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A Preliminary Study on Physic Nut (*Jatropha curcas* L.) in Thailand

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Abstract: A series of field experiments on Physic nut (*Jatropha curcas* L.) was carried out on Warin soil series (Oxic Paleustults) at the Experimental Field, Rajamangala Institute of Technology, Nakhon Ratchasima Province, Northeast Thailand. A Randomised Complete Block Design with four replications was used for each experiment. The results showed that Warin soil series is a poor, acidic sandy loam soil type in Northeast Thailand. The Physic nut of Chaiyaphume cultivar gave highly significant differences on growth in height and leaf number. Whilst Prae (Pae), Lampoon and Pitsanulok cultivars gave highly significant differences on leaf number alone. October planted Physic nut trees gave a highest mean value of seed yield. Seed yield increased with an increase in planting distances between rows and within rows. Stem cuttings for planting at a length of 90 cm gave the highest seed yield. Both tillage and non-tillage had no significant effects on seed yields. The longer the storage period of seeds the poorer the germination %. Raw Physic nut oil can be used in the substitution to a diesel engine fuel oil for tractor units and other diesel engines.

Key words: Germination %, Physic nut, planting distances, tillage, no tillage

INTRODUCTION

Jatropha curcas nut is commonly known as Physic nut or Purging nut. This crop is grown in most regions of Thailand. Its origin is believed to come from the Central America. This oil crop spread to Thailand by the Portuguese merchants more than two centuries ago. The Portuguese used Physic nut oil derived from seeds for making soap for washing dirty clothes and others. In Thailand, there are five species of Physic nut found in most regions of the country. They include *Jatropha curcas* L. *J. gossypifolia* L. *J. multifida* L. *J. integerrima* L. and *J. podagrica* Hook[1]. Physic nut could be considered as one of many important oil crops since its seeds can be used as an essential raw material for making several industrial products such as paints, polishing oil, cosmetic and many others. This crop has a bushy structure with many branches and its height could range from 2-7 m. Physic nut plants could thrive on well in most soil types in Thailand. They could be able to survive more than 20 years after sowing or planting. Its growth characteristic is similar to a native castor bean (*Ricinus communis* L.). It has chromosome numbers of N = 18[1]. Its cluster of flowers produces pods with a number of seeds in each pod. In Thailand, it normally flowers twice a year, i.e. in dry season and rainy season. Maturity of seeds takes approximately 60-90 days after flowering. Seed length can range from 17-19 mm with a width of 8-9 mm. 100-seed weighs approximately 69.8 g[2]. Seed yields can range from 393 to 1,131 kg ha^{-1}[3]. Seed oil content based on dry weight basis can reach 34 and 54.68% without husk[4]. Raw oil content being squeezed from dry seeds with the use of a hydraulic pressure after filtered through with an intensive sieve can be used in substitution to a diesel fuel oil for diesel tractors, diesel water pumps and other diesel engines with an outstanding performance comparable to diesel fuel oil[5]. Therefore, the objectives of this study include: (1) to obtain information on soil conditions of the Nong Rawiang Experimental Field, (2) to achieve some feasibilities in growing Physic nut being collected from different provinces of the country and other information related to growth and seed yield of Physic nut such as seed characteristics and others, (3) seed germination % of different storage periods and other related information.

MATERIALS AND METHODS

This investigation was carried out at Nong Rawiang Experimental Field, Rajamangala Institute of Technology, Nakhon Ratchasima Province, Northeast Thailand. A series of experiments was carried out on Warin soil series (Oxic Paleustults). The experiments carried out are: (1) a trial on germplasm collection with the use of seeds, (2) effects of planting dates and planting distances on growth with the use of stem cuttings. For this experiment,

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planting distances used between rows and within the rows were 1x1, 2x2 and 3x3 m. They were used as treatments. Seed yields were collected during the second year after transplanted. (3) effect of different lengths of stem cuttings on growth and seed yields. The lengths of cuttings used were 5, 10, 20, 30, 40, 50, 60, 70, 80 and 90 cm. They were used as treatments. (4) tillage and no tillage plantings with the use of stem cuttings. The three treatments used were no tillage, ploughing once, ploughing once with ridging and (5) seed germination % in relation to different seed storage periods. For seed germination test, 200 seeds were sown directly into germination trays for each replication. The seed storage periods under room temperature were 0, 7, 14, 21, 28, 56, 84 and 112 days after being harvested and they were used as treatments. For items 1-4, a randomised complete block design with four replications was used. The plot dimension used was a 6x8 m in width and length for each of these field experiments with a walking path of 2 m between the plots. The land areas being used for each of the four experiments were ploughed twice followed by harrowing once except no tillage treatment of the item 4. There was no chemical fertiliser added to the soil in all of the four field experiments. The data of each experiment were collected where appropriate. For a trial on germplasm collection, i.e. item No. 1. Seeds of Physic nut were collected from 10 provinces. They include Chaiyaphume, Prae (Pae), Lampoon, Pitsanulok, Udon Thani, Nan, Nakhon Ratchasima, Khon Kaen, Nong Kai and Prae (Muang). They were used as treatments. Two hundred seeds obtained from each province were sown in germination trays and seedlings were transplanted into plots at four months after germination. Stem cuttings for items 2, 3 and 4 were obtained from the local area of Nakhon Ratchasima Province. Seedlings were transplanted into their respective plots with a planting distance between rows and within rows of 2x2 m, respectively. Initial soil samples of each plot were taken at random. The soil samples were analysed for organic matter %, total nitrogen (%), available phosphorous (ppm), exchangeable potassium (me/100 g), cation exchange capacity (me/100 g) and electrical conductivity (EC, micro mhos/cm) using the methods described in Trelo-ges *et al.*[6]. Eight months after transplanted, plant height and number of leaves were recorded. The obtained data were statistically analysed where appropriate using MSTAT C[7].

