

IDENTIFICATION OF ELITE GENOTYPE OF
***Jatropha Curcas* L.**

THESIS

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Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola
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DECLARATION OF STUDENT

I hereby declare that the experimental work and its interpretation of thesis entitled **"IDENTIFICATION OF ELITE GENOTYPE OF *Jatropha curcas* L."**, or part there of has not been submitted for any other degree or diploma of any University, nor the data have been derived from any thesis/publication of any University or Scientific Organization. The sources of material used and all assistance received during the course of investigation have been duly acknowledged.

Place : Akola

Date: 19/05/2007



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Enrolment No.: X/826.

CERTIFICATE

This is to certify that the thesis entitled **"IDENTIFICATION OF ELITE GENOTYPE OF *Jatropha curcas* L."**, submitted in partial fulfillment of the requirements for the degree of "MASTER OF SCIENCE", in Agriculture (Agricultural Botany) of the Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, is a record of bonafide research work carried out by **Mr. Wasu Sachin Panjabrao** under my guidance and supervision. The subject of the thesis has been approved by the student's advisory committee.

Place : Akola
Date : 23/05/07


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(S.P. Wasu)

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LIST OF ABBREVIATION

@	-	At the rate of
%	-	Per cent
/	-	Per
Cm	-	Centimeter
Kg	-	Kilogram
GCV	-	Genotypic coefficient of variation
PCV	-	Phenotypic coefficient of variation
H	-	Heritability in broad sense
DF	-	Degree of freedom
EGA	-	Expected genetic advance
<i>et. al</i>	-	<i>et alia</i> (and associates)
CPT	-	Candidate Plus Tree
Sig.	-	Significant
g	-	Gram
m ²	-	Square meter
ha	-	Hectare
i.e.	-	<i>id est</i> (that is)
m	-	Meter
No.	-	Number
SE	-	Standard error
viz.	-	<i>Vide licet</i> (namely)
Σ	-	Summation
Vg	-	Genotypic variance
Vp	-	Phenotypic variance
CD	-	Critical difference

CHAPTER – I

INTRODUCTION

Jatropha is originated from the hot regions of Central and South America i.e. Brazil and is distributed in the tropical and subtropical parts of the world. In India *Jatropha curcas* is distributed through out the country.

Jatropha is a member of the family *Euphorbiaceae*. The *Euphorbiaceae* family comprises approximately 8000 species, belonging to 321 genera.

The important species and genus are *Jatropha curcas*, *Jatropha gossypifolia*, *Jatropha glandulifera*, *Jatropha multifida*, *Jatropha nana* and *Jatropha polliana*, having chromosome number of $2n=22$ (rarely $2n=44$). Amongst these *J. curcas* is commercially exploited for their fruits to extract oil according to (Leon, 1987 and Mabberley, 1987 and Rehm and Espig, 1991). *Jatropha* is a large shrub attaining height of about 3 to 4 meters. The leaves are alternate, entire with long petiole and palmately 3-5 lobed. Flowers are arranged in loose pannicals of cyme having yellowish green colour with five petals, ten stamens and trilobed ovary. The inflorescence is formed in the axil of leaf and flowers are formed terminally with female flower usually slightly larger. Flowering occurs in hot and rainy seasons, pollination carried out by insects. Both male and female flowers are found on the same plant. In the condition where continuous growth occurs resulting from long

days and irrigated conditions an imbalance of pistillate or staminate flowers productions result in higher number of female flowers.

Fruits are set in winter, it may produce several crops during the year if soil moisture is not limiting and temperatures conditions are optimum. Each inflorescence yield a bunch of 7 to 10 or more fruit measuring 2 to 3.5 cms long and 1.5 to 2.5 cm wide. A three bivalent cocci is formed after the seed is mature and fleshy exocarp dries. The fruits are mature when the capsule colour changes from green to yellow, 2 to 4 month after fertilization. The blackish, thin shelled seeds are oblong and resemble small castor seeds.

Jatropha grows well in low rainfall conditions (it requiring only about 200 mm of rain to survive) it can also respond to higher rainfall (up to 2380 mm). *Jatropha* can bloom and produce fruit all round the year under favourable climate.

Jatropha is adaptable to wide range of climatic conditions. It is capable of growing in wide range of humid to semi arid / arid tropical and subtropical environment. *Jatropha* is known to grow well in shallow soil and is commonly found growing in gravel, sandy and clay soils. It is also adaptable to low fertility sites and alkaline soils, although better seed yields are obtained on poor quality soils if fertilizers or manure containing small amount of calcium, magnesium and sulphur are used.

The *Jatropha* species were traditionally used for medicine, pesticide and as a live hedge. It can be cultivated on poor soil under low rainfall and as such it may be used for afforestation of denuded barren lands extending to 75 million ha. in India. Further this species is rarely infested with pest or diseases and does not act as an alternate host for majority of the pests. The non-palatability to live stock is another added advantage of this crop. *Jatropha* produces latex, bark and roots have been used to extract dyes and marking ink for clothes. Strengthening of research for use of oil as an substitute for fossil fuel, quality soap production, insecticide use and in paint industry is needed. The seed oil was used mainly for soap production because of growing interest in extracting seed oil in Cape verde, several study were carried out to assess the feasibility of setting up oil extraction plants (Esteves 1960, Andrade 1978, Cossel *et al.* 1982). In India, oils extracted from seeds of different species have been traditionally used as a source of energy for lighting and heating. Gradually these oils were used for more valuable purpose such as production of soap, candle, cosmetics and pharmaceuticals. In the past, the use of these oils as a substitute for diesel was not encouraging because diesel was available at a much cheaper price. However with the increasing price of petroleum products and increasing concern on oil pollution, vegetable oils are likely to have a permanent demand from the automobile industry in the future.

Presently most of the non-edible oils are obtained from oilseed of tree species. Important tree-borne oilseed species in India are Neem (*Azadirachta indica*) Karanja (*Pongamia pinnata*), Mahua (*Maduca species*), Undi (*Calophyllum inophyllum*) and Jatropha (*Jatropha curcas*).

Tree Borne Oil Seed being perennial crops need a strong tree improvement programme before their popularization and large scale planting. The economics of use of biofuels as an alternative to diesel largely depends on the yield and recovery of oil. Hence there is an urgent need for improving the yield of the tree borne oil seeds through a well defined tree improvement programme. It refers to the judicious use of the genetic variability, use of suitable breeding techniques and the use of appropriate silvicultural practices to obtain the desired end product for a selected tree species.

A well defined tree improvement programme includes selection of desirable species, selection of desirable provenances within a species, selection of desirable families and individuals within a provenance and controlled breeding including recombination and hybridization.

With these considerations, the present investigation "Identification of Elite Genotype of *Jatropha curcas*" L. has been carried out with the following objectives".

Objectives

- 1) Survey and collection of plus trees of *Jatropha curcas*.
- 2) Selection of superior plus trees suitable for marginal land on the basis of phenotypic characters.
- 3) To study the growth performance of plus tree clones.
- 4) To study the growth performance of half sib progeny of plus trees.
- 5) To study effect of hormones on reproductive behavior of *Jatropha curcas*

CHAPTER - II

REVIEW OF LITERATURE

The literature pertaining to '*Jatropha curcas*' been reviewed in detail.

2.1 Origin and Distribution

Linnaeus (1753) was the first to name the physic nut *Jatropha curcas* L. according to the binomial nomenclature of "Species plantarum" and this is still valid today. The genus name *jatropha* derived from the Greek *jatros* (doctor) *trophe* (food) which implies medicinal uses.

Martin and Mayeux (1984) identified the Ceara State in Brazil as a center of origin. *Jatropha curcas* is a large shrub distributed in the most tropical and subtropical region's of the world. *Jatropha* exhibit a wide environmental tolerance and found in both the seasonally dry tropics as well as equatorial regions. It is adopted to marginal and degraded land in the semi arid and arid tropics. Propagation is easily done by seeds and cutting and its growth is rapid. It is planted worldwide as a hedge since it is not palatable to livestock. Distribution of *Jatropha* beyond tropical America was likely by the Portuguese who transported *Jatropha* to Asia and Africa where it has naturalized and widely utilize on local basis.

Cano. (1986) reported that the *Jatropha curcas* is widely distributed in wild or semi cultivated stands in central and south America, Africa, India and South East Asia.

Heller (1996) stated that *Jatropha curcas* L. is native of central America. It is a big shrub, growing to a height of about 3 m. and branches spread upto 4-5 m. It is well adapted to arid and semi-arid condition marginal soils with low-nutrient content, medium altitude, (90-500 m), moderate temperature (20 to 28°C) and low to heavy rainfall (300-1000 mm or more).

Anonymous (2004) reported that *Jatropha curcas* comes on flowering in the month of September to December at Dehradun. The fruit mature two to four month after flowering and turns yellow when mature. A hot and humid climate helps in the early germination of seeds.

2.2 Botanical description

Dehgan and Webster (1979) described the leaves of physic nut. The leaves has 5 to 7 shallow lobes, which are arranged alternately. Inflorescences are formed terminally on branches and are complex, possessing main and co-florescence with paracladia. Botanically, it can be described as a cyme. The plant is monoecious and flowers are unisexual, occasionally hermaphrodite flowers occur. Ten stamens are arranged in two distinct whorls of five each in a single column in the androecium and in close proximity to each other. In the gynoecium, the three

slender styles are connate to about two thirds of their length, dilating to massive bifurcate stigmata.

Pollination of the physic nut is by insect. Dehgan and Webster (1979) stated that it is pollinated by moths because of its sweet, heavy perfume at night of greenish white flowers, versatile anthers and protruding sexual organs, copious nectar and absence of visible nectar glands. When insects are excluded from the greenhouse, seed set does not occur without hand pollination. The rare hermaphrodite flowers can be self pollinating during field trials.

Kobilke (1989) describe the *Jatropha curcas* as a small tree or large shrub which can reach a height of up to 5 m. the plant shows articulated growth, with a morphological discontinuity at each increment. Dormancy is induced by fluctuations in rainfall and temperature or light. The branches contain latex. Normally, five roots are formed from seedlings, one central and four peripheral. A tap root is not usually formed by vegetatively propagated plants.

Heller (1992) observed a number of different insects that visited flowers of *Jatropha*. The staminate flowers open later than pistillate flower in the same inflorescence promotes cross pollination. Munch (1986) did not observe this chronological order in Cape Verde. It seems that the mechanism is influenced by the environment. After pollination, a trilocular ellipsoidal fruit is formed. The exocarp remains fleshy until the seeds are mature.

The seeds are black, 2 cm long and 1 cm thick. The caruncle is rather small. Wiehr (1930) and Droit (1932) described the microscopical anatomy of the seeds in details, while Singh (1970) described that of fruits. Gupta (1985) investigated the anatomy of other plants parts. The physic nut is a diploid species with $2n = 22$ chromosomes.

2.3 Improvement of *Jatropha curcas*

Jatropha curcas being a perennial crop needs a strong genetic improvement programme before popularization and going for large scale planting. The economics of use of biofuel as an alternative to diesel largely depend on yield of fruits and recovery of oil. The genetically tested material need to be used for large scale planting of *Jatropha curcas*.

