This means that, this species to be easily cultivated in marginal land where not suitable for food crop productions.

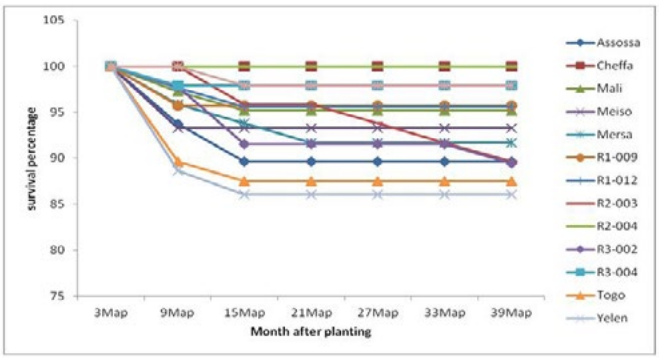

Figure 1: Percent survival rate of Jatropha curcas provenances at 39 months after planting at Shewarobit site: MAP = month after planting

Plant height and Root collar diameter

The growth rate varied very differently by source; for example, after 9 months of growing, tree height was 66.53cm with root collar diameter 3.32 cm for source Yelen versus only 111.9 cm height with root collar diameter 4.68 cm) for source Cheffa (Table 1& Figure 2). After 27 months of growth the above-mentioned sources, average tree height and root collar diameter were 164.55 (8.13) and 198.44 (8.85) cm, respectively. After 39 months, growing the root collar diameter and plant height of 14 provenances ranged from 8.43 to 10.36 cm and 180.74 to 227.54 cm, respectively and an average size of 9.8 cm in root collar diameter and 210.57 cm in height.

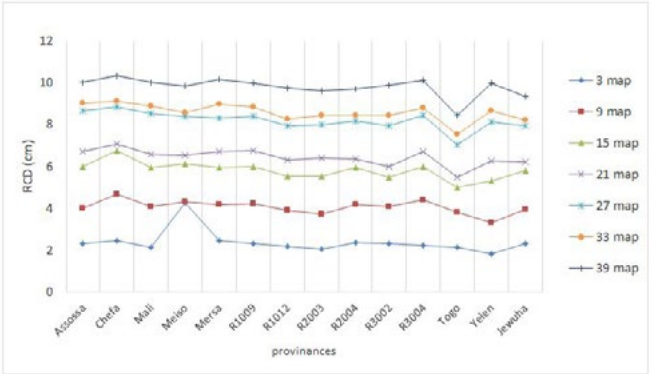

Figure 2: Root collar diameter (cm) of Jatropha curcas provenances at different months after planting

Table 1: Plant height (cm) of Jatropha curcas provenances at different months after planting at Shewa Robit site

	3 map.	9 map.	15 map.	21 map.	27 map.	33 map.	39 map.
Assossa	39.21	83.86	149.13	170.46	193.74	211.33	220.16
Chefa	46.76	111.9	162.89	177.27	198.44	213.75	227.54
Mali	31.98	86.66	146.55	161.58	186.66	201.35	219.53
Meiso	33.59	87.93	143.8	159.92	180.7	196.67	214.14
Mersa	44.23	88.31	142.73	156.73	176.11	187.3	209.76
R1009	40.47	104.94	160.63	173.51	192.3	203.71	222.82
R1012	37.05	94.76	143.36	159.08	175.31	186.92	201.87
R2003	31.98	85.35	142.84	158.03	179.27	191.29	212.64
R2004	36.68	98.68	154.02	166.21	183.12	191.29	208.13
R3002	39.63	88.61	146.83	158.44	174.99	185.67	199.62
R3004	37.22	107.99	163.93	177.94	195.68	203.14	218.57
Togo	32.42	68.33	118.68	132.42	153.99	165.46	180.74
Yelen	23.71	66.53	123.43	143.78	164.55	184.79	205.62
Jewuha	41.21	91.11	145.75	162.27	179.13	189.11	206.87

Seed & oil yield

The mean seed yield of each provenance was estimated from the dry seed weight of collected from all trees in a plot in a year (Table 2). The average seed yields of 14 provenances were 1958.786 kg /ha/year with a minimum 1031.6 kg/ha/year and a maximum of 3016 kg/ha/year and the maximum seed yield was three-times greater from that of the minimum. Therefore, physic nut cultivation is the most important for oil production. The average oil yields for the 14 provenances were 69101.46 kg/ha/year. The maximum oil yield was three-times that of the minimum, ranging from111169.8 kg/ha/year for provenance of Cheffa and to 36343.27 kg/ha/year for Togo provenance (Table 2).

Table 2: Number of branch /plants, number of seeds/pods, seed oil content (%), seed and oil yield k.g/ha of the study population at Shewa Robit site.

