2. LITERATURE REVIEW

2.1 The Important of Diversity

Ecological research has revealed that insect attacking is often more severe on plant grown in monoculture than in crop mixture or in diverse natural vegetation (Cromartie 1991). Several records of pest outbreaks have been related to the use of monoculture (Altieri and Gliessman 1983, Conway 1987). Root (1973) indicated that cropping systems are providing concentrated resources and uniform physical conditions that encourage insect invasions. He added that herbivorous insect pests are more likely to colonize and remain longer on crop host that are concentrated in these simple environments. As a consequence populations of specialized pest attain economically undesirable levels (Altieri 1987). Altieri (1987) pointed out that insect pests are frequently less abundant in policultures than monoculture. Risch (1983) reviewed 150 published studies and found that 53 percent of the pest species in the survey were less abundant in polycultures, 18 percent were more abundant in polyculture, 9 percent showed no difference and 20 percent showed variable response. Risch (1983) compared insect species associated with sweet potato monocultures and polycultures in Costa Rica and found more natural enemies and fewer herbivorous insect individuals in policultures. In experiments conducted in the Philippines, spider prey more heavily on maize borers when maize was grown in association with peanut than in monoculture (Litsinger and Moody 1976).

Pest reduction in policultures have been reported by Murdoch (1972), Litsinger and Moody (1976), Risch (1981), Altieri and Letourneau (1982), Altieri (1983), Risch (1983), Altieri et al. (1986), Conway (1987), and Altieri (1988). Root (1973) reported that the herbivorous insect pests are more likely to colonize and remain longer on crop host that are concentrated in uniform physical conditions in monocultural systems. As a result, population of specialized pests attain economically undesirable levels. Altieri et al. (1987) inferred that the specialized insect pests will be less abundant in polycultures when the mixtures are composed of host and nonhost crops. Specialist pests will have a more difficult time locating, remaining and reproducing on their preferred hosts when these plants are more dispersed spatially and masked by the confusing visual and chemical stimuli presented by associated nonhost crops. They also reported that, in Colombia, beans intercropped with corn had fewer leafhopper adults E. Kraemeri and Moore than monoculture beans. The lower incidence of the fall armyworm Spodoptera frugiperda (J. E. Smith) lower in polycultures than in monocultures has been reported by Risch (1981).

Planting of a different varieties of crop species in the same field as the main crop is known as interplanting. Arthropod pest damage in the main crop can be reduced if the interplanted habitat interferes with pest colonization of the main crop and provides a reservoir for natural enemies (Donald et al. 1986). Altieri and Liebman (1986) showed some possible effects of intercropping on insect pest populations.

Examples included were: (1) crop background: certain pest prefers a crop background of a particular color and texture. For instances, aphid Brevicoryne brassicae Linneaus., flea beetle Phylotreta cruciferae (Goeze), and cabbage butterfly Pieris rapae Linneaus. are more attracted to cole crops with a background of bare soil, (2) masking or dilution of attractant stimuli: presence of nonhost plants can mask or dilute the attractant stimuli of host plant leading to a breakdown of orientation, feeding and reproduction processes of flea beetle P. cruciferae on collards, (3) repellent chemical stimuli: the populations of diamondback moth Plutella xylostella Linneaus were repelled from cabagge/tomato intercrops due to the aromatic odors of certain plants disrupted host finding behavior. They added that crop mixtures enhanced natural enemy complexes because of the diverse habitats offered many important requisites for adult predators and parasites, such as nectar and pollen sources, which are not available in a monoculture. Thus, reducing the probability that they will leave or become locally extinct. Cromartie (1991) inferred that the combination of plants can decrease economic loss by shifting insect feeding to valuable crop in intercropping as the stem borers Ostrinia spp. in a maize/sorghum intercrop preferred to attack the tallest plants of both species, resulting in less yield reduction in mixed cultures.