Breeding objectives will depends on use of oil yield , in most cases, be the most important part of physic nut cultivation. Components that contribute to physic nut oil yield per hectare are number of pistillate flowers per inflorescence and subsequent number of capsule per shrub, number of seeds per capsule, 1000 seed weight, oil content of seeds (%) and plants per hectare. As the maximum number of seeds per capsule is limited and the agronomic factor of planting density does not offer much flexibility for increasing yields, selection should focus on the other yield components. (*Jatropha curcas*) in cross pollinated crop and hence mass selection could be the simplest method (Burley and Wood, 1976)

Ferrao and Ferrao (1984) found highly significant correlation in different seed sample for the 1000 seed weight and percent of crude fat content. This might be interesting from the breeders point of view as simple selection for high 1000 seed weight could imply increasing crude fat contents. It can not be concluded that shrubs which produce seeds of a high 1000 seed weight and consequently a higher crude fat content, will yield more oil per hectare. A high 1000 seed weight can also be the consequence of a low seed yield per shrub.

Sukarin *et al.* (1987) did not observed any morphological differences in the clones originating from different location in Thailand and planted in a provenance trial. The differences in vegetative development and first seed yield was not reported.

Heller (1992) tested a collection of 13 provenances in multi location field trial. Significant differences in vegetative development were detected among the various provenances at all locations. Plants of various provenances appeared very uniform as to morphological characters. Yield and yield component were analyzed and no significant difference were observed for parameter like weight of capsule per shrub and number of seed per capsule. The provenances differ significantly for yield parameters like number and weight of capsule per shrub, number and weight of seed per shrub and 1000 seed weight at the two year of age. The

seed yield per shrub was very low with maximum 9.6 g from provenance Benil after one year.

The calculation of correlation of different parameter showed the significant positive correlation between 1000 seed weight and crude fibre content.

Afforestation on the basis of provenance trial alone can improve productivity up to 50% (Zobel *et al.* 1998).

.According to Namkoong et al (1988) systematic provenance trial of different location have not been carried out with the physic nut to the desire extent. Ranking of families provenance's or species can change productivity completely.

Makkar (1998). studied the provenance's namely NC-5, NC-6, NC-9, NC-16, NC-45, NC-50 and NC-51 from Mexico. The average seed weight ranges from 0.53 g. to 0.65 g. for various provenances.

Aregheore *et al.* (1998). reported the lectin activity of toxic Cape Verde and Non-toxic Mexico provenances.

As per Anonymous (2005) the variability for oil content were ranged from 25.32% to 42.18% in different provenance.

2.4 Interspecific crosses

Dehgan (1984) conducted extensive trials on inter specific hybridization and reported the crossability of 20 species. The F₁ hybrid of *Jatropha curcas* x *Jatropha multifida* are more vigorous than parental species.

Prabakaran and Sujatha (1999) studied the naturally occurring interspecific hybrids of *Jatropha tanjorensis* species found abundantly in the Tanjore, Pudukottai, Trichirapalli and Ramnad districts of Tamilnadu State of India as a fence plant showed intermediacy in phenotypic characters of *J. curcas* and *J. gossypifolia*. A detailed survey at its place of occurrence supplemented with data employed from cytological and peroxidase iso enzyme study revealed that *J. tanjorensis* is a natural interspecific hybrid between these two species.

Sujatha and Prabhakaran (2003) reported that interspecific hybridization was successful between two economically important species of *Jatropha* viz., *J. curcas* and *J. interrigima*. The interspecific hybrids revealed morphological intermediacy for various vegetative characteristics but produced flowers with three distinct colours. Back crossing of the F₁ hybrids resulted in the number of flower colours varying from dark pink to white. The ornamental value of the genus hybridity was confirmed through PCR amplification using random primers.

Mukewar et al (2005) reported that the F₁ of cross *Jatropha curcas* x *Jatropha gossypifolia* resembled the female parent.

2.5 Seed Oil and Cake

Adam (1974) reported that the seed and oil were found to be toxic to mice, rat, sheep, goat, human and chicken. Hence its use as a food or feed source is presently limited.

Stirpe *et al.* (1976) reported that 12-Deoxyl - 16 hydroxy phorbol is present in the Kernel of *Jatropha curcas*.

Liberalino *et al.* (1988) Reported that the seed weight about 0.75 g and kernel represent about 65% of the seed mass. Report on chemical composition of kernel revealed protein and lipid content of 27-32 % and 58 - 60 % respectively.

The *Jatropha* bio diesel is similar to the bio-diesel from rape seed oil currently widely use in Europe (Foidl *et al.* 1996 and Rudramoorthi 2003) indicating its potential as renewable source of energy.

As per Anderibighe *et al.* (1997). *Jatropha* cake or meal fully defatted has less than 53% crude protein content.

Makkar *et al.* (1998). reported that the content of crude protein, lipid and ash in Kernel from raw seed ranges from 27 to 30%, 55 to 62% and 3.7 to 5.2 % respectively.

Several studies with animal by Liberalino (1988) have showned that the seeds are toxic. The meal has also been found to be toxic. This has therefore restricted its used as food or feed source. The toxic compound isolated from *Jatropha* seed include curcin

Lin Juon, *et al.* (2003) observed that the curcin has a strong inhibitory action upon protein synthesis in reticulocyte lysate and curcin has an obvious antitumour effect and its mechanism are related to the N-glycosidase activity.

As per Peter *et al.* (2003) the oil obtained from the seeds of *Jatropha curcas* has a requisite potential of providing a promising and commercially viable extender to the diesel oil. The oil has all desirable physiochemical characteristics of diesel.

Martinez *et al.* (2004) reported high protein (27.32%) and oil (58.60%) content in *Jatropha* seed. Although the seed cake meal is rich in protein it is toxic to rats, mice and ruminants and therefore, cannot be used as animal feed.

The cake of curcas as an organic fertilizer is superior to other organics like cow dung and cake. The curcas oilcake contains 4.44 % Nitrogen 2.09% Phosphorus and 1.68 % Potassium. The curcas oil has very high saponification value and can be used for making soap. The latex of curcas contains an alkaloid known as 'Jatrophin' is reported to be having anticancerous property. The tender twig are used for cleaning teeth, relieve toothache and straighten gum.

2.6 Germination

Kaushik (2003) reported that the storage period did not affect the germination percent and vigour index. The seedling raised from the seeds harvested at green stage of maturity showed significantly inferior root and shoot length.

Geethanjali *et al.* (2003) observed that when fruit were collected at green, yellow brown and dehiscent stages of maturity and subjected to germination test, the germination was poor at green stage and the germination was high at brown colour of fruit.

Sudhir Kumar (2003a) investigated the effect of seed size on germination and seedling growth of five provenances of *Jatropha curcas* L. collected from Tamilnadu. The seed were graded into large, medium and small. Large seeds are more in number compared to the other two sizes in all the provenances. The hundred seed weight, seed length, breadth and thickness were higher in large seeds of Coimbatore provenance and the lowest in Madurai. The germination percentage was high in Coimbatore provenance.

Sudhir Kumar (2003b) observed variation in seed parameters and germination of 10 provenance of *Jatropha curcas* L. collected from Tamilnadu and Kerla. The germination percentage, root length, shoot length, vigour index and biomass production was highest in Waldayer provenance and lowest in Paripati. The oil content was also higher in Waldayer provenance.

Ginwal *et al.* (2005), observed the significant seed source variation in seed morphology (colour, size and weight) seed germination (Viability, germination percent, germination energy, germination value) and seedling growth parameters (Survival percentage, seedling height, collar diameter, leaves/plant and

seedling biomass). The seed source of Chhindwara (M.P) was found to be the best source in comparison to other.

2.7 Micro and Macro propagation

Sardana *et al.* (2000) studied the regeneration of somatic embryogeneses in *J. curcas*. They reported that an efficient 2 stage method for plant regeneration from leaf explant derived embryogenic callus of *Jatropha curcas* was developed and standardized. Stage I was the induction of embryogenic callus and formation of globular embryos which required murashige and skoogs (MS) Gamborg's medium containing MS basal salts and Gamborg's vitamins, supplimented with r-benzyladenine + indole 3 acetic acid. Stage II was the induction of plantlets and it was on MS medium + gibberllic acid (3 mg/litre) + IAA (1 mg/litr.).

Rajore *et al.* (2002) had develop a method for production of clonal plants of *J. curcas* by in vitro production of multiple shoots from nodal segments. The nodal segment were cultured on MS basal midium supplemented with cytokinnis, viz., kinetin (kn), 6 benzylaminopurine (BAP) and Auxins, viz indole 3 acetic acid (IAA), Indote-3 butyric acid (IBA), Naphthalene acetic acid (NAA).

2.8 Nutrient Management and Seed yield

Seed yield referred in the literature vary considerably. The seed yield can be attributed to a variety of factor. Such as climate, intensity of management, size quality, size of land and genetic potential. The highest seed yield should be expected only

under the most favourable growing condition. Very limited literature is available regarding improvement of yield, propagation and cultivation practices. There is a urgent need to select candidate plus trees and hardy high yielding hybrids and to develop cultivation practices which increase seed yield.

Bhsabutra and Sutiponpeibun (1982) suggested that 5 year old *Jatropha* tree gave 4-5 kg seed per year in Thailand.

.Levingston and Zamoro (1983) reported that the commercial yield of *Jatropha curcas* in Cape verde was 400-1200 kg/ha.

Martin and Mayeux (1984) observed average yield of Cape verde *Jatropha* ranged from 650 - 2000 kg/ha and oil yield is 200 - 600 kg/ha.

Steinswat *et al.* (1986) reported that 14 months plant gave. 194 kg/ha seed and 318 g seed per shrub in Thailand.

Raina (1986) reported that the average size bush of *Jatropha curcas* yield 5 kg seed per year.

Ishii and Takeuchi (1987) reported 2146 kg/ha as average annual yield of *Jatropha curcas* in Thailand.

Sukarin, et al (1987) reported that the spacing of *Jatropha curcas*. 1 x 1 m without fertilizer gave 538 kg/ha seed yield in NE Thailand.

As per Banerjee (1989) report the average seed yield of *Jatropha curcas* is 4-5 kg/bush.

Miller (1992) and Heller (1996) reported 0.1t/h seed yield of *Jatropha*

According to Jones and Miller (1992) *Jatropha* is adapted to low fertility sites and alkaline soils. Better yields are obtained on poor quality soils if fertilizers containing small amounts of calcium, magnesium, and sulphur are used. Mycorrhizal associations have been observed with *Jatropha* and are known to aid the plant's growth under conditions where phosphate is limiting. They also reported that *Jatropha* could bloom and produce fruit throughout the year and dry climate has been found to improve the oil yields of the seeds. It is desirable to use only organic manures like farmyard manure, compost, vermicompost and green leaf manure to achieve sustainability. In poor to normal fertility lands, 10-15 tons ha⁻¹ of farmyard manure or compost has to be applied at the time of land preparation. The yield is only about 250-500 g per plant in the first year.

Jadhav *et al.* (1995) observed that spacing (2 x 1 and 2 x 2 m) did not affect growth of *J. curcas* but increase in levels of fertilizers the plant height, girth, leaves/ plant, petiole length, leaf area / plant , LAI and Absolute growth rate was high and girth progressively increased. Application of 3 g each of N and P₂O₅, and 2.0 g K₂O / plant at the wider spacing produced maximum height (57.2 cm / month) whereas the LAI and leaves / plant were maximum at closer spacing.

