THE EFFECT OF INCREASED PROPOLIS PRODUCTION ON THE PRODUCTIVITY OF A HONEYBEE FARMING SYSTEM

by

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DECLARATION

*I, **ANDRIES JOHANNES DE JAGER** herby declare that this research project submitted for the degree **Master of Technology: Agriculture** is my own independent work that has not been submitted before to any institution by me or anyone else as part of my qualification.*

……………………. ……………….

Signature of student *Date*

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PAGE

ABBREVIATIONS

%	Percentage
Kg	Kilogram
g	Gram
lb	pound
°C	Degree Celsius
m	Meter
mm	Millimeter
n	Quantity
cm^2	Square centimeter
LSM	Least square means
SE	Standard error
r	Correlation
p	Level of significance
Honey C	Honey control group
Honey T	Honey treatment group
Brood C	Brood control group
Brood T	Brood treatment group

Frames C	Frames containing bees in the control group
Frames T	Frames containing bees in the treatment group
Jul	July
Aug	August
Sept	September
Oct	October
Nov	November
Dec	December
Jan	January
Feb	February

PREFACE

The objective of this study was to investigate a method for stimulating increased propolis production in Cape honeybee (*Apis mellifera capencis*) hives. Honey production and pollination services are the main two sources of income for the commercial beekeeper in South Africa. To manage risk it was deemed advisable to investigate the potential of other hive products such as propolis to generate an extra source of income for the commercial beekeeper.

In this dissertation chapter one focuses on giving an overview of beekeeping in South Africa, a description of propolis and its uses as well as the market trends. Chapter two contains a literature review focusing on the factors that affect overall hive productivity such as genetic factors, environmental factors, management factors and colony structure. Chapter three deals with the materials and methods that were used during the study and chapter four discusses the results that were obtained. Chapter five constitutes a general conclusion.

CHAPTER 1

GENERAL INTRODUCTION

Beekeeping is an essential part of South Africa's agricultural industry. Honey and other bee products realise 100 million Rand in South Africa per annum (Langenhoven, personal communication, March 2001), and the added value of pollination from commercial honeybees in South Africa is estimated to be approximately 3.2 billion Rand per annum (Allsopp, personal communication, June 2000).

In recent years there has been a decline in the scope of beekeeping in South Africa. The primary reasons for this is the destruction of habitat and forage necessary to sustain honeybees, increased human populations and urbanization and the effect of pesticides and pollutants (Begg, 2001). Most beekeepers reside in urban areas, frequently moving with their hives in search of flowering plants or suitable bee forage. Beekeepers also face further problems such as theft and vandalism, hives dieing out due to the capensis problem, the rapid spread of Varroa destructor, reduced nectar flows and other pests and diseases such as Argentine ant, Banded Bee Pirate, Honey badgers and European Foulbrood. These problems have led to huge colony losses, which, in turn has resulted in loss of income and made beekeeping in general more expensive.

Besides the normal functions associated with honey production and pollination services, the South African beekeeper is generally unaware of the number of alternative products produced by bees, which can generate additional income. One of these relatively unknown products found in the honeybee colony, is propolis.

Propolis is a mixture of various amounts of beeswax and resins collected by the honeybee from plants, particularly from the flowers and leaf buds. The word propolis is derived from the Greek words: *pro* – which means to be “In front” and the word *polis* – meaning “city”. The function of propolis, is namely to seal and limit the entrance to the beehive. It is commonly believed that propolis is derived from the gummy secretions located on the bark of trees such as pine, gum and cypress trees. In fact propolis is a gum or resin gathered by bees from a variety of sources. Most of these sources, which supply resin for propolis production, are of plant origin. The resins obtained for propolis production are produced predominantly by newly budding flowers (Root, 1947; Anderson, Buys and Johannsmeier, 1993). Although the resin of plants constitutes the largest source of resin for propolis production, Anderson *et al.* (1993) found that bees will substitute plant resins with resins derived from non-plant substances such as paint, tar etc.

The gathering of resins for the production of propolis is a natural process and function performed by the worker bee in the hive. The worker bees use propolis to coat the inside of the nest cavities and brood combs, repair combs, seal small cracks in the hive, reduce the size of the hive entrance and mix small quantities with wax to seal brood cells. These uses are significant because they take advantage of the antibacterial and antifungal effects of propolis in protecting the colony against diseases. Bee Culture Magazine (1997) stated that propolis contains natural antibiotics, which protect the bee colony against diseases caused by bacteria and other microorganisms.

The composition of propolis depends on the type of plants accessible to the bees. Durham (1999) reported that the chemical composition of propolis consists mainly of flavenoids, phenolics and different concentrations of aromatic compounds (Table 1.1). Due to the flavenoid substances obtained from plants, propolis serves as an anti-oxidant, anti-bacterial, anti-fungal, anti-viral and anti-infectious agent. It is these protective agents that make propolis a sought after medicinal product. According to Root (1947) the general physical properties of propolis are that it is brittle when cold, melts at 50 °C, and is readily dissolved in chloroform or ether.