2.2 Management of Some Major Insect Pests of Mungbean

Mungbean, Vigna radiata (L.) Wilczek has become one of the most important economic crops in Thailand (Prabhavat 1990, Sepswasdi et al. 1989). The estimated area of mungbean under cultivation in Thailand is about 450,000 hectares and total annual production is approximately 250,000 tons (Chainuvati and Charnnarongkul 1990). About 100,000 farm families grow mungbean for their consumption and as a cash crop for additional income (Chainuvati et al. 1987). In the central and northern part of the country, the major mungbean growing season is from August to September when it follows maize in the upland areas (Chainuvati and Charnnarongkul 1990). The dry season mungbean is grown in irrigated land after rice. Current yields are, however, considerably low with average about 600 kg per hectare (Chainuvati and Charnnarongkul 1990). Many factors have effected the low yield, such as poor management practice and major insect pests (Chainuvati and Charnnarongkul 1990). The major cropping patterns in early rainy season are mungbean-soybean, mungbean-corn, mungbean-peanut, mungbean-cotton, mungbean-sorghum, mungbean-blackgram, mungbean-sesame. In late rainy season, maize-mungbean, peanut-mungbean, soybean-mungbean, sesame-mungbean are the major cropping system (Chainuvati and Charnnarongkul 1990). In dry season mungbean is grown in irrigated land after rice (Chainutvati et al. 1987).

Damage to insect pests still remains one of the most serious production constraints in mungbean (Sepswasdi et al. 1989). The following species are found associated with mungbean in Thailand, and many tropical countries: (1) the agromyzid flies, Ophiomyia phaseoli Tyron and (2) Melanagromyza sojae Zhentner, (3) the pod borer, Maruca sp., (4) the green stink bug, Nezara viridula Linneaus, (5) the cutworm, Spodoptera litura Fabricius, (6) the aphid, Aphis craccivora Kock and (7) the thrips, Megalurothrips usitatus Zehntner (Chainuvati et al. 1987, Sepswasdi et al. 1989, Quyen 1987, Tri 1987). Sepswasdi et al. (1989) noted that the infestation of cutworm, S. litura and M. usitatus during the end of vegetative to pod filling stages were resulted in yield reduction.

In Northern Thailand insect pests on mungbean have been routinely controlled with insecticides (Potan 1987). Since chemicals still continue to be the major means of defense against the insect pests of mungbean in northern Thailand, the consequence of using these chemicals have been reported by many workers (Hengsawad and Hengsawad 1983, Cayme 1990, Titayavan 1990, and Potan 1987). Thus, a search for alternative control practices which reduce the use of pesticides is required for integrated pest management programs. Several studies indicated that intercropping mungbean with pearl millet, Pennisetum americanum Linneaus; tomato, Lycopersicon esculentum Linneaus; okra, Hibiscus esculentus Linneaus; ricebean, Vigna umbellata Thunb. Ohwi and Ohashi; cowpea, Vigna unguiculata Thunb., soybean, Glycine max Linneaus;

black gram, Vigna mungo Linneaus or watermelon, Citrullus lanatus Thunb. can significantly reduce beanfly Melanagromyza sp. infestation (AVRDC 1981a, 1981b). Sehgal and Ujagir (1987) inferred that intercropping mungbean with non-host plants like sorghum or pearl millet decreased the incidence of bean leafhoppers Jassids spp. and other pest population. Jayaraj (1987) reported that mungbean cultivar CO 4 intercropped with cotton MCU 10 recorded a minimum incidence of leafhopper Empoasca sp. and Thrips spp.. He also recorded that the predatory coccinellid, Menochilus sexmaculatus Fabricius presented in all stages of its development on mungbean preying primarily on sucking pests. Sehgal and Ujagir (1987) reported that 26 species of parasites, predators in mungbean mixed culture. In Thailand, Poonsavasde et al. (1990) reported that about 54 % of the egg masses of the one-banded stink bug Piezodorus hybneri Gmelin was parasitized by Telenomus sp. and Trissolcus sp. in mungbean mixed culture throughout the season.

2.3 Management of Some Major Insect Pests of Upland Rice

A large number of insect species have been recorded as associating with upland rice in the field. Some cause damage regularly, whereas others are only occasionally important including ant, Pheidole sp., termite Odontotermes sp., Chaetocnema basalis (Bally), Snout weevil Hypomeces squamosus Fabricius, Lachnosterna sp., Melanotus sp., Oxya spp., Locusta migratoria manilensis (Meyon), stemborer, Chilo polychrysus (Meyrick), and rice bug,Leptocorisa acuta Thunb (Chantratat

1992). Among these pests ant, Pheidole sp.; snout weevil, H. squamocus; stemborer, C. polychrysus; rice bug, L. acuta have been reported as the major insect pests of upland rice Northern Thailand (Titayavan 1986, Chuntratat 1992). Numerous management practices of these insect pests have been introduced to the farmer, such as furrowing the field several times before sowing rice seed, good weeding management during tiller stage to control of insect larvae, and praying or coating seed with insecticides (Chuntratat 1992). Hengsawad (1986) reported that Agrionidae, Coccinellidae, Reduviidae, Carabidae, Staphylinidae, Miridae and spiders have been the most common and widely distributed predators of the insect pests of upland rice in Northern Thailand.

