CHAPTER V

DISCUSSION

5.1. Effects of intercropping on the population density of the sweet potato weevil (SPW)

5.1.1. Effects of intercropping on number of SPW and on percentage of damaged tubers

The low percentage of SPW colonizing sweet potato intercropped with corn and/or soybean (Table 7) suggests that intercropping may have affected its host searching behaviour. For example, percentage colonization by SPW, number of SPW per plant, and percentage of damaged tubers in the sweet potato monoculture was 7, 16, and 8 times that in the sweet potato + corn mixture, respectively (Table 7 & 8). Similar high levels of damage in sweet potato monocultures were also reported in Papua New Guinea (Sutherland 1986[b]). However, number of tubers per plant, weight of fresh tubers per 10 plants, and total value of the marketable yield in the monoculture were 3, 7 and 3 times that in the sweet potato + corn + soybean mixture and 3, 3 and 2 times that in the sweet potato + corn mixture, respectively (Table 9 & 10). For farmers who grow sweet potato primarily for home consumption, the monoculture would be attractive, because of the higher production of tubers which may give them a marketable surplus. The monetary index (MI) used to determine yield advantage of the different treatments (Table 10), illustrates that the greatest profit was obtained by growing sweet potato as a monoculture (treatment A), and then when intercropped with soybean (treatment C), resulting in a net gain of Can. $ 1269/ha and Can. $ 74/ha, respectively.

Thus, although the mixtures, particularly those including corn, were effective in reducing numbers of SPW, they were uneconomic, especially when they included both corn and soybean.

The low percentage of colonization and low number of SPW in intercropped sweet potato is probably a result of physical and biological effects of the intercropped plants on the weevils' activity, growth and development (Perrin 1977, Altieri 1987). The taller corn and soybean plants may act as physical barriers against SPW invasion of the sweet potato crop. Presumably, the SPW either moved away from the intercropped sweet potato to a more suitable location or had to spend extra time and energy to find the crop (Kareiva 1983). In a corn + bean mixture, Parfait & Jarry (1987) found that corn made the microclimate unfavorable for the bean weevil and modified the bean's phenology. Similar effects may be partly responsible for the reduced of SPW population in the corn + sweet potato mixture in the present study.

Furthermore, it is suspected that during the extended period of host searching in the intercropped systems, SPW would have been exposed to various environmental pressures, including higher population density of natural enemies (Kareiva 1983, van Emden 1990). Although, in the present study the natural enemies were not studied quantitatively, they were recorded in both the sweet potato agroecosystems and the surrounding area. For example, preying mantids, which are general feeders (Hollingsworth & Idoine 1992), were often seen searching for prey on the sweet potato foliage, although their effects on SPWs were not evaluated. Also, chickens from a nearby village were commonly seen searching for insects in the area surrounding the plots. Thus, the SPW would have been vulnerable to attack by these and other natural enemies while searching for a suitable host.

Predators and parasites are usually more abundant within mixtures than in monocultures (Perrin 1977, Altieri 1987). This may account for much of the reduction of the populations of SPW within the mixtures.

SPW orients to its hosts by means of chemical cues produced and released by the sweet potato leaves and tuber skin (Notthingham et al. 1988). In intercropped sweet potato fields, however, such chemicals may be masked by other chemicals from the intercrop plants, thereby making it more difficult for the SPW to locate and recognize its host.

5.1.2. Level of attack by SPW in relation to tuber formation.

Intercrop plants may affect the growth and development of the sweet potato crop, thereby making it less attractive to SPW.

The sweet potato that attracts SPW is released chemical during the formation of new tubers, which occurs between 28 and 56 DAP (Wilson & Lowe 1973, Wilson 1982). Because intercropped sweet potato probably receives less light than in monoculture, the resultant delayed tuber formation would also delay release of the attractant, and therefore effect the movement of SPW towards its host.

