8. CONCLUSIONS

1. While a wide range of insects visits the commercial sunflower capitulum. The most important insects contributing to pollination of sunflower are honeybees and spotted maize beetle, as inferred from their numbers and behaviour and morphological characteristics.
2. The diversity and abundance of anthophilous insects in a region is influenced by many factors, such as surface area of cultivated land, pesticide application and competitive nectar and pollen sources.
3. Though certain solitary bees are very efficient pollinators, their numbers are restricted in the study areas, presumably because of low reproductive rates.
4. Various nocturnal insects visits the sunflower capitulum but their role in pollination is of minor significance due both to their behaviour on the head and low numbers.
5. Daily and seasonal activity curves for honeybees indicated that they are present in sufficient numbers for effective pollination where hives are supplied by migratory beekeepers. Strip counting confirmed the theoretical calculation of one hive per hectare required for adequate pollination in commercial fields (Du Toit, 1987). Birch, et al. (1985) concluded that natural honeybee populations are invariably not adequate.
6. Cross-pollination efficiency of honeybees is very good as more than 50% of foragers land on the outer ring of

florets, moving to the inner ring where fresh pollen is available, before taking off for the next head. Movement between heads is indiscriminate, ensuring good pollen movement.

7. Anderson, et al. (1983) recommended a source of water for Apis mellifera scutellata where beekeepers migrate to summer crops such as sunflower. Water was present at dams in the vicinity of the hives. The importance of a fresh-water source for honeybees is uncertain, as water foraging reached a level of only 2% during the bloom period. No significant drop in nectar foraging was observed in sunflower fields in the studied regions.
8. The pollination efficiency of honeybees is confirmed by controlled cage plots with honeybees as pollinating insects, evaluated against similar cages with no insect pollinators. Cages with honeybees gave a yield of 1859 kg/ha (72% seed set) against 1221 kg/ha (45% seed set) of cages with no insect pollinators. A 52% yield increase was thus obtained with honeybees as pollinators.
9. With controlled cage studies the role of American bollworm larvae and flies were demonstrated to be insignificant. Spotted maize beetle was proved to be an efficient pollinating insect if present in sufficient populations. Their contribution are further restricted by their seasonality and pest status.

10. While quality and quantity of nectar varied significantly between cultivars, nectar accessibility is the most important factor affecting honeybee visits. Accessibility is influenced by plant growth. Lush vegetative growth of plants during seasons of high rainfall will result in large heads with deeper corollas, putting nectar out of the reach of honeybees. To avoid this, planting density should be increased in high rain seasons or areas to limit head diameter below 200mm.
11. Pollen trapping showed maize, grasses, Xanthium and Clematis as major 'other' pollen sources available to honeybees in vegetation surrounding sunflower fields. Mellisophalynology indicated Eucalyptus spp. as major 'other' nectar sources. With existing farming practices, competition from surrounding vegetation can be disregarded.
12. Surrounding vegetation can be important in attracting solitary bees, as these bees showed a general preference for flowers other than sunflower. This phenomenon could become important where the use of managed solitary bees should be attempted or in fields for hybrid seed production. Short-tongued solitary bees (Halictidae) visit sunflower for pollen only, as they can not reach the nectar in the tubular corolla. This, however, limits rather than enhances good pollen movement.