As per Reinhard, (1998), there are mixed reports on seed yield and performance over years. Cape Verde has about 8000 ha of *Jatropha* plantation covering 16% of its cultivated area and its seed exports fluctuated between 2000 to 5600 tons during 1900 to 1960. Assuming most of the produce is exported, the long time yield was in the vicinity of 0.3 tons/ ha. Mali has about 10,000 km *Jatropha* as hedge plants, @ 8 plants per mtr, gave yield of 0.8 kg seed (0.17 litre oil) per mtr of hedge. This planting density is close to 4000 plants per ha and the seed yield of 2.5 tones/ha was obtain.

Choudhari and Joshi (1999) in their studies observed that *J. curcas* is a multipurpose large shrub which has potential to produce 35-40% seed oil on an weight basis. The oil is renewable resource and a safe source of energy. It is viable alternative to diesel, Kerosene, LPG, Furance oil and fuelwood.

Mukta et al., (2000) reported that In India, local varieties are used and about nine species have been recorded in Wealth of India. Better germplasm is available in other countries but not treid in the country. Adaptive trials were undertaken at Hissar, Hyderabad, Bangalore and Sardar Krishinagar. Hissar trials gave seed yield of 1733 kg /ha. Five year old plantation at Directorate of Oilseed Research Narkoda farm near Hyderabad having typical marginal red soil planted with spacing of 3 x 1.5 m (i.e. 2222 plants per ha) gave a maximum yield in individual tree of 760 g.

Raju and Ezradanam (2002), reported that *J. curcas* is a monoecious, protandrous and sub tropical strub. The ratio of male to female flowers is 29: 1 Both flowers sexes open synchronously. The sexual system facilitates geitonogamy and xenogamy. The flowers visitors include bees, ants thrips and flies. Bees and flies affect geitonogamy and xenogamy, while ants and thrips affect only geitonogamy.

Gurudev *et al.* (2003) has studied 15 population from Tamilnadu, Kerala and Karnataka reported seed yield of 3 years old plant ranges from 52.91 g to 181.66 g/plant.

The application of 20 g urea, 120 g single super phosphate and 16g of potash for each pit at the time of planting. Organic manure should also be added during pit filling. Thereafter, an application of 45:48:24 kg NPK per ha is recommended (Patil *et al.*, 2003). The 400 gm compost or FYM per pit and fertilizers like 20 g urea + 120 g single super phosphate and 16 g murate of potash is recommended near the planting hole and the fertilizers should be covered with soil. In case of transplanted crop, the above mentioned fertilizers should be applied at the time of transplanting or immediately after the plants establish in the pits. Urea may be applied in two splits @ 10 g per plant, the first split should be applied one month after basal dressing and second split after two months of basal dressing. The refilling of pits with loamy soil should be completed by May and

NPK (15:15:15) should be applied at 250 g per pit (Patil and Singh,2003).

Ratree (2004), studied the preliminary performance of *J. curcas* in Thailand. They observed that the chaiyaphume cultivar gave highly significant differences on growth in height and leaf number while Lampoon and pitsanulok cultivars gave highly significant differences on leaf number alone. Stem cutting for planting of a length of 90 cm gave the highest seed yield.

Arruda *et al.* (2004) reported that physic nut is an alternative crop for the northeast semi arid region of Brazil. It requires a high amount of sunlight and a little amount of water to grow.

Mani *et al.* (2005) reported the data on yield attributes revealed that 50 kg of N, 75kg of P₂O₅ and 75 kg/ha of K₂O with FYM @ 12.5 t/ha and azophos @ 25 kg/ha is the ideal dose for attaining the higher pod yield, seed yield and 100 seed weight.

2.9 Mutation Breeding

Pandey and Datta (1995) studied sensitivity to gamma radiation in *Jatropha curcas* as a potential oilseed crop. The effect of various gamma rays doses on cotyledons were studied. Seedlings with 3 rather than the normal 2 cotyledons were observed at frequencies of 5.9, 7.5, 10.9 and 5.0 per cent by using 0, 6, 12 and 18 Krad treatments. Changes in cotyledon position, shape and size and stomata number were also observed following

irradiation. The results indicate that mutagenesis has the potential of inducing desirable variation in *Jatropha curcas*.

2.10 Other Uses

Anonymous (1995) reported the latex of *Jatropha curcas* contains an alkaloid called 'Jatrophin' which has an anti cancerous property. Plant Juice and leaf Juice which cures the purgative and homeostatic pites, twig sap are use for wounds and ulcers.

Girach *et al.* (1995) twig / stem of *Jatropha* cure the Dental complaints (Tooth ache, gum inflammation, gum bleeding, pyorrhoea etc.).

Matsure *et al.* (1999) reported that water Extract of branches of *Jatropha* are use in HIV, Tumor.

Banjo *et al.* (2001) investigated extract from the plant are known for their medicinal properties and their effect on wide array of organism including insects pests, mollusks and nematodes.

CHAPTER – III

MATERIAL AND METHODS

The present study entitled "Identification of Elite Genotypes of *Jatropha curcas* L." was conducted during 2004-2005 in the Field of College of Forestry Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola, with a view for selection of candidate plus trees, from different district of Maharashtra States.

3.1 Survey and collection of plus tree of *Jatropha curcas*

Selection of plus tree was done by using subjective grading system proposed by Zobel and Talbert (1984). The following observation were recorded for selected candidate plus tree.

1. Site data

The actual position of selected candidate plus tree were recorded by using the instrument viz global positioning system. The latitude, longitude, district, tehsil and village was recorded for each CPT.

2. Plant height (m)

The plant height was recorded in meter from the ground level to the tip of the main branch.

3. Basal girth (cm)

Basal girth was recorded in centimeter of the base of the plant i.e. 5 cm above the ground level

4. Plant canopy (m)

Plant canopy was measured in meter by total length of the canopy multiplied by total breadth of the canopy of individual candidate plus tree

5. Female to male ratio in flower

Male and female flowers are counted from inflorescences and their proportion was recorded.

6. Number of capsule / bunch

7. Percentage of seed weight in fruit

8. Yield per plant (kg)

The actual seed yield was taken from selected candidate plus tree in kilogram were recorded.

9. Number of seed per fruits

10. 100 seed weight (g)

The weight of 100 seeds from each of the candidate plus tree was measured in gram separately.

11. Oil percent

The seed oil content was determined by following soxhlets technique from bulk of each of the selected candidate plus tree.

12. Days for floral initiation

Floral initiation time was recorded for each of the selected candidate plus tree.

13. Fruit maturity period

Fruit maturity period was recorded at 50 per cent fruits maturity of the selected candidate plus tree

14. Pest and diseases

3.2 Oil content and characterization studies

The seeds of the selected CPT were analysed for oil content. The oil content analysis and oil characterization studies were carried out by Soxhlet method

3.3 Raising of Nursery

The fully developed healthy seeds were selected for sowing. The seedlings were raised in polybags of size 10 x 20 cm. The poly bags were filled with sand, soil and FYM mixture in the ratio of 1:1:1. The seeds were sown at the depth of 1 cm and covered with fine rottened compost. The bags were irrigated with the help of water can for 7 days. The seedlings emerges 4 to 5 days after sowing. The irrigation will be given after every 8 days interval for rest of the period. The one seedling per bag were maintain. The seedlings were ready for transplanting after 60 days from sowing.

Following observation were recorded

1. Survival percentage after 21 days
2. Seedling height at the end of 21 days

Seedling height was recorded in centimeter from the ground level to the tip of the seedling at the end of 21 days.

3. Collar diameter (mm).

Measured by using digital vernier calliper with 0.01 mm resolution from above the ground.

4. Fresh weight of seedling.

The individual seedling was lifted from the nursery without damage to any roots or rootlets. The root part are wash with fresh water and dried with blotting paper immediately. The weight was taken on the balance before any desiccation of the seedling.

3.4 Soil preparation and pit digging

The pit of size 30 x 30 x 30 cm were dug in the month of May. Spacing was 3 x 3 m. The pit were refilled by mixing 1/2 to 1 kg of FYM and 40 to 50 g Methylparathion (2%) dust/ pit. The dust used to protect the plant against termite.

3.5 Experiment of clonal evaluation

The cutting of 30 cm length and 2 to 3cm diameter were taken from the last year growth. Five cuttings of individual plus tree were planted in the polythene bag of size 15 cm x 25 cm.

3.5.1 Details of experimental design for clonal evaluation

1. Experimental Design	:	Randomized Block Design
2. No. of Replication	:	Two
3. No. of clones/ replication	:	20 (Twenty)
4. No. of progenies	:	Two
5. Spacing	:	2 x 2 m.

6. Date of transplanting : 3rd August 2005
7. Method of planting : Row planting (Plate 1)

3.6 Experiment on half - sib progeny evaluation.

The progeny of individual CPTs raised in poly bag from the seed of selected CPTs will be use for planting. The two month old seedling will be use for planting.

3.6.1 Details of experimental design for half - sib progeny.

1. Experimental Design : Randomized Block Design
2. No. of Replication : Three
3. No. of CPT/ replication : 20
4. No. of progenies/CPT : 25
5. Spacing : 3 x 3 m.
6. Date of sowing : 11 July 2005
7. Method of planting : Row planting (Plate 1)

3.7 Observations recorded for clonal and half-sib progeny

The data was recorded on five randomly selected plant for progeny evaluation and each plant character was recorded for clonal evaluation.

1) Plant height

The plant height was recorded in centimeter from the ground level to the tip of the main branch.

2) Basal girth

Basel girth was recorded in centimeter of the base of the plant i.e. 5 cm above the ground level.

3) Number of branches / plant

Number of main and sub branches per plant was counted.

4) Leaf area (m^2)

It was expressed in m^2 and was determined by measuring maximum length and breadth of leaf

5) Floral initiation time

Floral initiation time was recorded for 50% plant in each of progeny.

6) Seed yield / plant (g)

Seed weight per plant was worked out from the seed weight of five selected plants.

7) Oil content (%)

Bulk seed of progeny was used for estimation of oil content by soxhlet method.

3.8 Climate and weather condition

Akola is situated in the subtropical zone at latitude $22^{\circ}.42$ N and longitude $77^{\circ}.02$ E at an elevation of around 307.415 meters above the mean sea level.

The Meteorological data recorded at the field of Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola During 2004-2005 furnish in Appendix -1.

3.9 Effect of growth hormones on reproductive behaviour of *Jatropha curcas*

The solution of GA₃-50 ppm. 50 mg of GA₃ was dissolved in few ml of distilled water and the volume was made upto the one litre by adding distilled water. Similarly, solution of GA₃-100 ppm were prepared by taking 100 mg. of GA₃ by adopting the above said procedures. For preparing the solution of salicylic acid 100 ppm and 150 ppm and Ethrel 500 ppm and 1000 ppm the required quantities of chemicals were dissolved in few ml of KOH solution and the volume was made upto 1 lit. by adding distilled water.

By using hand sprayer the two sprays were given 1st spray was taken in the 1st week of July and second spray was given after 10 days from the 1st spray.

