INTRODUCTION
1.1 Insect plant interaction

Ehrlich and Raven (1964) were among the first to propose a defined ecological role for the plant products as defense agents against herbivorous insects. They proposed that through the process of co-evolution insects are able to detoxify certain defensive agents so that eventually they may become feeding attractants. Such a hypothesis helps to explain the relatively restricted feeding preferences of many types of insects, especially the lepidopterans. Several laboratories initiated research to test this co-evolutionary theory and to attempt to establish a defense role for secondary compounds.

Green plants utilize metabolic pathways and biochemical cofactors for counting carbon dioxide and water to sugars, nitrogen to aminoacids and to synthesize nuclotides, lipids and simple organic acids. These substances are termed as primary metabolites. The primary plant metabolites are the starting materials for the biosynthesis of specific, genetically controlled and enzymatically catalyzed complex compounds known as secondary metabolites (Geissman and Crout, 1969).

It has been very well recognized that secondary plant metabolites serve as important agents in the defense against insect herbivores as they act as insect repellents, feeding inhibitors, and for toxins, thus protecting plants at different phases of growth. These secondary metabolites are synthesized in a dynamic state, as evidenced by their rapid rate of turnover and degradation. The major functions of secondary metabolites in plants are as chemical signals in the ecosystem and as antibiosis agents against insects and pathogens. To perform these functions, a vast array of these compounds are synthesized by plants. There are three major pathways for the production of secondary metabolites in
Plants. They are: 1) the acetate-malnate pathway, (2) the acetate-mevalonate pathway, and (3) shikimic acid pathway.


Major classes of secondary plant metabolites involved in host plant resistance to insects belong to terpenoids, phenolics, flavonoids, quinones, alkaloids, cyanogenic glycosides, glucosinolates, nonprotein aminoacids, carbohydrates / polymers.

Insects have developed resistance to most of the synthetic pesticides and will develop resistance to future insecticides as long as present application techniques and use pattern prevail. This is not surprising when viewed in ecological and evolutionary perspectives. Insecticides resistance is a dynamic multidimensional phenomenon, dependant on biochemical, physiological, genetic
and ecological factors. All of these vary with species, population and geographic locations. Resistant strains developed through the survival and reproduction of individuals carrying altered by one or more of many possible mechanisms that allow survival after exposure to an insecticide. The selective pressure exerted by the insecticide, sharply increases the frequency of the genetic condition expressed as resistance within the exposed populations (Bruttslen, et al., 1986).

Herbivorous insects have co-existed with higher plants for nearly 250 million years. During the co-evolution plants have produced many allelochemicals (as metabolic bi-products) such as alkaloids, terpenoids and phenols for defense against herbivora and pathogens (Frankel, 1958). These chemicals are often appreciably toxic and have favoured the evolution of counter adaptations in behavioral adaptations, modified physiological process and biochemical adaptations.

Insect often rely on complex of general purpose defensive enzymes to overcome the potential toxicity of plants they eat (Brattsten et al., 1986). Plants vary considerably in their food value for different insects and host plant specifically is based on insect nutritional requirements. The nutritional quality of plant tissues does not differ qualitatively but vary quantitatively. The distribution of secondary products particularly phenolic compounds tend to vary in different host plant tissues.

Resistance mechanisms of crop plants appear to operate through the development of several chemicals responsible for non preference mechanisms in resistant plant varieties both for feeding and oviposition which ultimately affect the colonization of the pest species. The utilization of aspects of allelochemicals in herbivore defense has further highlighted the fact that those insect species
which adopt a particular plant as a source of food has to neutralise the barrier is presumably of considerable significance. Since any insect which succeeds in overcoming this chemical barrier has to utilize, expend a lot of energy and detoxifying system continuously to thrive on the host plant.

Various plant species not only exert strong influence on the growth and nutritional physiology of insects (Reese, 1977) but also on the detoxification system because of their constituent allelochemicals. Induction of detoxification enzyme system as a result of feeding on particular host plant has been demonstrated in several insect species.

Majority of the plant allelochemicals effectively disrupt the life cycle pattern of insects. Nearly 72 plant species have been reported to serve as food plants for castor semilooper *Achaea janata* L. This capability of *Achaea janata* L. to utilize successfully such a wide range of host plants indicates unique physiological and biochemical adaptability.