TABLE 1.1: **COMPOSITION OF PROPOLIS**

CLASS OF COMPONENTS	GROUP OF COMPONENTS
Resins	45 to 55% Favenoids Phenolic acids
Waxes and fatty acids	25 to 35% Beeswax and waxes from plant origin
Essential oils	10% volatiles
Pollen	5%
Other organics and minerals	5% 14 Trace minerals Ketones Lactones
Other chemicals	Cinamic Acid Cinnamyl alcohol Vanillin 5,7 – dihydroxyflavone 3,5,7 trihydroxyflavone Acacetin Kaempferid Rhamnocitrin Pinostrobin 5 hydroxy – 7,4 dimethoxyflavone 5,7 dihydroxy – 3,4 dimethoxyflavone 3,5 hydroxy – 7,4 dimethoxyflavone

	5 hydroxy 7,4 dimethoxyfavonol Cafeic acid Tectochrysin Isalpimin Pinocembrin Ferulic acid

(Marcucci 1995; Woisky and Salatino, 1998)

The gathering of resin for propolis production is apparently a function of the foraging worker bee in the hive. The forager gathers and tears off bits of sticky resin from a resin source with the mandibles assisted by the two front limbs. The resin is transferred to the pollen baskets through the use of the front and middle legs. At the hive the resin is transferred to other worker bees that "process" it to form propolis. The pollen sacks are filled with propolis, by loading the pollen sack on one leg first and then the other (Anderson *et al*., 1993). Root (1947) observed that with the arrival of the worker bee at the hive, the propolis is removed from the pollen sacks in the same way as the resin was gathered, by means of the mandibles and front limbs. However, this process is performed by hive worker bees and not by the foraging worker bee. The hive worker bees dispose of the propolis to the designated areas. It can be assumed that in this process of collecting and modelling resins, they are mixed with some saliva and other secretions of the bees as well as with wax. According to Anderson *et al*. (1993) the method of communicating the hive's propolis requirements to the foraging worker bees is not known.

Propolis based products form part of the growing natural health products market in South Africa. According to Primedia (Cliff Calder, personal communication, March 2001) this market has grown from 1.3 million Rand in 1992 to 23.1 million Rand in 1997. The estimated current market is approximately 35 million Rand. Currently 93 percent of the propolis products in South Africa are manufactured by Propolis Health Products, a health line of Yad Mordechai, which is an Israeli company with a local distribution outlet (Du Plessis *et al*., 2000). Local manufacturers and producers make up the other 7% of the propolis products.

Propolis is a product not commonly known in South Africa. Research done by Du Plessis *et al.* (2000) has however, shown that there is an unlimited demand for propolis in the global market. The largest demand for propolis is by Asian countries. Japan is importing 120 tons of raw propolis per annum with a commercial value of 2000 million Yen. Their own production is estimated at 5 tons per annum (Jetro, 2001). The price of raw propolis depends largely on the demand for propolis by Asian countries. The autumn 2000 edition of BEE BIZ reports that propolis has soared to 150 New Zealand dollars per kilogram in New Zealand. In Canada the price of propolis has increased from $ 6 per pound in 1990 to between $ 12 and $ 20 per pound in 2000 (Clay, 2001). The current market rate in Japan is 10,000 yen per kg (Jetro, 2001).

The objective of this study was to investigate a method for stimulating increased propolis production in Cape honeybee (*Apis mellifera capensis*) hives.

CHAPTER 2

FACTORS AFFECTING OVERALL HIVE PRODUCTIVITY

2.1 INTRODUCTION

Proper hive organization is an indication of good hive management, since it has been shown that maintaining a brood area in the bottom box of the beehive and allowing honey storage in the upper supers enhances colony productivity. Increased colony yields are possible only with well-populated colonies in areas with abundant nectariferous flora (Krell, 1996). However, the productivity of well-populated colonies is greatly influenced by factors such as such as genetic composition of the colony, environmental stress, management practices and colony structure. A review of these factors is discussed in this chapter.

2.2 GENETIC FACTORS

2.2.1 Variation in Specie and race

Propolis production: Some bee colonies are more avid collectors of propolis than others. According to Krell (1996) foraging for propolis is known only in the western honeybee *Apis mellifera.* The Asian species of *Apis* does not collect propolis while tropical races of *Apis mellifera* have also been reported as producing very little propolis. This is in contrast with Michener (1974) who concluded that all species of Apis as well as many species of stingless bees collect propolis. Accordingly, stingless bees collect large quantities of plant resins, saps and gums which are incorporated with beeswax to make cerumen for nest building. Adam (1983) found that the Carniolan bee collects less propolis than other European races of bees. The Italian bee *Apis mellifera ligustica* also collects very little propolis (Philips, 1928). Rultner (1988) reports the behaviour of the Iberian bee *Apis mellifera iberia* as having a quick defence reaction, being nervous on the comb, a heavy user of propolis and propensity to swarm. According to Krell (1996) bees, which produce lager quantities of propolis, could be selected if required.