3.9.1 Details of experiment for effect of hormones in non replicated trial

1. Treatment : 1) GA₃ - 50 and 100 ppm
2) Ethrel - 500 and 1000 ppm
3) Salicylic acid - 100 and 150 ppm.
4) Control spray without chemical
2. No. of plant / treatment : Five

3.9.2 Observation to be Recorded

Plant height (cm), Basal girth (cm), Number of branches/plant, Number of Inflorescence / branch, Number of male female flower and Number of fruits/plant

3.10 Statistical Analysis

The arithmetic average of five plants treatment was computed and the same is used for further calculations.

3.10.1 Analysis of variance

The data were subjected to the analysis of variance as given by Panse and Sukhatme (1967) for all the character. Following ANOVA was set up.

ANOVA

Source	D.f.	S.S.	M.S.
Replication	(r-1)	SSr	MS ₁
Genotypes	(g-1)	SSg	MS ₂
Error	(r-1) (g-1)	SSe	MS ₃

'F' test was used to measure the overall significance of the differences amongst the selected (CPTs, S.E. and C.D. were calculated as follows to compare the genotypes)

$$S.E.(d) = \sqrt{\frac{2MS_3}{r}}$$

$$C.D. = S.E (d) \times \text{Tab. t.}$$

(0.05 and 0.01 at error d.f.)

For non replicated data $SE_{\pm}$ is calculated by

$$SE = \frac{\left(\frac{\sum X^2 - (\sum X)^2 / N}{N-1} \right)^{1/2}}{\sqrt{N}}$$

3.10.2 Variability estimates:

Genotypic and phenotypic variances were calculated as follows.

$$V_g = (MSS_t - MSS_e) / r$$

$$V_p = V_g + V_e$$

Where V_g = genotypic variance

V_p = phenotypic variance

Coefficient of variability were worked out by the formulae suggested by Allard (1960)

$$PCV (\%) = (\sqrt{V_p} / \bar{x}) \times 100$$

$$GCV (\%) = (\sqrt{V_g} / \bar{x}) \times 100$$

Where,

PCV = Phenotypic coefficient of variation

GCV = Genotypic coefficient of variation

$\bar{x}$ = Population mean

Heritability in percentage was calculated by formulae

$$H = (V_g / V_p) \times 100$$

Where H = Heritability (broad sense)

The expected genetic advance at five percent selection intensity was calculated by the formula.

$$\text{Genetic advance} = (V_g/V_p) \times \sqrt{V_p} \times k$$

Where K = Selection differential at five percent selection intensity

(K = 2.06)

CHAPTER IV

EXPERIMENTAL FINDING'S

The experimental findings of the investigation "Identification of Elite Genotype of *Jatropha curcas* L." are presented under the following subheads:

- 4.1 Details of candidate plus trees.
- 4.2 Analysis of variance for seedlings.
- 4.3 Analysis of variance for plus tree clones.
- 4.4 Analysis of variance for half-sib progenys.
- 4.5 Variability estimates for seedling growth
- 4.6 Variability estimates for clonal evaluation trial
- 4.7 Variability estimates for half sib progeny
- 4. 8 Seed oil content
- 4.9 The effect of hormones on flowering and fruit yields.

4.1 Details of candidate plus trees

The candidate plus trees were selected from Amravati, Akola, Washim, Buldhana, Jalna, Aurangabad and Jalgaon District. The candidate plus trees were selected by using subjective grading method. The details of location of candidate plus trees were given in Table 1.

The observations on growth and yield parameters of candidate plus trees are given in Table 2. The mean and range of various traits of candidate plus trees are given in Table 3.

Table 1 : Details of location of candidate plus trees

Sr. No.	CPT Code	Location			Latitude E	Longitude N	Approximate Age of Mother Tree (years)
		Dist	Taluka	Village			
1	CPT-1	Amravati	Chandur Bazar	Ghatladki	21.1	77.6	8
2	CPT-2	Amravati	Morshi	Ambada	21.2	77.9	15
3	CPT-3	Amravati	Morshi	Ambada	21.2	78.1	10
4	CPT-4	Akola	Akot	Akot	21.0	77.0	8
5	CPT-5	Washim	Malegaon	Sirpurjain	20.2	76.9	6
6	CPT-6	Jalgaon	Yawal	Kingaon	21.0	75.7	7
7	CPT-7	Jalgaon	Chalisgaon	Patnadevi Mandir	20.5	74.9	7
8	CPT-8	Jalgaon	Chalisgaon	Patnadevi	20.5	74.9	11
9	CPT-9	Amravati	Ajangaon Surji	Pandari	21.2	77.2	8
10	CPT-10	Jalna	Bhokardan	Bhokardan	20.1	75.7	6
11	CPT-11	Buldhana	Mehkar	Anjani Kd.	20.0	76.4	12
12	CPT-12	Amravati	Chandur Bazar	Sonuri	21.1	77.6	6
13	CPT-13	Akola	Murtizapur	Murtizapur	20.5	77.2	7
14	CPT-14	Akola	Telhara	Telhara	20.8	76.8	10
15	CPT-15	Aurangabad	Sillod	Bhorkhed	20.2	75.6	10
16	CPT-16	Aurangabad	Sillod	Golegaon	20.2	75.6	12
17	CPT-17	Buldhana	Lonar	Azizpur	19.9	76.4	11
18	CPT-18	Buldhana	Lonar	Azizpur	19.9	76.4	10
19	CPT-19	Aurangabad	Sillod	Shivna	20.2	75.6	7
20	CPT-20	Aurangabad	Sillod	Ajantha	20.2	75.6	12

CPT = Candidate plus tree

4.1.1 Plant height (m)

Plant height ranged from 2.5 to 5.6 m. The maximum height was recorded by CPT-1 (5.60) followed by CPT-2 (5.0). The dwarfest genotype was CPT-18 (2.5) and CPT-19 (2.5).

4.1.2 Basal girth (cm)

Basal girth range from 45.00 to 110.00 cm. The maximum girth was observed in CPT-15 (110.00) followed by CPT-11 (95.00). The minimum girth was (45.00) cm of CPT-6 followed by CPT-7 (45.00).

4.1.3 Plant canopy (m)

The range for plant canopy was from 1.5 to 6.0. The maximum plant canopy was observed in CPT-2 (6.0) followed by CPT-11 (5.5). Whereas the minimum plant canopy was seen in CPT-6 (1.5) followed by CPT-7 (2.0).

4.1.4 Yield per plant (kg)

The highest yielding candidate plus trees was CPT-11 (3.5) followed by CPT-8 (2.5) and CPT-7 (2.0). The low seed yielding candidate plus trees were CPT-3 (1.0) and CPT-5 (1.0) i.e. 1 kg/plant. The average seed yield/plant was 1.47 kg.

4.1.5 Number of capsule per bunch

The mean values ranged for number of capsule per bunch were from 7.0 to 11.0. The (11.0) number of capsule per bunch were observed in 9 CPTs. The minimum 7.0 capsule/bunch were recorded in CPT-3, CPT-13 and CPT-18.

4.1.6 Female to male ratio in flower

The female to male ratio in flower ranged from 1:26 to 1:29. The average female to male ratio of CPT was 1:27.

4.1.7 Percentage of seed weight in fruits

Percentage of seed weight in fruits ranged from 62 to 81%. The maximum percentage of seed weight in fruits was observed in CPT-1 (81.0) followed by CPT-2 (80.0). The minimum percentage of seed weight in fruit was CPT-6 (62.0).

4.1.8 Number of seed per fruits

The number of seed per fruit was ranges from 2 to 3. The average number of seed per fruit was 2.69.

4.1.9 100 Seed weight (g)

The range of 100 seed weight was from 57.1 (CPT-15) to 82.0 (CPT-2). The other promising candidate plus trees were CPT-1 (81.0) and CPT-12 (81.0) Average test weight was 70.05.

4.1.10 Oil percentage

The maximum oil percentage was recorded by CPT-3 (42.36%), CPT-2 (38.07%) and CPT-17 (37.61%). The oil percentage ranged from 26.64(CPT-20) to 42.35 (CPT-3). Out of total 20 CPT, 65% of CPT are with more than 35% oil content. Average oil percentage was 35.34%.

Table 2 : Observation on growth and yield parameters of candidate plus trees

Sr. No.	CPT Code	Plant Height (m)	Basal girth (cm)	Plant Canopy (m)	Female to male ratio in flower	Number of Capsule per bunch	% of seed weight in fruits	Yield per plant (kg)	Number of Seed per Fruit	100 seed weight (g)	Oil per cent
1	CPT-1	5.6	75	4.5	1:29	11	81.0	1.35	2.6	81.04	37.06
2	CPT-2	5.0	80	6.0	1:27	9	80.0	1.15	3.0	82.02	38.07
3	CPT-3	4.0	70	5.0	1:26	7	76.8	1.00	2.3	77.08	42.36
4	CPT-4	4.0	65	3.5	1:27	9	64.0	1.30	3.0	76.09	32.57
5	CPT-5	3.0	50	2.5	1:29	11	70.0	1.00	2.6	73.03	35.47
6	CPT-6	4.0	45	1.5	1:27	9	62.0	1.50	3.0	65.14	34.23
7	CPT-7	3.0	45	2.0	1:28	10	68.0	2.00	3.0	70.15	32.47
8	CPT-8	4.0	80	3.0	1:29	11	70.0	2.50	2.6	68.22	36.33
9	CPT-9	3.0	60	3.0	1:29	11	65.0	1.11	2.3	65.23	32.03
10	CPT-10	3.0	60	2.5	1:28	11	70.0	1.25	2.6	70.03	35.85
11	CPT-11	4.5	95	5.5	1:28	10	75.0	3.50	3.0	75.05	35.97
12	CPT-12	4.5	50	3.5	1:29	11	63.2	1.10	3.0	81.12	33.94
13	CPT-13	3.5	50	3.0	1:26	7	68.0	1.10	3.0	75.43	36.51
14	CPT-14	3.0	55	3.0	1:27	9	68.9	1.00	2.6	60.34	37.05
15	CPT-15	4.0	110	4.5	1:29	11	70.7	1.50	2.6	57.12	34.84
16	CPT-16	4.0	55	3.0	1:29	11	69.1	1.20	2.3	64.02	35.09
17	CPT-17	2.7	80	3.0	1:28	10	77.6	2.00	2.6	67.21	37.61
18	CPT-18	2.5	75	2.5	1:26	7	75.2	1.50	2.6	65.23	37.60
19	CPT-19	2.5	60	3.0	1:29	11	67.3	1.00	2.6	71.31	34.57
20	CPT-20	4.5	95	5.0	1:27	9	67.1	1.40	2.6	59.41	26.64
	Mean	3.66	67.75	3.47	1:27	9.75	70.40	1.47	2.69	70.05	35.34
	SE +	0.20	4.08	0.27		0.32	1.21	0.13	0.01	1.65	0.69
	CV %	24.64	26.92	34.80		14.84	7.69	42.11	2.36	10.59	8.74

* Floral initiation started in the month of August and continue upto September. Fruit maturity Oct-Nov. for all the clones.

* No Pest / disease was observed on mother plant of candidate plus trees.