India is one among top seven countries in the world in the cultivation of castor (*Ricinus communis*) plant for oil production. Annually it is grown over an area of 13.99 lakh hectares with a production of 12.49 m. tonnes (Anon, 1993a). There are as many as 30 other castor cultivating countries. Among them, Brazil, China, Soviet Union, The United States of America and Thailand are the major ones as they account for nearly 85 percent of the world production. Castor oil production not only sustains but also has been the cause for expansion of industrial growth in lubricant, soap, chemical and pharmaceutical production. It earns foreign exchange of the tune of more than 300 crores during 1993-94 by way of exporting oil hence emphasizing the importance of crop to the national economy. India is the first in the world to exploit hybrid vigor for elevating the
productivity. Major castor growing states in the country are Gujrat, Andhra Pradesh, Karnataka and Rajasthan which amounts to 98 per cent of the total production from 93 per cent of the castor area. Karnataka takes third position with the production of 17,700 tonnes from 22,200 hectares (1993-94) (Anon, 1995).

Among biological constraints in the castor production, undoubtedly insect pests dominate the scenario. Although more than 107 insect pests and mite species have been recorded so far, castor semilooper, *Achaea janata* L. castor shoot and capsule borer, *Dichocrosis punctiferalis* (Gvenee) ; leafhooper, *Empoasca flavescense* (Fabricius) are of greater economic importance. In recent years serpentine leaf miner, *Lyrimyzes tirfoliy* (Burgess) is also becoming serious on this crop. But its economic importance is yet to be clearly established. Besides, several hairy caterpillar like *Spilosoma obliqua* (Walker), *Euproctis sps. Pericalia ricini* Fabricious, *Amsacta albistriga* Walker also assumes regional importance and are sporadic pests. Among these the semilooper appears to cause more damage to the crop and defoliate the plants to the maximum extent and also destroy the fruits by sucking the sap.

Castor semilooper is the main and major pest in the rainfed area of Andhra Pradesh and Karnataka. The loss caused by this pest is so severe that it is imminent to take up control measures. This pest occurs regularly every where in the country wherever the castor crop is grown. Being a polyphagous pest it is known to attack important oil seed crops namely castor, ground nut and also other important commercial and ornamental crops which amount to 70 plus. The host plant plays the important role in maintaining the continuity of the pest throughout the year. This pest is one of the uncommon amongst pests whose
larvae as well as the adults have become pests of economic importance. *Achaea janata* is distributed from India to Hawai and Eastern Island and from Formosa and Newzealand. It is a major defoliator of castor in India, Thailand, Malaysia and Australia. Neonate larvae nibble only the epithelium of the leaf, second instar damages the leaves by making holes and the third and later instars defoliate the green foliage completely leaving only veins and midribs. Defoliation in the early stages restricts the growth of the plant and in the later stages affect the growth and development of capsules and seeds. In heavily infested fields complete destruction of the crop is very common.

Besides castor, the larvae also feed on the leaves as well as sprouts of pomegranate, ber, rose etc., in the adult stage the moth suck the sap and damages the fruits of citrus, guava, pomegranate etc. Thus in the light of multiple types of damage caused by the pests, it has assumed serious status in the dry land horticultural crops grown adjoining castor fields in Andhra Pradesh and Karnataka.

Inspite of serious damage caused by the pest, systematic efforts have not been made to study the off season activity, carry over of pests (make critical estimations of crop loss) based on the phenology of the crop. Though castor semilooper is attacked by good number of natural enemies, egg parasitoid *Trichogramma chilonis* Ishii, larval parasitoid, *Microplitis maculipennis* and *Zepigate* and some of the microbial agents exert greater biological resistance, the information on toxicity to its potential biocontrol agents is not much. Exploration for use of plant products in the management of pest is very much limited to very rear mentioning.
There is a need to have in depth knowledge of, off season activity, carry over of pest and extent of losses caused by the pest to have stable and sustainable integrated management of this pest. Evaluation of botanicals, microbial agents and new toxicant molecules against the pest and its potential parasites viz., *T. chilonis* and *M. maculipennis* are most needed to formulate sound IMP module or package to control the pest problem. Introducing the modules, perhaps, a sustainable management technology be advocated to the growers of castor and dry land horticulturists.