RESULTS

Soil analysis: Warin soil series (Oxic Paleustults) being used has a loamy and sandy texture. It contains sand particles of 79.35%, silt of 14.35% and clay of 6.30%. Mean values of organic matter (%), total nitrogen (%), available phosphorus (ppm), exchangeable potassium (me/100 g), cation exchange capacity (CEC, me/100 g), electrical conductivity (EC, umhos/cm) and pH were 0.55, 0.022, 13.04, 0.029, 1.59, 3.75 x 10^6 and 4.8, respectively.

Plant height and number of leaves: The results showed that the growth in number of leaves of Physic nut was highly significant within the four resources of Physic nut, i.e. Chaiyaphum, Prae (Pae), Lampoon and Pitsanulok cultivars, whilst the rest did not. Statistical significant differences on height were found only with the Chaiyaphume cultivar, whist other cultivars did not produce any significant differences due to sources of seeds, where it ranged from Udon Thani to Prae (Muang), respectively. Similarly, number of leaves followed a similar pattern to the plant height (Table 1).

Effect of planting dates and planting distances: The results on the effect of planting dates showed that Physic nut planted in October gave the highest mean value of seed yield (660^a g/plant) followed by June (397^b g/plant), August (351^{bc} g/plant), November (313^{bcd} g/plant), January (87^{de} g/plant), March (74^{de} g/plant), September (64^e g/plant), February (47^e g/plant), April (44^e g/plant), July (29^e g/plant) and May (2^e g/plant), respectively.

With the experiment on planting distances, the results showed that seed yields were significantly increased with an increase in planting distances between rows and within the rows ($p = 0.05$) but only up to the 2x2 m treatment. Seed yields ranged for the three planting distances were 8-12, 55-81 and 40-92 g/plot for 1x1, 2x2 and 3x3 treatments, respectively.

Effects on length of cuttings and tillage and no tillage: The results on length of cuttings showed that mean values of seed yields (g/plot) were highest with 90 cm treatment (818^a g) followed by 80, 70, 60, 50, 40 and 30 cm treatments with mean values of 714^a, 440^b, 248^c, 166^{cd}, 122^{cd},

Table 1: Mean values of plant height/plant and number of leaves/plant of Physic nut collected from 10 provinces in Thailand

Source of germplasm (Province)	Plant height (cm)	Number of leaves
Chaiyaphume	110*	116**
Prae (Pae)	101	89**
Lampoon	91	81**
Pitsanulok	80	74**
Udon Thani	97	61
Nan	86	55
Nakhon Ratchasima	101	51
Khon Kaen	83	51
Nong Kai	77	49
Prae (Muang)	94	48

Probability * = 0.05, ** = 0.01

and 21[d] g/plot, respectively. There was no seed yield attained from treatments with stem cuttings less than 30 cm. The best stem length cuttings were 90 and 80 cm, respectively.

The results on tillage and no tillage showed that among the three treatments there was no statistical significant difference found, but it seems more likely that the treatment without tillage gave a lesser expense on inputs than the rest.

Seed germination %: The results revealed that seed germination % significantly decreased with an increase in storage duration ($p = 0.05$). Mean values of germination % were 90, 89, 88, 86, 85, 77, 55 and 43 for storage number of days of 0, 7, 14, 21, 28, 56, 84 and 112 days after seed sowing, respectively.