Table 3: Variability in mother candidate plus tree

Sr. No.	Parameter	Mean	Range		SE	CV %
			Min.	Max.		
1.	Plant height (m)	3.66	2.50	5.60	0.2021	24.64
2.	Basal girth (cm)	67.75	45.00	110.00	4.0806	26.92
3.	Plant canopy (m)	3.47	1.50	6.00	0.2707	34.80
4.	Number of Capsule/bunch	9.75	7.00	11.00	0.3236	14.84
5.	% of seed weight in fruit	70.40	62.00	81.00	1.2125	7.69
6.	Yield /plant (kg)	1.47	1.00	3.50	0.1388	42.11
7.	Number of seed/Fruit	2.69	2.30	3.00	0.0143	2.36
8.	100 seed wt. (g)	70.05	57.00	82.00	1.6591	10.59
9.	Oil percent	35.34	26.64	42.36	0.6912	8.74

4.2 Analysis of variance for seedlings

The analysis of variance for survival, height, collar diameter and fresh weight of seedlings were given in Table 4. The variation for all characters was observed to be significant at 1% level of significance indicating substantial variability for all the characters among the CPT's.

The mean values of the CPT's for these various characters have been presented with their standard error and test of significance in Table 5. The results have been presented with each of the characters briefly.

Table 4: Analysis of variance for nursery seedling of CPTs

Source of Variation	D.F.	MSS			
		Survival of seedling after 21 days (%)	Seedling Height (cm)	Collar diameter (mm)	Fresh weight of seedling (g)
Replication	2	10.85	4.46	0.97	61.26
Treatment	19	115.01**	14.37**	3.87**	116.63**
Error	38	10.41	3.72	0.61	19.59

** Significant at 1%.

4.2.1 Survival of seedling after 21 days (%)

Survival of seedlings after 21 days were ranging from 56.33 to 82.33 per cent. The highest survival percentage was observed in CPT-14 (82.33%) followed by CPT-2 (79.00%), CPT-20 (78.66%). The lowest survival percentage were observed in CPT-17 (56.33%).

4.2.2 Height of seedlings (cm)

The seedlings height ranges from 22.66 to 31.33 cm. The CPT-2 (31.33) recorded highest seedling height and CPT-14 (22.66) with lowest seedling height.

4.2.3 Collar diameter (mm)

Collar diameter ranged from 4.83 to 9.28. The maximum collar diameter observed in CPT-19 (9.28) followed by CPT-20 (8.31). The minimum collar diameter is found in CPT-12 (4.83).

4.2.4 Fresh weight of seedlings (g)

Fresh weight of seedlings ranged from 16.48 to 39.79. The maximum fresh weight of seedling was observed in CPT-19 (39.79) followed by CPT-15 (38.62). The minimum fresh weight of seedlings is observed in CPT-11 (16.48).

Table 5: Growth performance of seedling

CPT No.	Survival of seedling after 21 days (%)	Seedling height (cm)	Collar diameter (mm)	Fresh weight of seedling (g)
1	73.33	28.00	7.76	32.58
2	79.00**	31.33**	7.66	28.60
3	74.66**	26.66	7.83	19.73
4	71.66	26.66	7.08	20.40
5	65.33	26.33	7.35	22.60
6	72.00	29.00**	7.56	28.12
7	67.66	29.33**	7.43	28.27
8	72.66	28.00	6.90	29.17
9	71.66	28.66	7.44	21.85
10	76.00**	26.66	6.44	22.86
11	72.00	27.00	6.50	16.48
12	65.66	24.66	4.83	25.41
13	75.33	26.00	6.32	23.90
14	82.33**	22.66	5.53	25.37
15	68.33	27.33	6.29	38.62**
16	71.33	23.00	5.23	32.45
17	56.33	25.33	5.42	32.98**
18	60.33	23.33	8.06**	31.80
19	72.00	26.66	9.28**	39.79**
20	78.66**	28.66	8.31**	32.94**
Mean	71.3	26.73	6.96	27.69
SE(d) +	1.02	1.11	0.45	2.55
'F' Test	Sig.	Sig	Sig	Sig
CD at 1%	2.06	2.14	0.90	5.15

** Significant at 1% as compare to average value

On an average 21 day seedling posses 5 leaf

4.3.4 Leaf area (m²)

The leaf area ranged from 0.45 to 3.70. The maximum leaf area was observed in CPT-6 (3.70) followed by CPT-5 (3.08) and CPT-1 (3.02). Whereas the minimum leaf area were observed in CPT-10 (0.45) .The average leaf area was 1.89 m² .

Table 6: Analysis of variance for plus tree clones

MSS					
Source of Variation	D.F.	Plant Height (cm)	Basal Girth (cm)	Number of branches per plant	Leaf Area
Replication	1	664.22	2.50	0.10	0.55
Treatment	19	1418.41**	6.19**	1.36**	1.46**
Error	19	220.54	2.64	0.52	0.50

** Significant at 1 %

Table 7: Growth performance of clones

CPT No.	Plant Height (cm)	Basal Girth (cm)	No. of Branches per plant	Leaf area (m²)
1	148.50**	14.75 **	2.50	3.02**
2	93.00	11.50	2.50	1.72
3	130.00	12.75	3.50	2.32**
4	137.00 **	12.75	2.50	1.88
5	133.50	13.75	3.00	3.08 **
6	107.50	14.00	4.00	3.70 **
7	143.50 **	14.00	2.50	1.81
8	80.50	12.50	5.00**	1.67
9	71.50	11.25	2.50	0.52
10	71.00	9.50	2.50	0.45
11	80.50	10.00	2.00	1.59
12	94.00	12.50	3.00	2.13**
13	102.00	9.00	1.50	0.89
14	106.00	11.50	2.50	1.74
15	105.00	11.00	4.00	1.11
16	123.00	13.00	4.00	1.07
17	108.00	12.00	3.50	2.15**
18	47.50	8.50	2.50	2.12**
19	90.00	13.00	3.00	2.47 **
20	110.50	13.75	2.95	2.36 **
Mean	104.12	12.05	2.97	1.89
SE(d) _±	14.85	1.62	0.72	0.05
F test	Sig.	Sig.	Sig.	Sig.
CD at1%	31.08	2.40	1.51	0.10

Sig= Significant.

** significant at 1% as compare to average value

4.3.5 Floral initiation and seed yield per plant of clonal trial of candidate plus trees.

The observations regarding days to floral initiation in 50% of plants after planting and seed yields per plant of clonal trial were given in Table 8.

Out of 20 CPT included in trial, only 10 clones revealed the initiation of flowering after 60 to 65 days. The CPT-1 and CPT-5 showed floral initiation within 60 days followed by CPT-2 and CPT 6 in 62 days. The other clones like CPT-7, CPT-9, CPT-10, CPT-11, CPT-13 and CPT-17 showed floral initiation after 65 days.

Floral initiation was not observed in CPT-3, CPT-4, CPT-8, CPT-12, CPT-14, CPT-15, CPT-16, CPT-18, CPT-19, CPT-20.

The seed yield obtained during first year were given in Table 8. The highest seed yield was obtained from CPT-5 (47.49) followed by CPT-7 (24.25g). The remaining candidate plus trees revealed seed yield ranging from 5.20 to 15.42g during first year.

Table 8: Flowering & seed yield data of clones of selected CPT's

Sr. No.	Name of CPT	Days to flowering after planting	Seed yield (g)
1	CPT-1	60 day's	10.90
2	CPT-2	62 day's	5.20
3	CPT-3	-	-
4	CPT-4	-	-
5	CPT-5	60 day's	47.49
6	CPT-6	62 day's	15.42
7	CPT-7	65 day's	24.25
8	CPT-8	-	-
9	CPT-9	65 day's	4.85
10	CPT-10	65 day's	6.85
11	CPT-11	65 day's	6.98
12	CPT-12	-	-
13	CPT-13	65 day's	7.03
14	CPT-14	-	-
15	CPT-15	-	-
16	CPT-16	-	-
17	CPT-17	65 day's	5.94
18	CPT-18	-	-
19	CPT-19	-	-
20	CPT-20	-	-

Floral initiation started in the month of August and continued upto September

Fruit maturity was observed from October to November

4.4 Analysis of variance for half-sib progenys of CPT's

Analysis of variance were presented in Table 9. The variation for basal girth and number of branches per plant were observed to be significant at 1 per cent level of significance. Indicating substantial variability for basal girth and number of branches per plant among the progenys of CPT.

The mean values of the progenys of CPT for various characters have been presented with their standard error in Table 10. The results have been presented with respect to each of the growth characters briefly.

Table 9: Analysis of variance for half-sib progeny of CPTs.

MSS					
Source of Variation	D.F.	Plant Height (cm)	Basal Girth (cm)	No. of branches per plant	Leaf Area
Replication	2	6689.19	32.65	18.50	1.15
Treatment	19	672.27	5.60**	11.31**	2.33
Error	38	408.25	2.29	4.67	1.87

** Significant at 1%.

4.4.1 Plant height (cm)

Plant height ranged from 92.06 to 141.86 cm. The maximum height was observed in progeny of CPT-19 (141.86) followed by CPT-2 (141.26) and CPT-17 (139.46). The minimum height was observed in CPT -13 (92.06). The average plant height was 121.28.

4.4.2 Basal girth (cm)

Basal girth ranged from 12.20 to 17.66 cm. The maximum basal girth was observed in CPT-2 (17.66) followed by CPT-19 (16.66), CPT-20 (16.00) respectively. The minimum basal girth was observed in CPT-13 (12.20). The average basal girth was 14.52.

4.4.3 Number of branches per plant

The number of branches per plant ranged from 1.40 to 10.46. The maximum number of branches per plant was observed in CPT-2 (10.46) followed by CPT-19 (5.73) CPT-20 (4.46). The minimum number of branches per plant were observed in CPT-13 (1.40). The average value for number of branches per plant was 1.76.

4.4.4 Leaf area per plant (m²)

Leaf area is ranged from 0.82 to 4.46 m². The maximum leaf area was observed in CPT-1 (4.46) followed by CPT-2 (3.58) and CPT-14 (3.08). The minimum leaf area was observed in CPT-9 (0.82). The average value for leaf area was 2.22.

For number of branches per plant CPT-2 was significantly higher than all other CPTs. The CPTs other than CPT-2 are at par with each other.

Table 10: Growth performance of half-sib progeny

CPT No.	Plant Height (cm)	Basal Girth (cm)	No. of Branches per plant	Leaf area (m²)
1	135.63	14.86	4.13	4.46
2	141.26	17.66**	10.46 **	3.58
3	133.14	14.20	3.13	2.49
4	130.53	14.06	3.46	1.97
5	121.00	14.13	3.73	2.54
6	114.93	13.33	2.66	1.85
7	110.50	13.53	2.33	1.17
8	101.73	12.93	1.66	1.24
9	130.40	15.76	3.60	0.82
10	118.00	14.66	3.80	2.88
11	110.46	13.93	2.73	2.14
12	100.80	13.00	1.80	2.77
13	92.06	12.20	1.40	2.40
14	110.40	14.53	2.33	3.08
15	116.33	14.53	3.26	2.59
16	108.53	13.40	2.20	2.16
17	139.46	15.73	3.60	1.73
18	136.26	15.46	3.73	1.59
19	141.86	16.66	5.73	1.24
20	132.20	16.00	4.46	1.72
Mean	121.28	14.52	3.51	2.22
SE(d)±	16.49	1.23	1.76	1.11
F test	N Sig.	Sig	Sig	N Sig.
CD at1%	-	2.49	3.56	-

** significant when compared with average value

4.4.5 Floral initiation and seed yield per plant of half-sib progenys of candidate plus trees.

The observation regarding days to floral initiation after planting and seed yield per plant of half- sib progeny evaluation trial were given in Table 11.