Honey production: Different species of stingless bees are native to tropical Asia, Africa, Australia and America. In America and Africa they are kept in hives for their honey. According to Graham, (1993) *Apis dorsata*, of which the nest consist of only one comb, produce a substantial amount of honey and in many countries of tropical Asia more honey is harvested from wild nests of *Apis dorsata* than from hives of *Apis cerana* or *Apis mellifera*. Graham further states that the comb of the little bee *Apis florae* yields only a few pounds of honey. It was reported by Adam (1951) that the Carniolan bee is an excellent honey producer and comb builder and caps the cells of honey with paper white wax cappings.

Brood production: The amount of brood produced may vary in different species of bees. *Apis cerana* does not produce as large a colony as *Apis mellifera* and is thus subsequently kept in smaller hives (Kapil, 1971).

The Carniolan bee maintains a large brood nest during the summer if pollen is available (Adam, 1951). Philips (1928), Park (1938) and Goedze (1964) stated that the Italian bee's (*Apis mellifera ligustica*) strong disposition to brood rearing results in large colony populations which are able to collect a considerable amount of nectar in a short period of time. According to Ribbons (1953) the Italian bee increased brood rearing during nectar flows, but bees of the Caucasian strain fill the brood chamber with nectar and reduce the egg laying of the queen.

2.3 ENVIRONMENTAL FACTORS

2.3.1 Temperature and season

Propolis production: Temperature has an influence on propolis production because the bees use propolis to insulate and protect the hive from the external environment. Iannuzzi (1993) found that propolis is deposited at a greater rate on a propolis trap if it is placed on the cold face (the side that receives very little warmth from the sun) of the hive. Orgen (1990) states that in cooler regions bees are prone to propolise the hive a great deal more than in warmer regions.

Temperature also influences the rate at which propolis is collected by the worker bees. Increased temperatures soften the waxes and resins of plants making them more pliable and easier for the bees to process and manipulate. Iannuzzi (1983) stated that bees start working late morning and discontinue early afternoon. On a very hot day they may start working sooner and continue later. According to Root (1947) bees have not been observed collecting propolis in the early morning hours, when temperatures are low. However, as the temperature rises during the day, the number of worker bees collecting propolis tends to increase. This is in contrast to pollen collection, which occurs early, and late in the day.

Root (1947) states further that propolis is predominantly gathered during the summer months. However, an increase in propolis production towards the autumn months has been reported. According to Krell (1996) it is possible that propolising will be more active at the beginning of the raining season. This can be ascribed to the bees preparing for the cold winter. By insulating the hive from the external environment and regulating the temperature inside, the hive becomes easer to regulate. In contrast, Bonney (1995) ascribed this increased propolis production in the late summer to be a normal occurrence in behaviour, initiated by the reduction in wax secretion from plants and not as the result of temperature.

Honey production: Temperature has an influence on nectar production because temperature influences the physiology of the plant. With high temperatures chemical changes in the plant take place more rapidly resulting in increased nectar secretion. Records of honey production in the United States by Jorgensen and Markham (1953) and in Norway by Kierulf (1957) and Ukkelberg (1960) indicated a direct correlation between honey crops and air temperatures. According to

Anderson *et al.* (1993) warm days and cool nights are more favourable for nectar secretion than a constant temperature regime. This effect was noted by Kropacova and Halsbachova (1970) in field studies with white clover, though not with sainfoin. In a controlled temperature experiment with red clover no effect between day and night temperatures on nectar flow was observed by Shuel (1952). In similar tests with alfalfa in which a constant 25 °C day night temperature regime was compared with a 32 – 18 °C alternation, with total degree hours held the same for both regimes, nectar yield was significantly higher under the constant temperature (Walker *et al*., 1974).

Temperatures to which plants are exposed prior to flowering may affect the number of flowers produced and hence the total nectar yields per plant. In experiments with soybeans a daytime temperature increase from 28 to 32 °C reduced flower production by more than 50% (Robacker *et al*., 1983).

Where honey production is obtained from shrub or tree species, temperature effects due to sunshine are extremely complex and difficult to predict. Nectar flows in red ironbark and eucalyptus sideroxylon, were reported to be influenced by long-term weather conditions over several years preceding the honey harvest. Cool temperatures at the time of flowering favoured nectar flow (Graham, 1993).

Brood production: Proper brood development is dependent on temperatures inside the cluster around the brood being maintained within one degree of 35 °C (Himmer, 1927; Simpson, 1961). There is little or no brood rearing during the coldest parts of the winter, and cluster temperatures are maintained at a relatively cool 20 °C (Corkins, 1930; Haydack, 1958). However, Root (1947) stated that in cool frosty nights the amount of brood would not go beyond one or two frames. If considerable brood is in the hive when a severe cold spell is experienced the result is referred to as chilled brood.