Name of population	Seed yield k.g/ha/yr.	Seed oil content (%)	Oil yield k.g/ha	No. branch/plant	No. seeds/pod
Cheffa	3016.0	36.86	111169.8	8.89	2.70
R1-009	2711.3	33.65	91235.25	6.02	2.53
R3-004	2566.2	34.99	89791.34	6.98	2.50
Mersa	2390.5	36.06	86201.43	6.93	2.56
R2-004	2154.4	34.61	74563.78	6.22	2.50
Meiso	2116.7	35.91	76010.70	6.45	2.50
R3-002	1960.3	34.82	68257.65	6.72	2.53
jewiha	1856.9	36.35	67498.32	6.86	2.65
Assossa	1849.8	36.10	66777.78	6.19	2.55
R1-012	1793.9	34.95	62696.81	6.24	2.43
Mali	1406.9	32.10	45161.49	5.96	2.46
R2-003	1360.7	34.55	47012.19	5.80	2.46
Yelen	1207.8	37.01	44700.68	5.70	2.33
Togo	1031.6	35.23	36343.27	5.27	2.60
sig. (0.05)	ns	ns	ns	ns	ns

Relationship of height, RCD, seed yield and oil yield with selected physic nut morphological properties.

Simple correlation analysis was carried out for selected physic nut morphological properties with plant height, seed yield, oil yield, number of branches per plant and number of seeds per pod (Table 3). Jatropha tree height is significantly correlated with RCD ($R=0.55$, $p<0.001$), seed yield ($r=0.589$, $p<0.01$) and oil yield ($r=0.579$, $p< 0.001$), meaning that seed and oil yields increase with tree sizes. However, number of seeds per pod is not significantly correlated with the tree height, seed yield, oil yield and RCD. This means that, the biggest Jatropha trees could be given higher seed and oil yield without sinking the number of seed per pod.

Table 3: The relationship between some selected physic nut morphological parameters with seed and oil yield Note: NBP is number of branches per plant; NSP is number of seed per plant

	Height	RCD	Seed yield	NBP	Oil yield	NSP
Height	1					
RCD	0.855***	1				
Seed yield	0.589***	0.545***	1			
No. of branch/plant	0.649***	0.687***	0.478***	1		
Oil yield	0.579***	0.531***	0.880***	0.379**	1	
No. of seed /pod	0.131*	-0.012	0.308*	0.125	0.21	1

Conclusion and Recommendation

Generally, jatropha tree grows very fast, but growth rate seed and oil yields do not vary between provenances. Even if statistically significant difference is not shown for four provenances (Chefa, R1-009, R3-004 and Mersa), they should be chosen for future seed sources to produce crude oil due to their relative higher seed number and oil yield. We can conclude that high oil yield seed sources were collected and selected and, subsequently, successfully cultivated to produce Jatropha oil that was further processed to high-quality biodiesel. Further work is needed to study the changes of Jatropha growing characteristics and oil yield with plant ages. More research requires regarding determination of time of optimum yield of Jatropha trees.

Declaration

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

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Author contributions

The first author more contributed to this paper.

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Conflicts of interest

There are not conflict of interest between authors.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Permit

Permission to handle our study land was given by shewarobit town administration office.

References

1. Ragauskas, A. J., Williams, C. K., Davison, B. H., Britovsek, G., Cairney, J., Eckert, C. A., ... & Tschaplinski, T. (2006). The path forward for biofuels and biomaterials. science, 311(5760), 484-489.
2. Tilman, D., Hill, J., & Lehman, C. (2006). Carbon-negative biofuels from low-input high-diversity grassland biomass. Science, 314(5805), 1598-1600.
3. Kumar, A., & Sharma, S. (2011). Potential non-edible oil resources as biodiesel feedstock: an Indian perspective. Renewable and Sustainable Energy Reviews, 15(4), 1791-1800.
4. Heller, J. (1996). Physic nut-Jatropha curcas L. Promoting the conservation and use of underutilized and neglected crops. International Plant Genetic Resources Institute, Rome, Italy. International Plant Genetic Resources Institute, Rome.
5. Dereje, H. (2010). Phenotypic and Molecular Characterization of Physic Nut (Jatropha curcas L.) Populations in Ethiopia (Doctoral dissertation, Addis Ababa University).
6. Pant, K. S., Khosla, V., Kumar, D., & Gairola, S. (2006). Seed oil content variation in Jatropha curcas Linn. in different altitudinal ranges and site conditions in HP India. Lyonia, 11(2), 31-34.
7. Ngethe, R. (2008). Jatropha for poverty alleviation: the Kenyan experience. In national stakeholders consultative workshop on biofuel. KEFRI, Muguga (pp. 5-6).