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Physic nut (*Jatropha curcas*): Miracle Plant or a Treat in Ethiopia?

Getinet Alemaw' Rebuma Merera and Getaneh Nigatu
Melkassa Research Center, P. O. Box 436 Adama, Ethiopia, E-mail getalebir@gmail.com

አህፅርኦት

ጃትሮፋ፣ አይደርቄ ወይም ጉሎ በመባል የሚታወቀው ተክል በሞቃታማና ዝናም አጠር አካባቢዎች በስፋት ለምዶ ይታያል። ተክሉ ርጥበት ሲያገኝ የሚስማማውና ዕድገቱም ፈጣን ብዙ ቅጠል፣ ቅርንጫፍና እንቡጥ የሚያወጣ ሲሆን ዝናብ ሲያቋርጥና ርጥበት ሲያጥረው ቅጠሉን በማራገፍ ወደ መንቃልፎ ይገባና መልሶ ዝናብ ሲጥል እንደገና በመንቃት ዕድገቱን ይቀጥላል። የአይደርቄ ፍሬ እስከ 35% ዘይት ይዘት ያለው ሲሆን ዘይቱም ሆነ ፋጉሎው ለምግብ ወይም ለመኖ የማይውል ሲሆን ዘይቱ ለሳሙና ኢንዱስትሪ እና ናፍጣን ሙሉ በሙሉ ወይም በድብልቅ በመተካት ሞተርን ሊያንቀሳቅስ ይችላል። በመሆኑም የኢትዮጵያ ፌደራል መንግስት አይደርቄን በባዮፊውል ፖሊሲና ስትራቴጂ ውስጥ ሰፊ ቦታ ሰጥቶት በደረቃማና በተራቆቱ ቦታዎች ላይ በየክልሎች በስፋት በማልማት ላይ ይገኛል። አይደርቄ አጥጋቢ ምርት ለመስጠት ለም መሬትና እንደማንኛውም ሰብል የተሻሻለ አያያዝ ይፈልጋል። ተክሉ ለምግብ፣ ለመኖና እንጨቱም ለማገዶ የሚውል በመሆኑ በስፋት ማልማቱ ሊታሰብበት የሚገባ ሲሆን በተለይም የእንስሳትና ዱር አራዊትን መኖ ሊሻማ ይችላል።

Abstract

Physic nut or Ayderkie in Amharic and Gullo in Oromiffa is a bush or small tree adapted in the drier and warmer areas of Ethiopia. It endures moisture stress by dropping its leaves during dry period and flourishes when the rain comes. The plant has received enormous attention of the government as raw material for biodiesel industry. Hence a serious of silvicultural and genotype testing have been carried out in the Central Rift Valley of Ethiopia. The result indicated that physic nut has a very narrow genetic base probably due to its ease of vegetative propagation. Furthermore, the plant needs intensive improved management such as sufficient moisture, mulching, fertile soil, and pruning for successful seed production. Although, physic nut is thought to have least disease and insect incidence, it is not the case in Ethiopia. Physic nut is not used as food, feed, or firewood; its use lies only in hedges and in the soap industry. Over all, the myths of physic nut are unfounded and its distribution needs to be regulated.

Introduction

Physic nut (*Jatrophacurcas* L) originated in Central America and now found distributed in all drier areas of the tropics and sub tropics. It is believed to be distributed by Portuguese colonizers via Cape Verde and then to Africa and Tropical Asia. In Ethiopia, it is locally known as *Ayderkie* in Amharic and *Gullo* in Oromiffa mostly grown in low land dry areas. It is found growing as live fences to exclude animals. The plant strives well on poor and degraded soils and is neither browsed by animals nor used as firewood. It is propagated mostly by cutting but can also be planted using seed. Propagation of physic nut using cuttings promoted for its easier and wider distribution; but may have limited its genetic variability. The plant drops its leaves during the dry period and goes to dormancy while flourishing when the rain comes. The plant bears seed once in a year following the rainy season; however, it can flower and set seed if moisture is

available throughout the year. The seed contains oil but neither its oil nor the meal remaining after its oil extraction is consumed as feed or food. All plant parts particularly the seed is known to be toxic to mammals because of phorbol esters and curcin that are present in all plant parts (Hellar 1996). The composition of toxic substances is known to be very high in the seed than roots, stems, leaves, stem, and branches. Nontoxic and edible physic nut varieties have been identified in Mexico (Makkar et al 1998). In Ethiopia, there is no report on the consumption of physic nut and it is only known as a live fence.