It has often been suggested that in spring, brood rearing reaches a peak level, from which it inevitably declines, and some results do suggest that egg laying increases most vigorously after a period during which it was restricted (Ribbons, 1953). Low temperatures help to produce such a restriction.

Adult populations of honeybees are directly correlated to brood production. In East Lothian, Scotland mean adult populations of honeybees grew from 18000 in late May to nearly 37000 in early July, falling to 13000 in late September, while mean brood populations increased from 15000 to 24000 in mid June and then declined to almost nothing over the same period. There was a positive correlation between adult bees and brood until late June when brood numbers began to decline (McLellan, 1978). As fall approaches colonies reduce their brood rearing and foraging activities in preparation for winter.

2.3.2 Moisture and humidity

Propolis production: Bees collect propolis to insulate the hive from moisture by gluing the lid and walls of the hive. This assists the bees in maintaining the correct humidity levels within the hive (Anderson *et al*., 1993; Iannuzzi, 1995). The correct humidity is necessary for the development of brood in the hive (Mobus, 1972; Bonney, 1995). Therefore, propolis serves not only in keeping rain and other forms of moisture from entering the hive, but also from leaving the hive.

Honey production: As a result of the hygroscopic property of nectar, there is a negative correlation between the relative humidity of the atmosphere and the sugar content of nectar. A change in sugar concentration may alter the attractiveness of the plant to nectar gatherers (Anderson *et al.,* 1993). According to Butler *et al*. (1972) nectar-sugar yields in cotton in Arizona decreased with decreasing relative humidity (R.H.) as the day advanced probably owing to water stress in the plant. In contrast with these findings, nectar-sugar yields in detached flowers cultured on sugar solutions increased as the R.H. was reduced (Shuel, 1956). This can be ascribed to the fact that lowering the humidity enhanced the flow of solution to the nectaries in the absence of a moisture stress.

The most important effect of humidity on nectar production is manifested as an inverse correlation with concentration of solids (Park, 1929). As nectar is secreted it begins to undergo an exchange of water molecules with the surrounding atmosphere, tending to approach an equilibrium with it but not attaining it (Corbet *et al*. 1979). Unless atmospheric humidity is very high, the result will be a net loss of water from molecules from the nectar and an increase in sugar concentration. The rate at which nectar increases depends on humidity, air movement, temperature and degree to which nectar is protected by the flower parts (Graham, 1993).

Brood Production: Humidity in the hive is important to prevent brood from drying out. According to Root (1947) excess moisture can cause dysentery which is a functional disorder due to an insufficient number of bees to maintain colony warmth and too long retention of the faeces during the winter.

2.3.3 Light

Propolis production: Bees also collect propolis to insulate the hive from light, rain and vibrations (Iannuzzi, 1995). Propolis production may be increased if a slight gap in the lid is made allowing light to enter the hive. This increased light flow into the hive will stimulate the bees to increase propolis production in order to seal the hive (McAddam, personal communication, May 10, 2000). Propolis production is also stimulated if the lid is rotated 30 degrees so that a gap to the exterior is formed (Mann Lake Ltd., personal communication, May 21, 2000).

Honey production: The intensity and duration of sunlight have a direct bearing on the amount of nectar secreted by plants since through photosynthesis carbohydrates are formed, which appear in the nectar. Honey production in a tenyear period in Saskatchewan, Canada showed hours of sunshine to be the most influential weather factor (Hicks, 1977). Scale hives situated in white clover fields in New Zealand lost weight when solar radiation fell below 50 % on average (Walton, 1977). Long-term honey production records in the United States indicate a correlation with clear weather conditions (Kenoyer, 1916; Jorgensen and Markham, 1953). Sunlight was the most important factor influencing nectar yield in alfalfa (Pedersen, 1953). A close association was found between the amount of solar energy reaching plants in the 24-hour period immediately preceding nectar collection and nectar yield in red clover (Shuel, 1952) and between hours of sunshine for a similar period and nectar yields of sainfoin and white clover (Kropacova and Haslbacova, 1970).

2.3.4 Plant source

Climate determines present day floristic patterns as well as the overall location of agricultural regions by allowing certain crops to be grown most economically in certain areas. However, within these areas, production of specific crops concentrates on lands best suited for them, particularly when farming costs are high, and the location of these land is influenced by geology, landforms and soils.

Propolis production and quality: It has been reported that bees collect resins from a large variety of plants. A greater diversity of plant growth will result in greater diversity of resin production, which influences the chemical composition and quality of the propolis. According to Woisky and Salatino (1998) the chemical composition of propolis varies greatly and depends directly on the local flora and penology of the host plants, and indirectly on the locality and time of collection.