Out of 20 CPT's progeny, only 10 CPT progeny showed floral initiation after 70 to 75 days. The progeny of CPT-1, CPT-2, CPT-4, CPT-16, CPT-17 and CPT-20 revealed floral initiation after 70 days. The CPT-10, CPT-11 and CPT-18 revealed floral initiation after 75 days.

The maximum mean seed yield was recorded by CPT-2 (9.73 g) followed by CPT-1, CPT-4, CPT-10, CPT-11, CPT-16, CPT-17, CPT-18. These candidate plus trees revealed seed yield ranges from 5.33 to 7.21g. The seed yield is yet to be stabilize and low during first year.

Table 11: Flowering & seed yield data of half-sib progeny of selected CPT's

Sr. No.	Name of CPT	Day's to flowering after planting	Seed Yield (g)
1	CPT-1	70 day's	5.33
2	CPT-2	70 day's	9.73
3	CPT-3	-	-
4	CPT-4	71 day's	6.85
5	CPT-5	-	-
6	CPT-6	-	-
7	CPT-7	-	-
8	CPT-8	-	-
9	CPT-9	-	-
10	CPT-10	72 day's	5.96
11	CPT-11	72 day's	4.87
12	CPT-12	-	-
13	CPT-13	-	-
14	CPT-14	-	-
15	CPT-15	-	-
16	CPT-16	70 day's	5.73
17	CPT-17	70 day's	7.21
18	CPT-18	72 day's	4.15
19	CPT-19	75 day's	9.30
20	CPT-20	70 day's	8.83

4.5 Variability estimates for seedling growth

Variability parameter like phenotypic coefficient of variation (P.C.V.) and genotypic coefficient of variation (G.C.V.) heritability estimates and expected genetic advance were estimated for all the growth characters and the results obtained were presented in Table 12.

4.5.1 Phenotypic coefficient of variation

It can be seen from Table 12 that phenotypic coefficient of variation for different growth characters ranged from 9.00 per cent for survival seedling after 21 days to 26.09 per cent for fresh weight of seedlings. Estimates of PCV were slightly high for seedling collar diameter (18.67%) followed by seedlings height (10.08%).

4.5.2 Genotypic coefficient of variation

It can be observed from table 12 that genotypic coefficient of variation for different character ranged from 7.04 per cent for seedlings height to 20.63% for fresh weight of seedlings. Estimates of genotypic coefficient of variation were slightly high for seedlings collar diameter (14.93%). Whereas the magnitude of genotypic coefficient of variation was comparatively low for survival of seedlings after 21 days (8.00%).

4.5.3 Heritability estimates

Heritability estimates ranges from 48.83 per cent for seedlings height to 77.00 per cent for survival of seedlings after 21 days. Estimates of heritability were slightly high for seedlings collar diameter (63.90%) and fresh weight of seedlings (62.49%).

4.5.4 Expected genetic advance

The expected genetic advance for different characters ranged from 9.75 per cent for seedlings height to 33.55 per cent for fresh weight of seedlings. Expected genetic advance were slightly high for seedlings collar diameter (24.56%) and

comparatively moderate values were recorded for survival of seedlings after 21 days (14.9%).

Table 12: Estimates of phenotypic coefficient of variation, genotypic coefficient of variation, heritability and expected genetic advance over mean of seedling growth.

Sr. No.	Character	Mean	Range		Phenotypic coefficient of variation (%)	Genotypic coefficient of variation (%)	Heritability estimates (%)	Expected genetic advance over mean (%)
			Min.	Max.				
1	Survival of seedling after 21 days (%)	71.30	56.33	82.33	9.00	8.00	77.00	14.90
2	Seedling Height (cm)	26.73	22.66	31.33	10.08	7.04	48.83	9.75
3	Seedling Collor diameter (mm)	6.96	4.83	9.28	18.67	14.93	63.90	24.56
4	Fresh weight of seedling (g)	27.69	16.48	39.79	26.09	20.63	62.49	33.55

4.6 Variability estimates for clonal evaluation trial

Variability parameter like phenotypic coefficient of variation (P.C.V.) and genotypic coefficient of variation (G.C.V.) heritability and expected genetic advance (E.G.A.) were estimated for all the characters and the results obtained are presented in Table 13.

4.6.1 Phenotypic coefficient of variation

It can be seen from Table 13 that phenotypic coefficient of variation for different characters ranged from 17.43 per cent for basal girth to 52.37 per cent for leaf area. Estimates of phenotypic coefficient of variation were slightly high for plant height (37.12%) followed by number of branches per plant (32.86%) and Phenotypic coefficient of variation was comparatively low for basal girth (17.43%).

4.6.2 Genotypic coefficient of variation

It can be observed from Table 13 that genotypic coefficient of variation for different characters ranged from 14.23 per cent for number of branches per plant to 36.65 per cent for leaf area. Estimates of genotypic coefficient of variation were slightly high for plant height (34.86%). Whereas the magnitude of genotypic coefficient of variation was comparatively low for basal girth (14.73%).

4.6.3 Heritability estimates

Heritability estimates ranges from 40.20 per cent for basal girth to 86.88 per cent for plant height. Moderate heritability estimate values were recorded for leaf area (48.97%) followed by number of branches per plant (44.68%).

4.6.4 Expected genetic advance

The expected genetic advance for different characters ranged from 14.43 per cent for basal girth to 50.79 per cent for

leaf area. The expected genetic advance was moderate for number of branches per plant (30.16) and low for basal girth.

Table 13: Estimates of phenotypic coefficient of variation, genotypic coefficient of variation, heritability and expected genetic advance over mean of clonal evaluation trial

Sr. No.	Character	Mean	Range		Phenotypic coefficient of variation (%)	Genotypic coefficient of variation (%)	Heritability estimates (%)	Expected genetic advance over mean (%)
			Min.	Max.				
1	Plant Height (cm)	104.12	47.5	148.50	37.12	34.86	86.88	41.32
2	No. of branches per plant	2.97	1.50	5.00	31.86	14.23	44.68	30.16
3	Basal Girth (cm)	12.05	8.5	14.75	17.43	14.73	40.20	14.43
4	Leaf area	1.89	0.45	3.70	52.37	36.65	48.97	50.79

4.7 Variability estimates for half-sib progeny

Variability parameters like phenotypic coefficient of variation (P.C.V.) and genotypic coefficient of variation (G.C.V.) heritability and expected genetic advance (E.G.A) were estimated for all the characters and the results obtained are presented in Table 14.

4.7.1 Phenotypic coefficient of variation

It can be seen from Table 14 that phenotypic coefficient of variation for different characters ranged from 12.67 per cent for basal girth to 85.78 per cent for leaf area of plant. Estimates of phenotypic coefficient of variation were slightly high for number of branches per plant (83.18%). Whereas phenotypic

coefficient of variation was comparatively low for plant height (18.36%).

4.7.2 Genotypic coefficient of variation

It can be observed from Table 14 that genotypic coefficient of variation for different characters ranged from 7.22 per cent for basal girth to 62.90 per cent for number of branches per plant. Estimates of genotypic coefficient of variation was slightly high for leaf area (43.68%). Whereas the magnitude of genotypic coefficient of variation was comparatively low for plant height (7.73%).

4.7.3 Heritability estimates

Heritability estimates ranged from 17.73 per cent for plant height to 32.44 for basal girth. Heritability estimates value were 325.12% for number of branches per plant followed by leaf area of plant (25.92%).

4.7.4 Expected genetic advance

The expected genetic advance for different characters ranged from 6.70 per cent for plant height to 49.24 per cent for number of branches per plant. The lowest values were observed in basal girth (8.47%) and leaf area (9.44%).

Table 14: Estimates of phenotypic coefficient of variation, genotypic coefficient of variation, heritability and expected genetic advance over mean of half-sib-progeny trial.

Sr. No.	Character	Mean	Range		Phenotypic coefficient of variation (%)	Genotypic coefficient of variation (%)	Heritability estimates (%)	Expected genetic advance over mean (%)
			Min.	Max.				
1	Plant Height (cm)	121.28	92.06	141.86	18.36	7.73	17.73	6.70
2	Basal Girth (cm)	14.52	12.20	17.66	12.67	7.22	32.44	8.47
3	Number of branches per plant	3.51	1.40	10.46	83.18	62.90	32.12	49.24
4	Leaf Area (m ²)	2.22	0.82	4.46	85.78	43.68	25.92	9.44

4.8 Seed oil content

The oil estimation of the seed collected from mother of candidate plus trees and oil estimates of bulk seed of half sib progeny were given in Table 15. The oil content of bulk seed of half sib progeny was lower than the oil content of seed of mother of candidate plus trees for all CPTs except for CPT-10, whose oil content was higher (40%) as compare to seed oil content of mother trees 35.85%. The oil content of the clones which produce the seeds during first year ranged from 28 to 40 per cent.

Table 15: Seed oil content of mother CPT and half-sib progeny

Name of CPT	Mother CPT seed oil percent	Half-sib progeny seed oil percent
CPT-1	37.60	30.60
CPT-2	38.67	32.57
CPT-4	32.57	28.60
CPT-10	35.85	40.60
CPT-11	35.97	28.61
CPT-16	35.09	32.03
CPT-17	37.61	34.07
CPT-18	37.60	36.51
CPT-19	34.57	28.60
CPT-20	26.69	30.09

4.9 Effect of hormones on flowering and fruit yields

The effect of various hormonal treatment on the characters plant height, basal girth, number of branches per plant, number of inflorescence per plant, male to female ratio, number of fruits per plant were given in Table 16.

The hormonal effect was not observed on growth characters. The GA₃ 100 ppm and ethrel 1000 ppm increased number of inflorescence/plant and number of fruits/ plant as compared to control.

Table 16: Effect of hormones on flowering and fruit yield

Treatment	Plant Height (cm)	Basal Girth (cm)	No. of branches	No. of Inflorescence per plant	Female to male ratio in flower	No. of fruits per plant
Salicylic acid 100 ppm	134.2	16.6	21.2	5.2	1:29	10.0
Salicylic acid 150 ppm	139.4	18.6	28.2	3.2	1:28	7.0
GA ₃ - 50 ppm	158.6	18.4	20.6	3.6	1:29	8.0
GA ₃ - 100 ppm	148.8	17.5	27.6	8.6	1:29	13.2
Ethrel- 500 ppm	140.0	17.0	12.4	5.0	1:29	9.4
Ethrel- 1000 ppm	141.4	15.2	16.2	10.0	1:28	16.0
Control	134.4	16.6	28.4	4.6	1:29	9.2
Mean	142.40	17.13	22.09	5.74	1:28	11.86
SE (m) $\pm$	3.28	0.44	2.39	0.96	-	1.18
CV %	6.08	2.58	28.56	44.59	-	26.39



Clonal Evaluation



Progeny Evaluation



Flowering Branch



Fruiting Branch

CHAPTER - V

DISCUSSION

The intensive forest management activities, such as site preparation or fertilization, never will yield maximum return unless the genetically best trees are used. Conversely, it is also clear that no matter how excellent trees may be genetically, maximum production can not be achieved unless good forest management practices are use along with improved plant.