In Ethiopia, no one knows when and where physic nut was introduced but can be found in drier areas particularly East and North Shewa, Gamo Gofa, South Wello, North and South Omo Zones as well as in Gambella and Benishangul Gumuz Regions. Recently physic nut has received the attention of the federal and regional governments mainly because of its potential as biodiesel. The government of Ethiopia has approved biofuel policy and strategy since 2007 with physic nut as a source of raw material for biodiesel industry. Hence, the plant is being promoted in Amhara, Tigray, Oromia and Southern National and Nationalities Regional States mostly in dry areas and hillsides. So far, there is no breakthrough in its utilization except in detergent industry to manufacture soap. In some countries such as Australia, South Africa, Jamaica, Panama, Honduras, Porto Rico, and El Salvador physic nut is classified as a weed. South Africa has banned commercial production of physic nut. In Ethiopia, it has received a glorious reception as a miracle plant. Huge plantation program is being launched in regional states on the onset of the biofuel policy and strategy. On the other hand, the commercial utilization of the plant as a raw material for biodiesel industry beyond for detergent and rural household is not known. In Kenya and Tanzania, the plant has been tested to be uneconomical for commercial production (Wahl et al 2009, Wekesa et al 2009). Therefore a serious of tests have been conducted to develop silvicultural techniques of the plant as well as to identify high yielding provenance genotype. This paper reports on the yielding potential and response to silvicultural management factors and out lines its future prospects.

Materials and Methods

A serious of experiments has been carried out at Melkassa Agriculture Research Center and its Sub Center at Meisso to assess the potential of physic nut productivity in the Central Rift valley of Ethiopia. The oil content of international germplasm, seed yield of selected provenances and, effect of mulch, row, and plant spacing, were evaluated for four years.

Sixty-four accessions (40 local and 24 exotic) were evaluated at Melkassa and Meisso. All accessions were planted at Melkassa and Meisso in two rows, single plot spaced at 2 meters intra and 2.5 m inter row spacing. In the spacing trial,

three plant (2, 2.5 and 3 m) and four row (1.5, 2.0, 2.5 and 3.0 m) spacing were planted in three replications at Bishola and Melkassa main campus. Bishola is a trial site in the Southern end of the main campus Melkassa. The effect of mulch on the seed yield of physic nut plants at Melkassa was studied for four years. All testes at Melkassa were supplied with sufficient moisture during the dry period while those at Meisso and Bishola lack supplementary moisture supply. Data on seed yield was recorded for four years and oil content for two years. Similarly, the performance of four provenances of physic nut was evaluated for seed yield under supplementary irrigation at Melkassa.

The media to raise seedlings was prepared from sand, soil, and manure at a ratio of 1:1:1 were thoroughly mixed. Polyethylene pots were filled with growing media and watered to sufficient moisture. Two seeds were planted in each pot and reduced to one after four-leaf stage. Seedlings were watered every three days until they were eight weeks old. When they were eight weeks old, watering was reduced to once a week for hardening. Seedlings were transplanted in the field in pre prepared soil pits. Pit size was 40 cm x 40 cm, which were dug up a month earlier. The polyethylene bag was removed and seedlings containing soil media were put in the pits. Seedlings were cultivated every year to remove any annual and perennial weeds and other bushes. Seeds were harvested at maturity, dried and hand shelled. Seed yield was measured by recording the weight while seed weight was recorded as the weight of 100 seeds in gm. Oil content was determined using Nuclear Magnetic Resonance Spectroscopy, New Port Analyzer.

Results and Discussion

The rainfall at Melkassa ranges from 548.7 to 1093.1 mm during 1992 to 2011 that failed almost all from June to August. In the same period, the amount of rainfall at Meisso ranges 497 mm 1115 mm that fall between June and August. The mean maximum and minimum temperatures at both locations did not show wide range. During the same period, humidity in the air at Melkassa was 48 to 56% and 37-45% at Meisso. These climate parameters clearly indicate that the two locations are semi-arid.

The application of farmyard manure on physic nut plants increased yield substantially (Figure 1). Seed yield of physic nut increased as the amount of farmyard Manure increases although the amount was not increased as the tree grows. Similarly, application mulch on surfaces of the physic nut trees improves yield over the control due to moisture conservation. Among mulch sources, haricot bean mulch was better than grass and tef mulch probably because it is a legume. Figure 1 and 2 indicates that the yield of physic nut reaches over 25 quintals per hectare per year under good management and supplementary irrigation. Physic nut does not require intensive management once it is

established and such yield level seems to be adequate for oil seeds. However, such level of seed yield per hectare was achieved through good management and supplementary irrigation. In many cases, crops for irrigated farming must be very productive and high value to cover the cost of irrigation.