Bees gather resins for propolis production from a variety of tree species. The species composition often differs in different geographic localities. Bonney (1995) observed that bees preferred the resins from Eucalyptus, Pine, Poplar, Oak and Willow trees. The amount of propolis produced depended on the density of resin producing trees (Mann Lake Ltd., personal communication, May 21, 2000). MacAdam (personal communication, May 10, 2000) observed increased resin and subsequent propolis production in the vicinity of pine trees. However, the location of the hive and genetic strain of the bees were also reported as influencing the production of propolis.

Honey production: The most imported aspect for honey production is quantity of nectar sugar, which is a function of the average amount of sugar secreted per flower and the number of flowers. Bees visit most flowering plants at some stage or another, but very few of these yield nectar in noticeable quantities. The importance of these latter plants as sources of nectar depends directly on the extent and concentrations in which they occur, either as naturally growing indigenous plants (*Aloe* spp), as exotic trees for timber and shelter (*Eucalyptus* spp), as cultivated crops (kidney beans) or as fruit trees (*Citrus* spp) (Anderson *et al*., 1993). In herbaceous plants nectar sugar is likely to be of recent origin, while in trees and shrubs it may be derived from stored carbohydrates as well (Graham, 1993).

Brood production: Allsopp and Hepburn (1997) established that the rise and fall curves for drone and worker brood production were positively correlated with flower intensity and not with stored pollen. Flowering is the impetus for colony renewal and provides the intense flow of fresh pollen that drives brood production in the ascending phase of the colony cycle. Thereafter, flowering intensity declines and both adult and worker populations gradually diminish throughout the summer to reach an ebb in the winter (Allsopp and Hepburn, 1997).

2.3.5 Honey flow

Propolis production: During honey production very little propolis is produced in the hive (Root, 1947). However, MacAdam (personal communication, May 10, 2000) and Mann Lake Ltd. (personal communication, May 21, 2000) reported increased propolis production during honey production when propolis was collected by means of a propolis trap. Possibly, their findings can be ascribed to the increased activity of the bees during the warmer summer months, which may result in an increase in propolis production.

According to Krell (1996) some authors recommend propolis collection after the major nectar flow for better quality. This may be true in temperate climates where bees are preparing for over–wintering and therefore collecting more propolis in order to insulate the hive against the adverse weather conditions of the winter months.

Honey production: Beekeeping from major honey flows alone would be impossible if there were no other so-called minor sources of pollen and nectar to complement the major honey flow during the off season. These are important to bridge the periods between nectar flows, to build op swarms for major flows or to enable swarms to recover after such flows where pollen deficiency is a problem (Anderson *et al*., 1993). According to the results obtained by Mclellan (1978) honey stores increased during early and late summer nectar flows and decreased at other times leaving about 15.8 kg of honey at the end of the season for over wintering.

Brood production The effect of nectar supply on brood rearing is controversial. Merrill (1925) as quoted by Ribbons (1953) found springtime colonies with plentiful stores (20 lb.) of honey reared 50% more brood than those supplied with 6 lb. of honey stores. Ribbons (1953) states that Nolan's (1925) results do not indicate that the initial expansion of brood rearing was associated with a nectar flow, but brood rearing was well maintained during the subsequent main flow and fell off at the end of the nectar flow. However, Merril (1924) as quoted by Ribbons (1953) noted that colonies well supplied with stores of honey reached a peak in brood rearing during the last week in May when bad weather hindered foraging. After the main honey flow the egg laying activity of the queen will decrease and the amount of brood will be less than any time preceding the honey flow (Root, 1947) because there is no use producing a lot of worker bees and consumers of honey when they can not be of any help to the colony.

2.4 COLONY STRUCTURE

2.4.1 Age of the queen

The practical beekeeper has only one standard for assessing a queen and that is performance. She must be vigorous and prolific to enable her to develop and maintain a very populous colony.

Propolis production: No literature regarding the age of the queen on propolis production was found. It can be assumed that the age of the queen has a effect on propolis production because the age of the queen affects honey production and colony size which may have a direct effect on propolis production

Honey production: It is commonly accepted that the age of the queen determines her performance, and bee colonies that are not requeened annually seldom produce good honey yields. Hauser and Lensky (1994) found significant differences in honey yields between colonies headed by old and young queens. Colonies headed by young queens yielded 35 % more honey than those with old queens. In contrast with this Kostarelo-Damianidou *et al*. (1995) found no significant differences between colonies headed by 1-, 2-, or 3-year old queens. According to Anderson *et al.* (1993) inherited characteristics of paramount importance in selecting queens for honey production are the egg laying capacity of the queen, the longlivity of the workers, a reduced propensity to swarm, disease resistance and finally a drive to work.