Forest trees are plants with responses controlled by the environment and by genetics, like all other organisms. The following approaches can be used by tree breeder to increase seed production. Breeding can acscomplished for improved yield and quality on the more productive forested areas. Trees can be developed that will grow satisfactorily on sub marginal and uneconomic land and strains of forest trees can be developed that are more suitable for specialize uses.

The development of seed especially suitable for marginal sites is long term in nature but it will result in substantial benefit since this type of land is not suitable for other crops. For species like *Jatropha*, emphasis in tree improvement is to be given towards breeding for adaptability for marginal sites in addition to improving seed yield of trees. For better growth on these type of sites potential gain from breeding for adaptability for marginal sites are great and huge areas of such lands are available

for forest use. Tree breeders should keep in mind that higher seed production will not be obtainable from deficient soils, no matter how good the trees are genetically.

Tree response to the law of limiting factor. The most important limiting factor to increase seed yield of *Jatropha* is the genetic potential of the plant being use. The other factors necessary for good *Jatropha* growth will be limited moisture and nutrient. It is not possible to obtain large genetic gain without correcting the limiting factor. The idea held by some person that *Jatropha* can be planted with little care and still grow outstandingly well is totally unrealistic. The combination of genetics and intensive culture has been showed many time to be essential in agriculture. The old traditional variety of any crop did not take full advantage of intensive cultivation and fertilization, in contrast to this the recent hybrid their total genetic potential can be exploited if they are grown in best environment. The developing strains of *Jatropha* to overcome limiting environment factor increasingly important. The breeding has already made forestry crop profitable on marginal and sub marginal land for economical forest production under nutrient deficiency Lacaze et al. (1963), Goddard et al. (1976) Roberds et al (1976), Mc Cormick and Steiner (1978).

Heller (1992) discovered the existence of genotypes in *Jatropha curcus* especifically adapted to marginal conditions or which show strong vegetative growth during youth. This could be

of importance for establishing vegetation on very marginal site, as well as plantations to control erosion and supply mulching material without considering seed production aspects.

5.1 Survey and collection of candidate plus trees

Plus tree selection is one of the major component of tree improvement. In many species plus trees are selected for timber yield and disease resistance. The trees are generally selected for one trait at a time, although other characters are considered during selection. The trees are expected to serve the purpose for which the trees are selected. The yields potential varies with the age of trees and hence during selection the tree are compared with the tree of same age. The population was delineated based on agroclimatic conditions. The survey was started from the flowering period and pick fruiting season for location is predicted to assess for selection of tree during that period. The good fruit bearing trees are identified and assess for various growth characters and fruit yield. In plus tree selection the location details and growth character are recorded. The seed of selected trees are packed individually and brought to the laboratory. The seed are extracted and analyzed for oil content. Similar method was use by Manjre and Kumaran (2003), Kumaran and Manjre (1991), Umrani and Jerlin (2003), and Balasubramanian and Paramathma (2005) for Karanj

Gurudev Singh et al. (2003) conducted similar type of study in *Azadirachta indica* and selected 442 CPT which are high

fruit yielding. The CPTs identified based on their fruit yields are compared with fruit yield of check tree of the same diameter class growing around the CPTs. The seed yield per plant for selected CPTs of Neem ranges from 52.91 to 81.66 g.

The method of plus tree selection for timber are known and widely used in Pines (Zobel et al, 1988). Plus trees selection method was used in oil seeds like *Pongamia pinnata*, *Madhuca indica*, *Simarouba glauca* and *Azadiracta indica* by Rao and Venkaiah (2003), in *Jatropha curcas* by Anonymous (2005). There is an urgent need for selection of *Jatropha* for seed yield having high oil content in the seed. The objective will be achieved by selecting the trees for high seed yield in the field and further selection for oil content was done by analyzing oil content in the laboratory. There is a problem in a *Jatropha* since trees are distributed unevenly in border of farmers field and waste land. The age of the tree neither known nor uniform. The yield potential varies with age of tree and hence during selection the trees were compared with the tree of same age in a particular location and entire selection area is surveyed for a general assessment of seed production per tree in order to select best seed yielding tree. In present study the candidate plus trees was collected from Akola, Amravati, Washim, Buldhana, Jalna, Aurangabad and Jalgaon District. The approximate age of mother tree ranged from 6 to 15 years. Average height of the trees was 3.66 meter and basal girth was 67.75 cm. The average plant canopy spread was 3.4 meter.

The average female to male ratio was 1:27 and average number of capsule per bunch was 9 producing on an average 1.47 kg seed yield per plant. The average Test weight was 70 g average oil content was 35.3 per cent. The morphological characters like leaf colour, hairiness, stem colour, sepals, petals colour, anther and stigma colour was similar for all the trees. The most economical character is seed yield and oil content of the seed. The mother of the candidate plus tree were located at the border of the field without any specific application of fertilizer or irrigation. The care was taken to avoid the site were the benefit of irrigation and fertilizer was obtained to the border field. The CPTs were selected from the marginal site hence from the survey it is concluded that 10 years old trees gave seed yield of 1.47 kg. Similar results regarding seed yields were reported by Reinhard (1998) Stainswat et al. (1986), Miller (1992), Heller (1996) and Mukta and Ramanjoneyula (2000).

5.2 Clonal Trial

A clonal test is an experiment in which rooted cuttings are planted in the replicated design and clones are selected on the basis of their average performance in the experiment. In horticulture clonal selection is most frequently used in apple, tea and roses which produce variable off springs. After selection of clones planted in large scale which produce uniformity. Vegetative propagation is an important tool in tree improvement because true too type propagules of desired genotypes can be produce on large

scale and this is specially true for easy to root species like *Jatropha*. In present study the best phenotype were identified as CPT. The cuttings were brought from the individual CPT and rooted cutting were planted in the replicated trial. There was significant differences for growth characters like plant height, basal girth, number of branches per plant and leaf area.

The clones with significantly high value than mean value of population includes CPT-1,CPT-7 and CPT-4 for plant height, basal girth, CPT-8 for number of branches/plant,CPT-6, CPT-5 ,CPT-1, CPT-13, CPT-17, CPT-18, CPT-19 and CPT-20.The growth is yet to be stabilize and selection on the basis of first year growth may not be very effective. The heritability of clonal trial for plant height was high and the heritability for other characters were moderate. The expected genetic advance over mean was high in leaf area even though the heritability was moderate. This is due to higher phenotypic variation of the trait.

5.3 Half -sib progeny trial

The type of crossing system within a species has a major effect upon the variation pattern. Out crossing system which is common in *Jatropha* species produce highly variable heterozygous genetic population. Out crossing result in maintaining the variation needed for simple selection in breeding programme.

Tree selected as candidate plus tree have a good phenotype. The best way to evaluate the genetic worth of selected

parent is to grow their progeny in a way that allow estimation of parental breeding value. These enable one to separate parent whose phenotypic superiority may have resulted from growing in good environment from those that are superior because they have a good genotype. The easiest and least expensive means of creating progeny population is to use open or wind pollinated seeds from selected parent. The method is simple, consisting of collecting open pollinating seed from the parent trees that are to be tested. In the present study the seeds are collected from candidate plus trees individually. Open pollinated test provide estimates of additive genetic variance and heritability value for the population being tested, because only one parent is known, estimates of non additive variance can not be obtained. The draw back of open pollinated material is that the pollen plant is unselected and lowers the gain from selection efforts.

Reproduction by seed is a necessary part of tree improvement work. The heavy and regular seed production is taken for granted in most of field crops but trees, however are not grown for their seeds.

Crop plants have been subjected to selection for hundreds of generations so that modern crop plant breeder must improve on an highly improved crop. The tree breeders on an other hand generally start with in improved wild types. This may simple experiments in tree breeding may lead to very good gains.

Some of the plant species that produce oil seeds and can even grow on marginal land are now getting special attention. These species are also important because they do not interfere with the acreage of other crops. *Jatropha curcas* is most suitable species as provider of oil, organic manure, biopesticide, soil protection and revegetation on marginal land.

5.3.1 Evaluation of seedlings

The candidate plus trees open pollinated seeds were used for sowing in nursery. The analysis of variance for half sib progeny revealed that there was significant differences in survival, plant height collar diameter and fresh weight of seedlings.

The average survival was more than 70 per cent. There were significant differences in survival, seedling height, collar diameter and fresh weight of seedling raised from various sources. Sudhir Kumar (2003) and Ginwal (2005) used different sources of *Jatropha curcas* and reported similar results for seedling growth parameter.

The heritability estimates were high for seedlings collar diameter and fresh weight of seedlings and expected genetic gain were maximum for fresh weight of seedlings. The CPT-15, CPT-17, CPT-19, CPT-20 from Buldhana, Jalna and Aurangabad area revealed significantly superior fresh weight of seedlings than average value as compared to Amravati, Akola, Washim and Jalgaon district.

As per Wilkinson (1973) in forest trees juvenile - mature genetic correlation are less than one. Selection at Juvenile age which results in a group of select trees that may not be a very best group at the rotation age. There are references of poor performance of juvenile selected trees at the mature ages. (Kumaran and Manjre , 1991 and Bharti *et al.*, 1996).

5.3.2 Evaluation of progeny

There was no significant difference in between the CPTs of half -sib progeny trial for plant height and leaf area. However their are significant difference in the basal girth and number of branches per plant. The basal girth is very important character for xerophytic plants to store nutrient and water under stress condition. There is a scope for selection of CPTs on the basis of performance of progeny regarding basal girth and number of branches per plant. The CPT-2 revealed significantly higher value for basal girth and number of branches per plant than their respective average value. Gurudev *et al* (2003) reported significant variation in the progeny of 442 plus tree during survey. The significant variation was observed for plant height and collar diameter.

The basal girth and number of branches revealed medium heritability. The expected genetic advance over mean for number of braches per plant is 49.24 per cent. The selection for number of branches per plant will be effective since higher GCV percentage observed in number of branches per plant.

5.5 Hormonal trial

The hormones like Salicylic acid 100 and 50 ppm, GA₃ 50 to 100 ppm and Ethrel. 500 to 1000 ppm was spread on three years old plant and there was no difference in male to female ratio because of spraying of various hormones. However number of fruits per plant were higher in GA₃ 100 ppm and Ethrel 1000ppm treatment as compare to control. This require further experiment on different types of hormones with other concentration.

CHAPTER VI

SUMMARY AND CONCLUSION

The present investigation entitled "Identification of elite genotypes of *Jatropha curcas* L." conducted during 2004-05 at the field of College of Forestry Dr. PDKV, Akola with a view to estimate genetic variability among 20 candidate plus tree clones and half sib progeny collected during survey and collection from various districts of Maharashtra. The genetic variability was assessed in various characters.