In the spacing trial, 2.5 meters between rows and 2 meters between plants was optimum followed by 3 meters by 2 meters of inter and intra row spacing (Figure 3). Similar experiment was carried out at Bishola without supplementary irrigation. The highest seed yield 10 q ha^{-1} was obtained at 2 x 2 and 2.5 x 2 meters of row and plant spacing (Table 1.) However, 2.5 x 2 meters of row and plant spacing is preferred for ease of management particularly harvesting. The oil content of physic nut was not affected by spacing. The spacing experiment at Melkassa campus under good management and supplementary irrigation resulted in three times more seed yield than the similar experiment at Bishola. This was because the plants under supplementary irrigation at Melkassa were able to bear fruits throughout the year as compared to plants at Bishola, which were only able to bear fruit once a year using rainfall. Physic nut is a large bush and must be pruned at its first year for ease of management. One of the constraints of physic nut cultivation is harvesting hence pruning and optimum spacing are very important.

The seed yield of two exotic namely Kenya, Arusha, and four local namely Meiso, Sodere, Saula and Cheffa were studied for their yielding ability for four years under good management and supplementary irrigation (Figure 4). The seed yield of Arusha provenance imported from Tanzania was better particularly as compared to the indigenous provenances. It can also be concluded that the seed yield of physic nut at Melkassa condition with good management and supplementary irrigation can reach well over 30 quintals/ha. In literature seed yields of less than 5 q/ha in Cape Verde up to 50 q/ha in Nicaragua and 40 q/ha in Paraguay are reported (Heller 1996) without mentioning the level of management.

Table 1. Seed yield of four and five year old physic nut bushes planted at different spacing at Bishoal/ Melkassa under well managed condition.

Spacing between rows and plants (m)	Seed yield (kg ha^{-1})		Oil content (%)
	2005	2006	
2 x 1.5	376	769	31
2.5 x 1.5	78	527	30
2 x 2	752	1096	33
2.5 x 2	559	1095	31
3 x 2	415	769	29
2.5 x 2.5	313	435	30
3 x 2.5	285	266	30
3 x 3	54	209	31
Mean	354	645	31

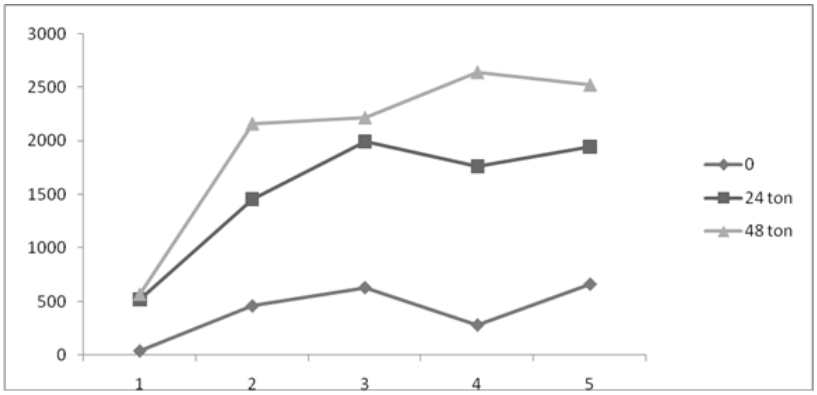

Figure 1. Effect of farm yard manure on the seed yield of physic nut at Melkassa.

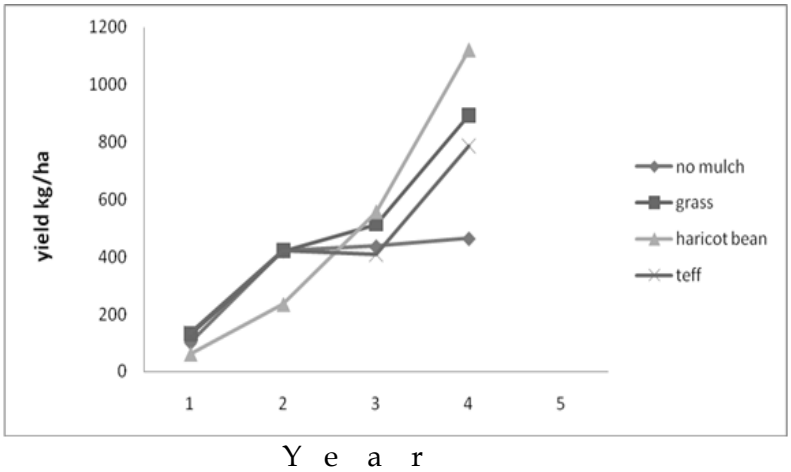

Figure 2. Effect of mulch on the seed yield of physic nut.