Brood production: From the results obtained by Hauser and Lensky (1994) the brood area of young queens was 23 % higher than that of old queens. These findings are similar to those of Kostarelo-Damianidou *et al*. (1995) who report that three-year old queens produced significantly less brood than young queens in comparable years. The older queens produced 35 % less brood during autumn, 35.8 % less brood during winter and 46.2 % brood less during spring on average.

Hauser and Lensky (1994) also observed that in spring the populations of workers in colonies headed by young queens were significantly higher than those headed by old queens.

2.4.2 Colony size

Propolis production: Iannuzzi (1983) established a positive correlation between the amount of propolis produced and the size of the colony. He assessed hive strength by means of flight counts (numbers of worker bees arriving during a given period) and comparing this with the production of propolis. Colonies with 80 bees / min, 109 bees / min and 99 bees / min entering the hive produced ¾ oz, 2 oz and ¾ oz of propolis respectively.

Honey production: Large populations are more efficient honey producers than smaller populations and more efficient brood producers (Harbo, 1986). Honey production per bee was found to increase as colony populations increased from 15000 to 16000 bees (Farrar, 1937). According to the results obtained by McLellan (1978) adult bee numbers and honey storage were significantly related only in the active season when both bee numbers and honey storage were increasing rapidly.

Brood production: In both small colonies and large colonies early in the season, the amount of brood rearing might be directly proportional to colony size, but at the height of the season one would expect the amount of brood rearing in large colonies not to be significantly affected by colony size.

According to the results obtained by Lee and Winston (1985) colonies founded by more populous swarms produced more brood. This is in agreement with beekeeping studies which show a positive relationship between colony size and brood production (Farrar, 1932; Moeller, 1961; Free and Racey, 1968; Nelson and Jay, 1972; Smirl and Jay, 1972). Those studies also implied that less populous colonies compensate for their relatively low brood production by increasing the brood/worker ratio, and suggest that brood to worker ratios were negatively correlated with colony populations. However, Harbo (1986) found that more crowded colonies produce less brood than less crowded colonies. Smaller populations tend to produce more brood per bee than larger populations.

2.4.3 Swarming

Propolis production: No literature regarding the influence of swarming on propolis production was found. It can be assumed that swarming will have a negative effect on propolis production since there is a reduction in colony size, resulting in less worker bees, which ultimately may affect propolis production.

Honey production: Swarming can have an effect on honey production since the size of the resident swarm is decreasing. Lensky and Hochenberg (1973) and Lensky and Cassier (1992) found the losses of honey due to swarming to be about 15kg/ colony.

Brood production: A positive relationship between brood area, and construction of queen cups and swarm queen cells has been reported in temperate climates (Simpson, 1960; Allen, 1965; Caron, 1970). In contrast with this, Hauser and Lensky (1994) found no significant effects of brood surface on the construction of queen cups and swarm queen cells in subtropical climates. Allsopp and Hepburn (1997) found that both swarming and supersedure are independent of any statistically significant changes in worker brood production in the Cape honeybee, which ultimately results in changes of adult worker populations. Swarming is also positively associated with drone production. However, more colonies rear queens for swarming in the ascendant phase of brood production than during brood decline (Simpson, 1960).

2.4.4 Amount of brood

Propolis production: Propolis is also used to line and repair brood combs and to disinfect them. According to Orgen (1990) bees use propolis to varnish the brood cells after the bee emerges, making the cell sterile for the next occupant. This use of propolis in the brood comb produces a dark colour and gives a hard texture after a few seasons.

Honey production: The size of brood area per colony may affect the quantity of collected honey either through the workers, which will emerge and become nectar foragers, or as larvae, which are consumers of nectar and are nursed by hive bees. Hauser and Lensky (1994) established a positive correlation between brood areas and the quantity of honey collected by colonies. They stated that the negative effect, which might have existed due to the consumption of honey by larvae, was rather negligible, compared with the positive effect of an increased number of foragers that collect nectar. Kostarelo-Damianidou *et al.* (1995) also found that honey yield increases with increasing amount of brood.

2.5 MANAGEMENT FACTORS

2.5.1 Method of production

Propolis production: The different methods used to harvest propolis have an influence on the amount and quality of the propolis produced. Iannuzzi (1983) described a trap constructed by cutting thirteen elongated slots in a removable piece of wood, which, was inserted in a gap cut on the side of the brood chamber. Unfortunately the trap tended to produce a large amount of splinters when the propolis was removed. He also found that a flexible plastic grid produced the purest quality. However, this trap did not produce more propolis than the slotted device known as the Bell Board, which takes a whole season to fill.

Krell (1996) stated that the cleanest collection methods employ special traps placed on top of the hive, below the covers or next to the lateral walls inside the hive. Bees do not mix as much wax with the propolis and no contamination occurs during harvesting when this method is used. This results in a cleaner yield in resin as contamination of propolis with wax, pieces of wood, paint and other debris should be avoided. It reduces the quality of the propolis. Krell states further that trap harvesting is faster and more productive than scraping propolis from frames, entrances and covers of hives. Trap harvested propolis usually fetches a better price due to the propolis being cleaner and therefore of better quality.