DISCUSSION

Physic nut is generally grown for fencings in most villages in rural areas in Thailand particularly in northeastern region due to its high tolerance to drought conditions. During the past decades particularly during the second world war and a few decades after that event, school children in the rural areas in Thailand used to collect dry seeds of Physic nut for used as a candle-like material by putting Physic nut seeds together in a small bamboo stick of 10-15 cm in length for lighting purposes and they used them as candle flame for reading books during nights when other fuel oils and electricity were not available (Professor A. Suksri of Khon Kaen University, personal communication). The data on soil analysis showed that Warin soil series (Oxic Paleustults) could be considered as a poor type of soil series with low nutrient content and a considerable degree of soil acidity. In addition, the availability of nitrogen, phosphorous, potassium was extremely low. This must be due to high leaching rate and also perhaps partly due to previous history of crop cultivation such as cassava (*Manihot esculenta* Crantz) and other crops. A large area of many soil types in Northeast Thailand had been used for cassava cultivation for overseas exportation. This type of crop cultivation in Northeast Thailand has been reported, such as Wongwiwatchai[8] and Suksri[9]. The significant differences in plant height and number of leaves of the Physic nut trees could possibly be attributable to the differences in genotype and their adaptability to the climatic conditions. Therefore, Chaiyaphume, Prae (Pae), Lampoon and Pitsanulok cultivars could be considered as the cultivars adapted fairly well to Warin soil series in Northeast Thailand. They could be of a high value for germplasm collection for further experiments. The suitable planting months found in this work include October and June, since Physic nut was able to produce high seed yields than any other planting months of the year. It may be possible that the cuttings of Physic nut, when planting require some considerable amount of soil moisture content to start with, i.e. the soil moisture content should be slightly lower than field capacity, hence root foundation could be able to establish for fast growing. Rainy season in Thailand normally starting from May to October, root development of the Physic nut cuttings if planted in rainy season may face water logging conditions due to high frequency of rainfalls. Therefore, a moderate amount of soil moisture content is required to provide adequate amount of O_2 for root development and respiration instead of water logging conditions. The water logging conditions may frequently occur in rainy season, thus preventing a rapid rate of root development[9,10].

The results on planting distances indicate that a significant seed yield comes from the planting distances of 2x2 m between rows and within rows. Seed yield was relatively low. This may be attributable to perhaps the short duration in growth of 1-2 years when Physic nut just began to establish a good foundation of branches for a large number of leaves. Another reason for this could possibly be due to the low amount of nutrients in soil. It may be possible that a higher amount of seed yield could be obtained from a wider planting distances when the Physic nut trees have advanced in age and a full growth is attained. The suitable length of cuttings found with this work is 90 cm and then a decline with the shorter lengths of cuttings. The cutting at 90 cm in length should have provided a greater amount of reserved assimilates in the plant tissues, thus a rapid growth of Physic nut trees should be attained. That is why seed yield attained during the second year of the establishment was the highest. Therefore, this length of cuttings may be of appropriate length for cutting preparation for a large scale of Physic nut production. The effect due to the methods of tillage was not statistically significant. This could possibly be due to the high efficacy of Physic nut where they could thrive on well in most sandy loam soils so inputs on land preparation are not needed provided that weed problem is not severely occurred. Okabe and Somabhi[11] reported that high seed yield of Physic nut (300 kg ha^{-1}) could be obtained when grow in sandy loam soils (Warin soil series, Oxic Paleustults) with the application of a complete chemical fertiliser 15-15-15 (NPK) at a rate of 250 kg ha^{-1} but only a slightly increase with a higher rate of chemical fertiliser.

Seed germination % declined slowly with the longer storage periods when dry seeds stored under room temperature. The results indicated the slow deterioration of seeds with time. However, Pasabutr and Suthiponpaiboon[12] found that Physic nut seed stored under room temperature for 8 months gave germination up

to 80% but decreased to 42% after 9 months storage. Therefore, it may be of high advantage to store seeds in a low temperature as low as 20°C where high respiration rate could be reduced, thus it may be possible to prevent the rapid deterioration of seeds since oil seeds obviously loss its vigour more rapidly with time when store in a high environmental temperature. Longevity of seeds may be obtained by the use of micronutrients being sprayed to foliage during seed formation[9].

It is worthy to mention that Physic nut crop could possess a bright future for all developing countries if they could grow them in a large scale and be able to find adequate technology to produce a considerable amount of seeds per unit land area, since its oil content in seeds can be used to replace a diesel fuel oil for diesel engines[1]. Pholsen[5] did a trial in replacing Physic nut oil to a diesel fuel oil being used for a small tractor unit. He extracted raw Physic nut oil from seeds by a hydraulic pressure and then filtered through by a piece of cotton cloth material and able to obtain a number of litres of oil and then he directly filled in a diesel tank of a small tractor unit for the substitution of a diesel fuel oil. He found that there were no differences in the efficiency of the tractor unit between using Physic nut oil and the ordinary diesel fuel oil. Therefore, litres of raw Physic nut oil can be readily used for a replacement of the ordinary diesel fuel oil where there is no complication in extracting oil as it is done with coconut oil or even palm oil, i.e. for these two crops, it requires some different steps in the refinery processes. This simple way in extracting Physic nut oil from dry seeds reduces complicated processes and provided low input to attain several litres of Physic nut oil. The substitution of an ordinary diesel fuel oil by Physic nut oil for diesel engines in most developing countries should be of high advantage and their governments should pay more attention to this alternative choice of energy, e.g. Thailand and her neighboring countries.

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