1. INTRODUCTION AND AIM OF THE INVESTIGATION

1.1. Introduction.

Identification of plant species, as an energy source, was carried out in the United States of America (Nielsen et al., 1977; Buchanan et al., 1978; Wang and Hufman, 1981; McLaughlin and Hoffmann, 1982; Carr, 1985). Plants species which can be processed to provide a substitute for fossil fuel have attracted the interest of scientists more in the temperate than in the tropical zones. In this respect, the *Jatropha* L. spp. create interest among various developmental agencies. Presently, the genus *Jatropha*- a petro plant is of great importance across the globe for the cultivation to produce bio-diesel. It may be mention that in India, the Co-operative Land Development Bank of Maharashtra and the Co-operative Agricultural Development Bank, Hyderabad have come forward to finance *Jatropha* plantation for greening the wastelands. Besides, National Bank of Agriculture and Rural Development (NABARD) has also agreed to refinance such projects. The National Medicinal Plants Board (NMPB) of India is also providing subsidiary to the farmer for *Jatropha* plantations. The National Oilseeds and Vegetable oils Development Board (NOVODB), Haryana, India also providing subsidiary for the *Jatropha curcus* cultivation. India having nearly 175 hectares of wasteland is potential for the plantation of *Jatropha* spp. to fulfill the National bio-diesel production target of 20% by 2020. The mission for *Jatropha* plantation in North Eastern Regions of India is still at its initial stage.

The genus *Jatropha* belongs the family *Euphorbiaceae* under the tribe *Joanesieae of Crotonoideae* in comprised of approximately 170 known species. According to Pamidiamarri et al., (2009) the, genus *Jatropha* with 172 species having significant economic importance belongs to the family *Euphorbiaceae*. Dehgan and Webster, (1979) revised the subdivision made by Pax, (1910) and distinguish two subgenera (*Curcus* and *Jatropha*) of the genus *Jatropha*, with 10 sections and 10 subsections to accommodate the old and new World species. They postulated the physic nut (*Jatropha curcus* L.) to be the most primitive form of the *Jatropha*
genus. Species in other sections evolved from the physic nut or another ancestral form, with changes in growth habit and flower structures. Hierarchical cluster analysis of 77 new World *Jatropha* species showed for the most part concordance with Dehgan and Webster's, (1979) intrageneric classification (Dehgan and Schutzman, 1994).

The following are the other species that belong to the section Curcus; *J. pseudocurcus* Muell. Arg., *J. afrocurcus* Pax, *J. macrophylla* Pax & Hoffm., *J. villosa* Wight (syn.; *J.wightiana* Muell. Arg), *J. hintonii* Wilbur, *J. bartletti* Wilbur, *J. mcvaughii* Dehgan, Webster, and *J. yucatanensis* Briq. McVaugh, (1945) considered *J. yucatanensis* to be synonym of *J. curcus*. One species *J. villosa* is of Indian origin. Two *J. afrocurcas* and *J. macrophylla* are of East African origin, whereas all the other species in this section are native to the Americas.

Although most of the *Jatropha* species are native to the New World, approximately 66 species are native to the Old World. Dehgan and Webster, (1979) offered a key to the intrageneric taxa but this should not be considered as final since information is still lacking on many species. No complete revision of the Old World *Jatropha* exists. Hemming and Radcliffe-Smith, (1987) revised 25 Somalian species, all of the sub-genus *Jatropha multifida* L. and *J. podagrica* Hook. Of section peltatae,

*Jatropha intrigemma* of section Polymorphae, and *J. gossypifolia* of section *Jatropha* are well known and cultivated throughout the tropics as ornamental plants.

The true centre of origin of *Jatropha* L. spp., however still have to be found. A number of botanists have attempted to define the origin of *Jatropha*, but sources remain controversial. Martin and Mayeux, (1984) identified the Ceara state in Brazil as a centre of origin but without giving any authentic arguments. Vegetation forms given on the labels of herbarium specimens of the America reveals the highly probable centre of origin of the *Jatropha* L. spp. as in Mexico (and Central America). From the Caribbean, this plant was probably distributed by Portuguese seafarers via the Cape Verde Islands and former Portuguese Guinea (now Guinea Bissau) to other countries in Africa and Asia. No facts are available in the
literature before 1800 as to when the *Jatropha* was introduced in to Cape Verde (Serra, 1950). Freitas (1906), citing Pusich, says that the *Jatropha* already known several years prior to 1810, as he mentioned it in his book "Memoria ou descripcao physicopolitica das ilhas de Cabo Verde". Chelmicki and Varnhagen (1841) mention that exports of physic nuts had already began in 1836. Many information were published in the "Boletin oficial de Cabo Verde" from 1843 onwards to promote the planting of physic nut (Freitas, 1906; Serra, 1950). Burkil, (1966) assumes that the Portuguese brought the *Jatropha* to Asia: Perhaps it did not reach Malacca until a date when the Dutch were in possession for the Malys call it by a name meaning Dutch castor oil. Nevertheless, the Portuguese transported it to the Old World. The Javanese, among other names, call it Chinese castor oil. It is regarded in most countries, in Africa as well as in the East, as the 'castor oil plant', which shows that it was brought in and planted for oil; further, it is widely known as the 'hedge castor oil plant', showing where it was planted, namely in hedges. Merrill (Bur. Gov. Lab. Philipp. 6, 1903 p. 27) showed that it was in the Philippines before 1750. The genus name *Jatropha* derives from the Greek *jatros* (doctor) and *trophe* (food) which implies medicinal uses. According to Correll and Correll, (1982), curcus is the common name for physic nut in Malabar, India. Today it is cultivated in many countries.