Honey production: The most common form in which honey is produced is extracted honey, followed by cut comb and finally by section honey. Trends in the production and management costs of different forms of honey produced are summarized in Table 2.1. Extracted honey is the easiest to produce, but the return per unit mass of honey is the lowest. The most difficult to produce is section honey because it requires specialized management and knowledge from the beekeeper (Anderson *et al.*, 1993). Therefore, the price for section honey is much higher than the price of extracted honey.

Table 2.1. Trends in production and management costs of different forms of honey produced.

Honey-form	Labour	Skill	Capital	Costs	Volume	Price
Extracted	x	xx	xxxx	x	xxxx	x
Chunk	xxx	xx	xxx	xx	xxx	xx
Cut comb	xxx	xx	xx	xxx	xx	xxx
Comb section	xxxx	xxxx	x	xxxx	x	xxxx

(Anderson *et al.*, 1993)

Brood production: To produce adequate field bees, the queen must have sufficient space to lay in. This means that there must be a maximum number of good combs in the brood area. There must be only worker cells and no drone, transition or damage cells can be tolerated (Anderson *et al*., 1993). Therefore, it is advisable to replace a certain amount of old combs each year with wax foundation.

2.5.2 Ventilation

Propolis production: It is commonly observed that bee's propolize ventilation holes in hives and hive covers. Krell (1996) stated that light and particularly air circulation are important to stimulate propolis production. Accordingly, traps placed on top of hives should be covered, but the hive cover needs to be propped open slightly to increase air circulation and to allow in some light.

Honey production: Ventilation can be of great importance during the nectar flow because, excess unripe honey is stored in cells before it is properly processed and ripened by bees. Excess moisture is removed from nectar when being converted into honey and this moisture has to be dissipated. By providing extra ventilation the bees are able to remove this moisture-laden air and increased honey ripening will be facilitated (Anderson *et al*., 1993). Root (1947) observed bees forming two groups, one group fanning air out of the hive and the other group forcing air into the hive in order to bring about a strong circulation of air passing through the hive.

Brood production: Ventilation is important for temperature control in very hot weather. Large colonies can smother when the entrance is closed and ventilation is poor. The heat generated by the smothering bees often becomes great enough to melt down the combs, enveloping bees, brood, honey and all in a mass almost scalding hot (Root, 1947).

2.5.3 Stress, pests and diseases

It is generally accepted that stress factors favour the occurrence of disease in any living organism. Such factors include extended periods of cold rainy weather, periods of pollen and nectar scarcity or pesticide spraying which weakens colonies (Anderson *et al*., 1993).

Brood diseases like European Foulbrood, Chalk brood and Nosema attack the colony under stress and cause a lot of dead larvae. This has a negative affect on colony size, which affects honey production. MAFF (2000) reports that colonies heavily invested with Varroa show severe reductions in brood rearing and foraging capability, which can result in lower honey yields.

2.6 CONCLUSION

The objective of this chapter was to review some of the factors that influence the overall hive productivity in a honeybee colony. From the literature cited, it is evident that these factors make a major contribution to the variation found in hive productivity. However, management, which includes pest control, availability of forage, queen renewal and the maintaining of populous colonies, are the most important factors that influence the productivity of a honeybee colony. Therefore, the challenge to management is to seek for the most productive colonies in an apiary.

CHAPTER 3

MATERIALS AND METHODS

3.1 Study site

The colonies of bees used in this study were located in the George area, Southern Cape region, South Africa. (33.9 latitude south, 22.5 longitude east). The climate in this area is classified as Mediterranean. The average maximum and minimum temperatures for the George area are 19.2 and 9.4 degrees Celsius for the winter and 23.9 and 16.1 degrees Celsius for the summer with an annual rainfall of 715 mm (S.A. Weather Bureau, personal communication, June, 10, 2000). The area receives 60% of the rainfall in the summer months (Sept to Feb) and 40% during the winter months (March to Aug). However, during the collection period drought conditions were experienced with the area receiving less than 67% of the normal annual rainfall. The plant growth in the George area consists predominantly of indigenous forests, mountain fynbos and pine plantations.

3.2 Hives

The study was conducted over a nine-month period from the beginning of July to the end of March. Standard Langstroth (n = 12) hives containing 10-frames covered by honeybees (*Apis mellifera capensis*) were used. The hives were placed on stands 0.4 m above the ground, with the hive entrance facing a northeast direction to protect the hive from the prevailing wind and rain.