Field trial was conducted in randomized block design with 2 replication for clonal trial and 3 replication for half sib progeny trial. The observations were recorded for mother CPT viz. site data, plant height, basal girth, no. of capsule per bunch, percentage of seed weight in fruit yield per plant, number of seed per fruit, 100 seed weight, date of flowering, fruit maturity period, pest and diseases. For clonal and half sib progeny trial characters viz. plant height, basal girth, no. of branches per plant, total leaf area, date of flowering, seed yield per plant and oil per cent were recorded.

The survey and collection of candidate plus tree of *Jatropha curcas* from various district of Maharashtra revealed sufficient variation for growth and yield parameter. The seed yield of CPTs ranges from 1 kg to 3.5 kg of the plant ranging from 6 to 15 years of age. The variation for test weight ranges

from 59 to 82 g and oil content of seed ranges from 26.64 to 43.36 per cent.

In absence of other information, the oil content of the seed and nursery observation of seedlings of CPTs were taken as criteria for selection of CPTs to be included in clonal trial as well as half-sib progeny evaluation trial.

The total 20 CPTs were collected during present study.

The clonal trial of 20 CPTs revealed that there were significant differences in growth parameter like height, basal girth, number of branches per plant and leaf area per clone.

The maximum expected genetic advance over mean was observed for leaf area i.e. 50.79 per cent. Out of 20 clones, only 10 clones flowered from 60 to 65 days after planting. The seed yield clones ranges from 4.85 g to 47.49 g/plant. The maximum clone seed yield was observed in CPT-5 i.e. 47.49 g followed by CPT-7 and CPT-6. The growth and yield is yet to be stabilize.

The half sib progeny trial of 20 CPT revealed significant variation for basal girth and number of branches per plant. The variation for height and leaf area per plant were not significant. The mean basal girth was high in CPT-2 followed by CPT-19 and CPT-20. The EGA for number of branches per plant was high as compared to leaf area, plant height and basal girth.

The basal girth is the useful trait for xerophytic plant which helps to withstand the drier period and act as store house for food.

The numbers of branches per plant were maximum in CPT-2 followed by CPT-19 and CPT-20. The seed yield was low during first year.

The hormonal trial, reveals that there was no difference in height, basal girth and number of branches per plant. However numerically GA₃- 100 ppm and Ethrel- 1000 ppm showed highest estimates for inflorescence and fruits per plants. The further study of hormonal treatment is required for the conclusion.

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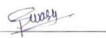
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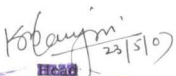
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*** Original not seen**

THESIS ABSTRACT

- a) Title of the thesis : **"IDENTIFICATION OF ELITE
GENOTYPE OF *Jatropha curcas* L."**.
- b) Name of the student : **Wasu Sachin Panjabrao**
- c) Name and Address
of major Advisor : Dr. J.S. Zope
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- d) Degree to be awarded : M.Sc. (Agriculture)
- e) Year of award of degree : 2007
- f) Major subject : Agricultural Botany
- g) Total number
of pages in the thesis : 80
- h) Number of words in the
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- i) Signature of student : 
- j) Signature, Name and
address of forwarding authority


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Department of Agricultural Botany
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ABSTRACT

The present investigation entitled "identification of elite genotype of *Jatropha curcas* L." was carried out during kharif 2004-2005 at the field of College of Forestry, Dr. P.D.K.V., Akola.

The study was carried out with the object to do the survey and collection of plus tree, selection of superior plus tree and done on the basis of phenotypic characters and to study the effect of growth hormones on reproductive behavior of *Jatropha curcas* L.

The observations were recorded for clonal and half-sib progeny trial for character viz. plant height, basal girth, number of branches per plant, leaf area, date of floral initiation, seed yield and oil content.

The observations on site characters, growth and seed yield of mother CPTs were recorded during survey and collection of CPT. The oil content of mother CPT seed ranges from 26.64 to 42.36 % the average seed yield of 10 years old plant was 1.47 kg/plant.

The clonal trial revealed significant differences in growth parameters like height, basal girth, number of branches per plant and leaf area. The highest EGA over mean was observed in leaf area m². Out of 20 clones only 10 clones are flowered during first year. The maximum yield was 47.49 g in CPT-5 per plant during first year.

In the half-sib progeny trial, there was significant variation for basal girth and number of branches per plant. The highest value of basal girth and number branches per plant was observed in CPT-2. The EGA for number of branches per plant was high as compared to leaf area, plant height and basal girth. The highest seed yield was observed 9.73 g in CPT-2 which was very low.

There was no effect of hormones on plant height, basal girth, number of branches per plant, number of inflorescence, female to male ratio and fruit yield.

VITA

Sachin Panjabrao Wasu was born at Daryapur Tal-Daryapur, Dist. Amravati in Maharashtra state, on Twenty First January Nineteen Eighty One. He passed the Secondary School Certificate (SSC) examination in Second class from New Highschool Main, Amravati. He completed Higher Secondary School Certificate (HSSC) examination with Second division from Shivaji Multipurpose Junior Science College, Amravati.

He joined B.Sc. Forestry at College of Forestry Akola. He completed this degree with Second division in the year 2004. Due to his special interest in genetics and plant breeding, he get admitted for M.Sc. (Genetics and Plant Breeding) in the year 2004 at Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola.

He has keen interest in research related to the field of Plant Breeding and Genetics.

APPENDIX –I

Weekly weather data for the year 2004-05 recorded at Agromet
Observatory, Dr. PDKV, Akola

N – Normal 1971-2000

A - Actual 2004-05

MW	Dates	Tmax		Tmin		BSH		WS		RHI		RHII		Evap		RF		Rainy Days	
		N	A	N	A	N	A	N	A	N	A	N	A	N	A	N	A	N	A
40	1-7 Oct	31.1	28.5	23.1	23.2	3.6	2.3	11.7	8.6	88	91	66	83	4.6	3.9	49.3	185.0	2.5	5
41	8-14	30.2	29.0	22.9	22.9	3.5	3.5	11.6	6.3	87	88	69	70	4.2	4.0	59.9	38.3	2.9	3
42	15-21	30.5	30.8	22.8	23.5	4.4	3.5	11.7	8.0	86	87	66	62	4.5	4.8	40.6	13.3	2.2	3
43	22-28	30.5	30.2	22.6	22.7	4.3	3.8	11.0	6.3	88	86	66	59	4.3	4.3	46.7	11.0	2.0	0
44	29-4 Nov	30.4	34.0	22.7	23.7	4.4	7.1	10.6	3.7	86	83	64	47	4.2	5.5	47.1	1.8	2.4	0
45	5-11	31.1	31.6	22.5	23.3	5.7	4.6	9.1	2.4	85	93	61	66	4.7	3.8	28.5	62.0	1.5	0
46	12-18	32.2	30.7	22.4	23.5	7.1	3.8	9.0	4.6	85	90	56	70	5.1	3.9	18.9	49.3	1.1	2
47	19-25	33.4	30.5	22.3	23.1	7.2	5.2	8.5	6.9	83	91	53	70	5.3	4.4	24.6	37.7	1.4	3
48	26-2 Dec	33.7	30.9	21.9	21.6	7.6	8.1	5.4	5.0	83	88	50	55	4.9	5.5	24.4	0.7	1.5	0
49	3-9	33.9	34.1	20.2	20.8	8.1	7.8	7.5	2.9	81	84	45	38	5.5	5.6	21.8	5.4	1.1	1
50	10-16	34.1	35.0	18.7	18.8	4.2	8.9	4.1	2.1	76	74	40	36	5.3	6.7	16.0	0.0	0.9	0
51	17-23	33.9	27.7	18.1	20.3	8.4	4.3	4.4	1.8	74	96	36	64	5.5	2.4	3.1	64.5	0.4	0
52	24-31	33.1	30.7	18.5	17.3	8.4	7.3	4.1	1.4	73	90	36	41	5.3	4.5	10.0	0.5	0.6	0
1	1-7 Jan	33.0	31.5	15.8	13.0	8.7	7.9	4.7	0.9	72	83	31	24	5.3	4.6	2.3	0.0	0.3	0
2	8-14	32.4	30.3	14.8	11.2	8.6	9.0	4.5	1.7	70	77	30	23	5.2	4.5	3.7	0.0	0.3	0
3	15-21	31.7	30.9	13.7	10.9	8.6	9.0	4.6	0.7	70	80	30	22	4.9	4.0	1.1	0.0	0.2	0
4	22-28	31.0	31.3	13.1	10.8	8.6	9.3	4.4	10.9	71	71	30	19	4.6	4.8	10.1	0.0	0.3	0
5	29-4 Feb	30.3	30.3	12.4	14.0	8.8	7.9	4.6	1.7	71	73	31	29	4.3	5.3	6.8	0.0	0.3	0
6	5-11	29.8	30.0	11.2	12.1	8.7	8.4	4.7	1.9	70	72	29	25	4.3	4.5	1.3	0.0	0.2	0
7	12-18	29.4	31.2	10.3	17.2	8.8	7.9	4.5	1.8	70	73	27	24	4.2	4.3	1.3	0.0	0.2	0
8	19-25	29.5	30.5	10.6	11.3	8.7	9.0	4.7	1.9	69	72	29	27	4.3	4.2	0.9	0.0	0.1	0
9	26-04 Mar	29.2	30.3	10.7	10.8	8.6	9.0	4.8	1.7	70	71	31	22	4.3	4.1	2.6	0.0	0.2	0
10	5-11	29.0	30.6	10.3	15.1	8.7	6.9	4.9	NA	78	75	30	37	4.2	4.4	1.7	0.0	0.2	0
11	12-18	29.2	29.3	11.3	10.4	8.6	8.6	6.3	NA	71	64	30	25	4.5	4.6	3.4	0.0	0.2	0
12	19-25	29.9	28.6	11.6	10.7	8.9	8.5	5.4	NA	69	57	28	27	4.8	5.8	0.9	0.0	0.1	0
13	26-1 April	30.8	29.8	11.8	14.2	9.1	6.7	5.5	NA	67	64	27	35	5.2	5.2	1.1	3.0	0.2	1
14	2-8	31.1	23.7	12.1	11.9	9.3	5.0	5.8	NA	61	91	25	59	5.6	3.1	2.8	28.3	0.2	3
15	9-15	31.3	32.9	11.9	15.3	9.1	9.1	5.6	NA	59	68	23	28	5.9	5.7	4.9	0.0	0.4	0
16	16-22	32.5	34.6	13.4	16.1	9.4	9.3	6.1	NA	56	55	22	25	6.6	8.2	0.1	0.0	0.0	0
17	23-29	33.0	31.6	13.8	13.6	9.5	8.7	6.5	NA	57	54	22	21	7.3	7.6	3.3	0.0	0.5	0
18	30- 6 May	34.7	36.1	14.8	19.1	9.6	7.4	7.0	NA	50	51	17	22	8.1	8.3	3.4	40.4	0.3	0
19	7-13	36.1	34.1	16.7	20.1	9.6	7.1	6.8	NA	44	65	18	36	9.0	7.7	2.1	0.0	0.3	0
20	14-20	37.3	35.1	17.5	17.2	9.6	9.6	6.9	NA	42	55	17	24	9.5	8.0	2.5	0.0	0.3	0
21	21-27	38.5	38.3	18.3	21.3	9.6	9.2	6.9	NA	37	44	13	19	10.5	11.5	0.3	0.0	0.1	1