*Jatropha* is grown under wide range of climatic conditions from tropic to sub-tropic and temperate regions. It can tolerate extreme temperatures from zero to 50°C. It grows well from sea level to an altitude of 1200 m in areas receiving 300-2500 mm of rainfall. However, it grows well in areas with higher rainfall. It is tolerant to drought and moderate frost. Its flowering is not sensitive to day length. At present, it is widely distributed in Australia, Florida, Hawaii, India, Malaysia, Oceana, Philippines, and Schychellus. It can grow in all types of soil, but performs best in well-drained soils. It can thrive well on degraded, gravelly rocky, sandy, calcareous and saline soils with low nutrient content.
1.2. Uses.

As ornamental plant.

*Jatropha*, under *Euphorbiaceae*, is a large genus with shrubs and trees distributed in the tropical and sub-tropical parts of the world. About nine species have been recorded in India. Some of them are grown in gardens for their ornamental foliage and flowers. In North Eastern Regions of India two species have been recorded. Of them *Jatropha gossypifolia* is grown in garden for its ornamental foliage. However, *Jatropha curcus* can be used for quick greening of wastelands for eco-rehabilitation and bio-aesthetic reasons. It can be used as a filler of all ugly vacant plots in urban and rural areas and to keep the obnoxious weeds like *Parthenium* under check.

As boardered plant.

*Jatropha* L. spp. are large, about 3-4 meter high occurring almost throughout India. They are found in India in a semi-wild condition. It is commonly grown as a live hedge around agricultural fields as they can be easily propagated through seeds and cuttings. It grows rapidly, is hardy to dry weather conditions and is not browsed by cattle. It can be cut or lopped at any desired height and is well adapted for hedges around agricultural fields. It does not compete with other agricultural crops and when planted on farm lands it can provide shelter from desiccating winds. It can also be used as hedge around meadows and forestation areas as well as to prevent soil erosion.

As potential oil crop.

In *Jatropha* the oil content is 35-40% in the seed and 50-60% in the kernels (Prajapati and Prajapati., 2005). The oil contains 21% saturated fatty acids and 79% unsaturated fatty acids. There is some chemical elements in the seeds which possess poisonous and purgative properties and render the oil non-edible for human consumption. Technologies are now available, whereby it could be possible to convert *Jatropha curcus* L. oil into edible oil that could prove to be a boon for developing countries.
As raw material for industrial uses.

*Jatropha curcus* L. oil has a very high saponification value and is being extensively used for making soaps in India and other countries. At present *Jatropha curcus* L. oil is being imported to meet the demand of cosmetic industry. In China, a varnish is prepared by boiling the oil with iron oxide. In villages, it is used as an illuminant as it burns without emitting smoke. It can be used for making lubricants and candles as in case of castor oil. It is used for wool spinning in England. The protein content in *Jatropha curcus* L. oil cake is used as raw material for plastics and synthetic fibers. It would also be advantageous to make use of *Jatropha curcus* L. oil as hydraulic oil. The *Jatropha* nuts and the oil it contains are excellently suited for use in soap manufacturing. In Mali, *Jatropha* is a traditional source for fat to use in soaps. The oil cleaning process produces filter residue, which, like the oil itself, can be used for making household soaps of good quality. In India also *Jatropha* oil serves in the large-scale industrial manufacture of soaps. *Jatropha* oil base soap is credited with both cleansing and medicinal effects.

Potential as medicinal plants.