Insect pests, diseases and weeds are important biotic constraints inflicting 20 – 25 per cent loss in the production of castor seeds. Synthetic pesticides have of course played a very significant role in restricting many pest problems. However, their indiscriminate use has taken its toll by creating several problems like pesticide resistance in insects, contamination of produce by toxic residues, resurgence of pests and effects on non-target organisms. The availability of the effective pesticides is dwindling day by day, further leaving less choice, among which to choose. These ill effects of synthetic pesticides have aroused interest in alternate methods of plant protection.

**1.2 Importance of botanicals**

Bio-active products of plant origin being less persistent in environment, easily biodegradable, safe to mammals and other non target organisms have therefore become the focus of attention today. Botanicals though were the oldest group of insecticides were over shadowed for a long time but now have received renewed outlook as an effective component in the integrated approach to control pest species.
Botanical pesticides are plant derived, natural products, belong to the group of so called secondary metabolites, which include thousands of alkaloids, terpenoids, phenolic compound and minor secondary chemicals. These chemicals have their biological activity with insects, nematodes and phytopathogenic fungi. Almost every plant species has developed a unique chemical complex that protects it from pests. The use of botanical pesticides for protecting crops from insect pests has assumed greater importance in recent years all over the world due to the growing awareness of harmful effects of synthetic insecticides. Now the study of natural pesticides contributes to the novel approval in control strategies of pests.

Investigations throughout the world are engaged in exploration of fauna for biological activity. It is estimated that only 15 per cent of the plant species have been suggested for biologically active compounds. Ahmed and Grainge (1988) listed 2121 plant species possessing pest control properties. The plant species listed out as potential pest control material include neem, sweetflag, cashew, custard apple, sugar apple, derris, lantana, ryania, groundnut, agave and crown plant etc. Grainge et al., (1988) listed 1005 species of plants having biocidal properties to insects including 384 species as antifeedants, 297 as repellents, 97 as attractants and 31 as growth inhibitents. This is clear cut indication that the plant kingdom is a storehouse of useful phytochemicals.

The most promising botanicals for use at the present time belongs to Meliaceae, Rutaceae, Asteraceae, Annonaceae, Sabitaceae and Canvellaceae, (Amason et al., 1989). One factor that has deterred the commercialization of natural products in the past have their complex structure and difficulty in their synthesis.
Botanical pesticides are readily available in many places, offer cheaper than their synthetic counter parts and their crude extracts are easy to prepare even by farmers themselves they are also less likely or slower to result in the development of resistance or resurgence of pests.

Among the potential plant species exploited, for insect control, neem takes a distinctive position. Though the neem has been used in pest control since time immemorial. Renewed out look towards this botanical has made possible to use the neem as an ecofriendly pesticide in the integrated management of noxious pest species. Plenty of neem trees are available in India, there is no dearth of plant material for the manufacture of an effective and non toxic neem product for use in the agriculture.

India has a vast wealth of plants, which are rich source of bioactive compounds and several more might still be lying unexplored. Potentiality of such plants were studied by many researchers. Leaf and fruit extracts of ber (Aegle marmelos), leaf extract of noochi (Vitex negundo) (David et al., 1988), opuntia and jetropha are effective against some pests. Leaf extract of pongemia (Pongmia pinnata) and noochi are also used to control pests of stored products and garments. Adattoda vasica, sweetflag (Acorus calamus), milk weed (Calotropis gigantea) also contain some toxic compounds which are effective against various pests.

Holihosur et al., (1996) reported that the leaf of the hedge plant Clerodendron inerme glabra contains juvenomematic activity on castor semilooper Achaea janata L. They have also reported that Bogainvillae glabra and Vitex nigundo and Lantana camara possess insecticidal activity. The cold
alcohol extraction method is suited for extraction of the toxin to the maximum extent.

The preliminary observations in our laboratory has also indicated that notorious weed plant the *Eupatorium* sps. possess insecticidal property and the cooked extract was also found to be quite effective. Singh and Upadhya (1993) have reported high mortality with natural products like lemon grass with geranium oil amongst the third and fourth instar larvae of the mosquito *Aedes aegypti*. With this back ground an attempt is made to explore the possibility of use of hedge and weed plants other than neem against the castor semilooper *Achaea janata* a notorious pest of castor with the following objectives.

### 1.3 Objectives

- To screen some plants for their insecticidal activity.
- Standardisation of the easy extraction procedure.
- To evaluate the different plant extracts for their varied activities.
- To fix the effective dose.
- To prepare formulations by using adjuvants and study their bioefficacy at the laboratory level.