The low number of tubers per plant, and the low weight of fresh tubers per 10 plants in sweet potato intercropped with corn were most likely caused by the lack of light that resulted from shading by the corn plants. Hahn (1977) found that a lack of light caused a decrease in the net assimilation rate and dry matter production, especially in the form of tubers. Moreno (1982), found that intercropping sweet potato with corn in Guatemala reduced sweet potato yield by 63 percent; whereas Roberts et al. (1983), found that in Trinidad the reduction ranged from 10 % to 44 %. Variations in yield were related to rainfall, the sweet potato cultivar, planting date and crop spacing (Roberts et al. 1983).

In the present study, yield was lower when sweet potato was intercropped with corn than with soybean (Table 9), presumably largely because of the greater shading effect of corn. Soybean may also have provided additional nitrogen to the sweet potato. This possible benefit, however, was not evident when sweet potato was intercropped with corn and soybean (treatment D; Table 9), probably because of competition from the corn for limited resources, particularly light, nutrients, water, and space; and under these conditions the sweet potato plants produced only a few and mostly small tubers. Therefore, although intercropping reduced the number of both pest insects and damaged tubers, it also resulted in a greater reduction in marketable yield.

Because of the lower numbers of SPW in the corn + sweet potato mixture, intercropping with corn seems to be the most promising strategy for control of SPW, and should be investigated further, but the 60 % reduction in economic value of marketable yield provides a considerable challenge to be overcome.

Until intercropping systems are found that both reduce pest damage, and produce higher or comparable yields and levels of profit to monoculture, the latter is likely to be preferred by farmers in Irian Jaya.

Among the intercropping systems examined in the present study, the sweet potato + soybean mixture (treatment C) is the best choice for increasing income and meeting nutritional requirements of the indigenous people in both the lowland and highland regions of Irian Jaya.

The introduction of soybean into an indigenous sweet potato cropping system in Irian Jaya presents several advantages. (1) Because soybean roots are infected with the nitrogen fixing bacteria, Rhizobium, their presence can increase the amount of nitrogen in the soil available to the sweet potato. (2) Protein-rich soybeans would also enhance the nutritional quality of the indigenous diet. The nutritional value of soybean has not yet been recognized, however, by Irian Jaya's indigenous sweet potato farmers (La Ahmady 1988), who still primarily regard soybean as a cash crop. (3) The soybean crop by providing the farmers with a second marketable commodity would help them to diversify their production base (Kass 1978). (4) The failure of one crop within an intercropping system as a result of adverse environmental conditions, such as drought, pests, or disease, can be compensated for the other crops (Kass 1978, Beets 1982). Thus, intercropping may provide yield stability, because an alternative crop may be a critical asset when the main crop is compromised by poor weather or other environmental stresses. (5). Soybean and sweet potato intercropped together appear to harbour fewer insect pests, diseases and weeds than when both crops are grown in pure stands.

5.2. Number of insect and spider families associated with sweet potato agroecosystems

The number of insect and spider families in the intercropped sweet potato systems were generally higher than in the sweet potato monoculture. Results indicate that the insect and spider population is more diverse in intercropped sweet potato than in a sweet potato monoculture and that this diversity changes with crop phenology.

This increase in arthropod diversity in intercropping sweet potato plots may simply represent the addition of the faunas of the component crops . An individual crop and its associated phytophagous fauna (usually specialized insects) in an intercropping system may directly or indirectly provide chemical cues attracting natural enemies (Price 1986). Predators and parasitoids, for example, may search and attack their host in the intercropping systems, based on the attractive body odor released by phytophagous insects. Also, they may find the phytophagous insects indirectly through chemicals released by the host plant on which their potential prey or host is feeding (Price 1986). Therefore, an individual crop and its associated fauna in sweet potato cropping systems may result in a higher number of insect species in intercropped systems (Risch et al. 1983).

There are numerous parasitoids and predators associated with insect pests of sweet potato and the other intercrops. For example, trichogrammids are known to parasitize the sweet potato horn worm, Herse convolvuli, L., and the Asian corn borer, Ostrinia furnacalis Guinee (Nafus & Schreiner 1986). The latter is also attacked by braconids, ichneumonids, chalcidids, eulophids, tachinids and by predators such as Orius spp.(Hemiptera: Anthocoridae), Chelisoches spp. (Dermaptera: Chelisochidae), and other insects and spiders (Nafus & Schreiner 1991). Many parasitoids and predators associated with each species of insect pest, will have contributed to the higher insect diversity found in the intercropped sweet potato systems.