*Jatropha* L. spp. is the stress-resistant perennial plant growing on marginal soils. These plants are widespread throughout arid and semi-arid tropical regions of the world and have been used as a traditional folk medicine in many countries. *J. curcas* L. is a source of several secondary metabolites of medicinal importance. The leaf, fruits, latex and bark contain glycosides, tannins, phytosterols, flavonoids and steroidal sapogenins that exhibit wide ranging medicinal properties (Debnath and Bisen, 2008). The plant products exhibit anti-bacterial and anti-fungal activities. The latex of *Jatropha* L. spp. contains an alkaloid known as "Jatrophin" which is believed to be having anti cancerous properties. The leaves are used for curing of cough, dyspepsia, leprosy and gynecological diseases. The seed paste is used for diseases like those that are used for snake bite, paralysis, piles and joints pains. The flowers are effective against diabetics. The
tender twigs provide relief for rheumatism. The root and bark have insecticidal properties. The roots are also reported to be used as antidote for snake bites. Branches are used as a chewing stick in Nigeria (Isawumi, 1978). The water and sticky sap flowing from the stem is used to arrest bleeding of wounds. Nath and Dutta, (1992) demonstrated that the wound-healing properties of curcain, a proteolytic enzyme isolated from the latex. Latex has antimicrobial properties against *Staphylococcus aureus, Escherichia coli, Klebsiella pneumoniae, Streptococcus pyogenes* and *Candida albicans* (Thomas, 1989). Kone-Bamba et al., (1987) had demonstrated the coagulating effects on blood plasma. Extracts from *Jatropha curcus* L. showed pregnancy-terminating effects in rats (Goonsekera et al., 1995). The authors suggested further studies to elucidate whether the embryo toxic effects is due to a specific action or a result of general toxicity. Muanza et al., (1995) found that a methanol extract of *Jatropha curcus* L. leaves afforded moderate protection for cultured human lymphoblastoid cells against the cytophatic effects of human immunodeficiency virus. Extract of the leaves showed potent cardiovascular action in guinea pigs and might be a possible source of beta-blocker agent (Fojas et al., 1986).

The leaf decoction of *Jatropha gossypifolia* L. is used for bathing wounds (Morton, 1968). Morton, (1981) and Omoregbe et al., (1996) reported that the leaf bath is used for sores, sprains, rash and bewitchment in Latin America and in the Caribbean; the poultices are used for sores and pains in Trinidad (Morton, 1981). The stem sap stop bleeding and itching of cuts and scratches (Morton, 1981; Hästen et al., 1996). In Southern Nigeria, herbalists and local people use to stop bleeding from the skin and nose and routinely use the extracts from fresh leaves or crushed leaves for the purpose.

In North Eastern Region of India, preparation from all parts of the *Jatropha* L. spp., including leaves and barks, fresh or as decoction, are used in traditional medicine and for veterinary purposes. Tender twigs of the plants are used for cleaning teeth. The juice is reported to relieve toothache and strengthen gums (Prajapati and Prajapati, 2005). Some
people of Assam have used the root of the *Jatropha gossypifolia* L. as magico-practices to eliminate evil from diseased persons. It is also used in the treatment of piles along with other plant species.

**Use for dye.**

The bark of *Jatropha curcus* L. yields a dark blue dye, which is reported to be used in Philippines for colouring cloth, fishing nets and lines (Prajapati and Prajapati, 2005). The dye may be extracted from leaves and tender stems and concentrated to yellowish syrup or dried to a blackish brown lumpy mass. The dye imparts to cotton different shades of tan and brown, which are fast.

**Use as insecticides and pesticides.**

The seeds are considered to be antihelmintic (Upadyay, 2000). They are ground with palm oil and used as poison to kill rats (Goonnasekera *et al.*, 1995). Aqueous extract of leaf is reported to have insecticidal properties (Solsoloy and Solsoloy, 1987). The insecticidal effects of *Jatropha* oil derive from approximately 2 per cent phorbol esters content. *Jatropha* oil and derivative phorbol esters are natural insecticide that can be locally produced and applied. In Ghana, the leaves are used for fumigating house against bed bugs (Upadyay, 2000).

Owing to its multiple uses, there exist unlimited potential. *Jatropha* L. *spp.* is potential in enrichment of soil, plant protectants and has molluscide effects, as non-conventional energy crops also. It is a crop with low capital investment, short gestation period, long productive period, unlimited employment potential in the rural areas; potential for creation of productive assets; boosting of village-based industries; providing non-conventional energy in a decentralized manner and above all having a potential for wastelands development. Generation of employment and capital formation to increase nation's income and quick greening of the country's 175 million hectares (Prajapati and Prajapati, 2005) of the wastelands are the need of the hour.
1.3. Aim of the Investigation.

There are two species of *Jatropha* L. which are found wild and available in North Eastern Regions of India. These two species are *Jatropha curcus* L. and *Jatropha gossypifolia* L. The present investigation included both the species keeping the objectives of study of cytology, floral biology, seed morphometrics and oil content.

Considering the *Jatropha* L. as a potential bio-fuel crop plant, the present investigation was initiated in two species with the following objectives:

(i) To study the karyomorphology and to develop karyotype and idiogram for each species of *Jatropha*.

(ii) To study the floral biology for detail understanding of their functions in the process of pollination. This will be helpful to conduct a planned hybridization programme.

(iii) To study the seed morphometrics.

(iv) To determine the oil content in *Jatropha* L. species.