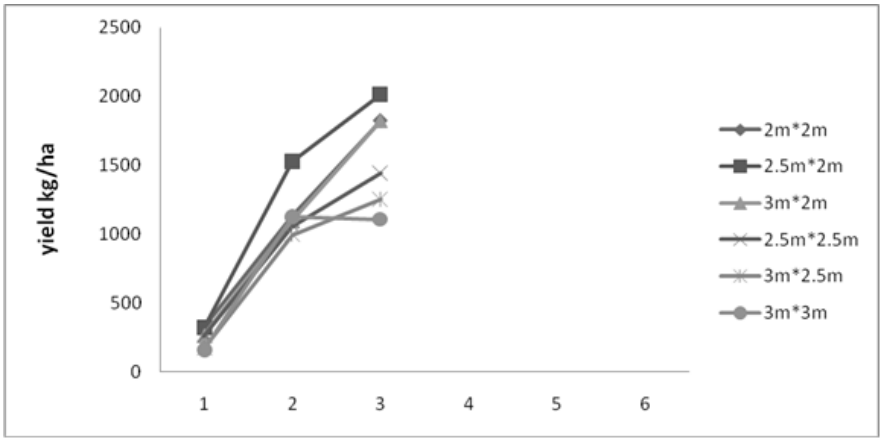

Figure 3. Effect of Spacing on the seed yield of physic nut for three years

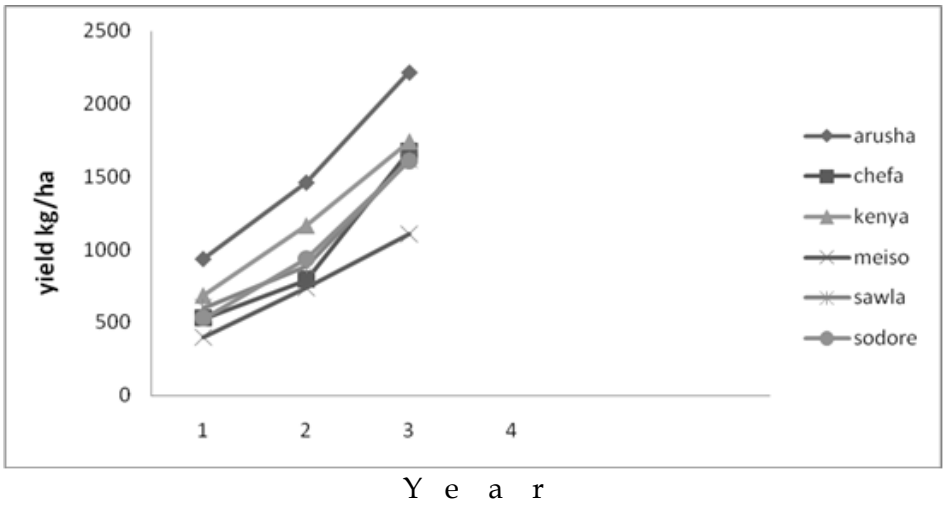

Figure 4. Yield of six genotypes of physic nut years

The oil content of 64 accessions grown at Melkassa and Meisso is indicated on Table 2. Local accessions have mostly higher oil content than the exotic accessions. Over all the oil content of physic nut is in the range of 22-35%, which is lower than sunflower, linseed, groundnut, and sesame, but about the same as safflower and higher than soybean under Ethiopian condition (Getinet 2013). Similarly, the seed weight of physic nut ranges 44 to 81 g/100 seeds at Melkassa. Both oil content and seed weight were higher at Melkassa than Meisso. The difference between Melkassa and Meisso in terms of mean minimum and mean maximum temperatures and precipitation was not significant except the higher value of relative humidity at Melkassa. The physic nut accessions showed limited phenotypic variability for many tree traits. Physic nut is cross-pollinating species and high level of variation was expected. However, the plant is propagated in many cases using cuttings and its ease of propagation may have limited its genetic variability. Montes *et al*. (2007) studied 225 physic nut accessions from India, Africa, and Latin America using AFLP. Low genetic variability was observed from India and Africa and high from Latin American accessions probably due to its ease of vegetative propagation. Basha *et al*. (2009) reported similar results involving physic nut accessions from 13 countries.