Even though the diversity of the arthropod fauna in an intercropped system is generally higher, the population density of each species of herbivore, however, is generally lower (Risch et al. 1983, Letourneau 1990). This is illustrated in the present study, where a smaller population of the spotted tortoise bettle, Aspidomorpha sp., a leaf-feeding insect exclusively associated with sweet potato, tended to be lower in the intercropped systems than in the monoculture (Fig. 17). Even though reasons for the lower population of the beetle in the intercropped sweet potato were not determined, previous research has shown that intercropping frequently causes dramatic decrease in a pest population (Pimentel

1961, Root 1973, Dempster & Coaker 1974, Perrin 1977, Karel et al. 1982, Altieri & Letourneau 1982, 1984, Cromatie 1983, Altieri & Liebman 1986, Tingey & Lamont 1988, van Emden 1990). For example the population densities of Empoasca fabae (Harris) and Aphis fabae Scopoli, were significantly less in plots intercropped with winter wheat than in those grown in monocultrure (Tingey & Lamont 1988). Similary the reduction of the population of the diamond-back moth, Plutella xylostella (L), was significantly less in plots where cabbages were intercropped with tomatoes (Buranday & Raros 1975). These authors also noted that intercrop plants acted as effective physical and biological barriers to insect pest infestation. However, the mechanisms in which intercropped plants prevent infestations are not always similar for all species of insects.

In the case of the spotted tortoise beetle, two hypotheses as suggested by Root (1973), may be used two explain the beetle's lower population density in intercropped sweet potato: the resource concentration hypothesis and the natural enemies hypothesis. The first hypothesis predicts that specialized insect pests will be less abundant in intercropped systems when the mixtures are composed of both host and non-host crops (Sheehan 1986, Altieri 1987). Therefore, in the present study, the spotted tortoise beetle, a specialist pest of the sweet potato crop, may have had a difficult time locating, remaining on, and reproducing on the sweet potato crop; the corn and soybean plants may have acted as physical barriers limiting movement of the beetle into or within the sweet potato plants. The beetle also may not have recognized the sweet potato plants because of chemicals produced by the other intercropped plants masking those of the sweet potato (Altieri 1987).

The second hypothesis states that high vegetation diversity improves conditions for natural enemies by providing a variety of habitats, and abundant food and shelter, resulting in increasing their numbers and efficiency in intercropping plots. For example, intercropping systems can provide more pollen and nectar sources that attract natural enemies and increase their reproductive potential (Sheehan 1986, Altieri 1987). Intercropping systems can also increase ground cover which favors certain predators such as carabid and staphylinid beetles, centipede and various arachanids, and can increase diversity of herbivorous insects, which can serve as alternative food sources for natural enemies, making them less likely to leave when the main pest species are rare (Altieri 1987).

In the present study, the spotted tortoise beetle may have been regulated by an increased number of natural enemies in the intercropped systems as compared with the monoculture. For example, chalcid wasps and encyrtinid hymenopterans that parasitize the oothecae and larva, respectively (Simon Thomas 1964, Kalshoven 1981), may be more abundant in the intercropped sweet potato, which provides a more enriched microenvironment for their development, than in the monculture.

The spider, Lycosa sp., was more abundant in the intercropped systems than in the monoculture, and numbers increased over time, reaching a peak at 56 DAP. Spiders are considered as pioneer arthropod species readily colonizing new habitats (Bishop & Riechert 1990). Their role in the present sweet potato cropping systems was not clearly defined, but spiders are commonly known as effective natural enemies (Bishop & Riehert 1990).

The larger spider population in the intercropped treatments may be, in part, accounted for by a more abundant and diverse population of insect prey found in these agroecosystems, and this would be favorable to the generalist spiders (Riehert & Lockley 1984).