2.4. Management of Some Major Insect Pests of Maize

In Thailand, there are numerous species of insect pest attacked different parts of corn in the field during wet season annually, namely, beet army worm Spodoptera exigua (Hubner), corn borer Ostrinia furnacalis Guinee, corn leaf aphid Rhopalosiphum maidis (Fitch), and corn earworm Heliothis armigera (Hubner) (Kongkanjana 1992 and Jamornmarn 1987). These insects cause damage to the corn by feed on seedling, leaves, corn flowers, corn ears or bore into the stem resulted in corn yield reduction. A range of 16.8% - 45% annual yield reductions has been reported by Kongkanjana (1992). He also reported that eggs of stem borer were parasitized from 41.7 - 47.8% in corn intercropped with legume crop whereas in corn mono crops 8.6 to 16.1 % of eggs were

parasitized. This has been resulted in reducing infestation of stem borer. Jamornmarn (1987) and Kongkanjana (1992) reported that as high as 80% of eggs of the army worm in Thailand were parasitized by Trichogramma australicum Girault. They also found that predators such as Chaysopa bacalis Walker; Proreus simulans Stal; Anthicus ruficollis Saund preyed on larvae of stem borer and decreased 76.7% of population. The reduction of aphid population was found to associated with the population of the coccinelid beetles Menochillus sexmaculatus Fabricius; Miscraspis discolor Fabricius and syrphid fly Syrphus sp..

2.5 Management of Some Major Insect Pests of Sorghum

The sorghum shoot fly Atherigona soccata Rondani, leaf aphid Melanaphis saechari Zehntner, Mythimna seperata Walker Heliothis armigera (Hubner) have been recorded to associate with sorghum in the field (Chawanapong and Jumroernma 1992). They pointed out that the sorghum shoot fly A. soccata remain as a major pest of sorghum in Thailand. The maggot feeds within the growing point of the plant causing a deadheart symptom. Approximately 0.63 % of yield is lost for each one percent increase in deadheart. Most control of sorghum shoot fly is by pesticides. Resistant sorghum varieties for controlling sorghum shoot flies are potentially useful in the control of sorghum shoot flies (Phisitkul et al. 1981). Phisitkul et al. (1981) stated that the complex of natural enemies, namely Reduviidids (Assassin bug), Chilomenes sexmaculatus Fabricius, Trichogramma sp.. Assassin bugs and

Dolichopodids (Long legged flies) were responsible for the reduced severity of these pests.

2.6 Management of Some Major Insect Pests on Sesame

There are various insect pests which attack different parts of sesame plant in the field. Among these insect pests, simsim webworm Antigastria catalaunalis Dup., gall midge Asphondylia sesami Felt., and flea beetle Aphondylia sp. have been recorded as a major pest of sesame (Acland 1980). In Thailand, simsim webworm, A. catalaunalis Dup. is one of important pest of sesame (Sattayavirut 1992). The larvae of simsim webworm attacks sesame by spinning a silken web around the terminal leaves and feed on the foliage and pods. Sattayavirut (1992) reported that chemicals still continue to be the major means of defence against these pests.

2.7 Possible Effects of Mixed-Cropping Systems on Insect Pests of Mungbean

Several theories to explain the reduction of pest in diversified plant systems may be applied to insect pests of mungbean in mungbean mixed cropping systems. Diversified plant stands are often found to have a richer fauna than sole crops because not only there are more food resources for herbivorous species but also higher population of predaceous arthropods which will have a stronger controlling impact on

the build up of a potential pest (Pimentel 1961, van Emden and Williams, 1974, Price and Waldbauer 1975). Way (1975) stated that the barriers or hazards to insect dispersal is an " outstanding and fundamental component of insect pest control ". This mechanical barriers interfere with pest dispersal behavior and decrease colonization efficiency which in turn results in lower population densities on the crop (Tahvanainen and Root 1972). Risch (1979) showed that non host plants interfered with the behavior of leaf feeding Diabrotica beetles. Upon colonizing a field composed of both non host and host plants, the beetles flew off again from a non host, perhaps out of the field. High relative humidity and more shade caused by dense crop stands which are favor in general entomophagous fungi and spiders have been reported by Perin (1977) and Ruhendi (1980). No literature relating to the insect species diversity in monoculture and mixed culture of mungbean with upland rice, corn, sesame or sorghum has been published in Thailand.