The seed yield and oil content of 13 provenances of physic nut grown at Meisso is indicated on Table 3. The test was grown under minimal inputs without mulch and supplementary irrigation. The oil content varied 29 to 36 % with seed yield of 2.55 to 4.87 q ha^{-1}. Although the oil content was satisfactory, the seed yield was very low as compared to many of the commercial oilseeds. The oil yield per hectare of all provenances was lower than 2 q ha^{-1} of oil. The difference in seed yields of silvicultural and variety tests at Melkassa campus under good

management and with supplementary irrigation and; the tests at Meisso and Bishola underlines the importance of good management and adequate moisture for higher seed and oil yield of physic nut. The national biofuel policy and strategy states that physic nut should be grown under non-arable degraded land to avoid the competition with food crops. Unfortunately, good management and fertile soil are prerequisites for higher seed yield and physic nut is not exceptional. It appears that the national biofuels policy and strategy lacks agronomic consideration for physic nut. For physic nut to be economical as biodisel feed stock, it must be cultivated as any other cultivated crop for higher oil and seed yield. Pandey *et al*. (2012) stated that physic nut is recommended for plantation on degraded lands in India. However, he further stated that degraded lands could not nourish and sustain adequately for optimum production as a biodisel feed stock. Furthermore Pandey *et al*. (2012) stated that physic nut plantation on degraded lands and natural ecosystems or degraded forestlands can affect both the habitat and food sources of wild life and other biota.

Table 2. Range, mean and standard deviation of seed weight and oil content of 64 physic nut accessions grown at Meisso and Melkassa

Trait	Location					
	Meisso			Melkassa		
	Range	Mean	SD±	Range	Mean	SD
Seed weight g/100 seeds	21.4-60.5	47.1	5.5	44.8-81.4	57.6	14.2
Oil content % dry seed	22.5-32.2	27.5	1.7	25.4-35.0	29.7	2.

Table 3 . Seed Weight, seed yield, and oil content of six-year-old 13 physic nut provenances grown at Meisso 2013 under stressed environment.

Entry	No. of trees	1000 seed weight (g)	Seed yield (q ha^{-1})	Oil content (%)	Oil yield (q ha^{-1})
R1-009	12	60.00	3.48	30.20	1.05
R1-012	15	60.00	2.55	28.80	0.73
R2-004	13	58.33	4.00	31.57	1.26
R2-008	14	60.00	4.87	29.23	1.42
R3-002	13	56.67	4.29	32.87	1.41
R3-004	10	60.00	0.98	33.30	0.32
Mali	14	61.67	2.99	30.30	0.90
Togo	5	58.00	4.02	30.40	1.22
DC-001	10	40.00	4.05	31.73	1.28
DC-002	13	63.33	3.42	27.07	0.92
DC-003	14	56.67	2.54	26.70	0.67
DC-004	13	56.67	3.79	29.30	1.09
DC-005	15	60.00	3.11	36.93	1.12
Mean	12	57.79	3.39	30.65	1.01

Insects and Diseases

Insect and disease surveys showed that among insects mily bug (probably various species) and cottony cusion scale are the major once. Cottony cusion Scale

feeds on the flower buds and young fruits causing complete destruction. This insect is also reported to be a major insect pest in India. Physic nut is reported to be insect and disease free (Heller 1996) however close examination of the plant showed that that is not so the case in Ethiopia. It appears that physic nut is very susceptible to Fusarium wilt and root rot. In literature, wilt caused by *Fusarium* spp., *Phytophthora* spp., *Pythium* spp. and on physic nut was reported from West Africa and India.

Conclusion

Physic nut oil can be used for non-edible purposes however that does not make it a significant commodity in commerce. For physic nut to be a competitive in vegetable oil industry including biodiesel it must be higher yielder containing high oil content well and above 40%. In degraded areas, the plant may be striving better than other species of plants but it does not bear significant amount of seed. For physic nut to be viable raw material in the biodiesel industry there must be high yielding provenance than the existing local genotypes that responds well to inputs such as fertilizer and moisture economically. It is unlikely that the harvest from degraded dry areas can support a biodiesel industry.

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