3.3 Data

The strength of each colony was determined by calculating the sealed and unsealed worker brood area, with the aid of a calibrated frame consisting of a grid of squares, each square consisting of an area of 6.25 cm^2 (1 square inch). The number of frames covered by bees in the hives was calculated and served as a further indication of colony strength. Colonies, considered of equal strength were then divided between the control and treatment groups. Hives (n = 6) were equipped with a commercial available propolis trap from JD manufacturers, Romeo, U.S.A. and compared to the propolis production from hives (n = 6) without traps, which served as the control group. The trap consist of a flexible plastic grid with tapered slots of 7mm x 0.3 mm and replaced the inner cover of the hives of the treatment group. At monthly intervals the propolis traps were removed from the treatment hives and replaced with clean traps. The removed traps containing propolis were placed in a freezer overnight and cooled to minus 4 degrees Celsius. At this low temperature propolis becomes brittle, making it easy to remove from the propolis traps. Propolis from the control and treatment group harvested according to the traditional method was harvested at 3 monthly intervals by scraping it from the frames and entrance of the hive. The propolis was weighed, sealed in a plastic bag and a representative sample from the control and treatment groups analyzed to determine the resin percentage. The resin percentage of the propolis was determined by extraction with a 25% ethanol solution as described by Sosnowski (1984). Total average propolis production, honey production, brood area, frames containing bees, resin % and income generated between the control and treatment group at the end of the collection period were recorded.

In order to determine whether the increased propolis production (obtained via the traps) has an effect on the normal productivity of the hives, the amount of honey brood and frames covered with bees were measured in both control and treatment groups. This was done at the time of removal of the propolis traps on a monthly basis.

Potential income from each colony was determined from the yield of honey and the yield and quality of propolis produced, valued at current market prices.

3.4 Statistical analyses

The average propolis and honey yield, brood area, frames containing bees and income generated at monthly intervals for the control and treatment groups were fitted to a fixed effects model. Hive averages were calculated over the experimental period (9 months) and treatments and subjected to a one-way analysis of variances using S.A.S (1998). Normality of the treatment means as well as homogeneity of variances was tested. The latter assumptions were violated so the Welch ANOVA was adopted. This ANOVA attempts to adjust for violations in the v homogeneity of variance assumptions. After the one-way ANOVA model was fitted, the residuals for normality and independence have also been tested using both visual and numerical techniques.

Correlation analyses with a view to understand the relationship among propolis, honey and frames of bee's productions were also performed. Linear regression was used to develop an equation (a linear regression line) for predicting a value of the dependent variables given a value of the independent variable. A regression line is the line described by the equation and the regression equation is the formula of the line. The regression equation is given by:

$Y = a + bX$

Where X is the independent variable, Y is the dependent variable, *a* is the intercept and *b* is the slope of the line. To test the slope of the regression line, 0 is used to determine the regression and shows a statistically significant linear relationship between X and Y. The hypotheses for this test are:

H0: slope = 0

Ha: slope $\neq$ 0

A low p- value for this test (less than 0.05) means that there is evidence to believe that the slope of the line is not 0, or alternatively that there is a statistically significant linear relationship between the two variables.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 INTRODUCTION

Propolis production can be a viable option to derive an additional income for the South African beekeeper. It involves minimal capital and labor input, which make it a low risk enterprise in a beekeeping system. With the world food and medicine trends to natural products, the natural antibiotics and medicinal substances in propolis can be of great value to the pharmaceutical and beekeeping industry.

The objective of this study was to investigate a method for stimulating increased propolis production in Cape honeybee (*Apis mellifera capensis*) hives.

4.2 RESULTS

The least square means (LSM) and standard errors (SEM) for the effect of propolis production on honey production, brood area, number of frames containing bees, propolis and income between hives with propolis traps and hives without propolis traps at monthly intervals are represented in Table 1.

There was no significant difference ($p > 0.5$) in honey production, worker brood area and frames containing bees between the hives with traps and hives without traps over the nine-month period. However, propolis production was significantly influenced ($p < 0.001$) by the propolis traps, with the hives containing traps producing on average 348.9 g, more propolis than the control group. Propolis production in both control and treatment groups was significantly influenced by honey flow ($p = 0.027$) producing (28 g and 260.2 g) propolis and (22.12 kg and 24.25 kg) honey from December to March. A positive correlation was also found between frames containing bees and worker brood area ($r = 0.73$).

TABLE 4.1 The lease square means (SEM) for propolis production on the production of honey, worker brood area, frames containing bees, resin %, propolis and income generated at monthly intervals and total production.

	Jul 2000	Aug 2000	Sept 2000	Oct 2000	Nov 2000	Dec 2000	Jan 2001
Honey (kg)		NS				NS	
Control	0	2.54 ± 1.08	0	0	0	8.1 ± 0.66	0
Treatment	0	2.28 ± 0.99	0	0	0	7.95 ± 0.53	0
Brood cm^2		NS	NS	NS	NS	NS	NS
Control	-	671.3 ± 241.81	156.3 ± 295.62	-122.5 ± 242.95	873.8 ± 385.01	337.5 ± 470.56	173.8 ± 474.
Treatment	-	986.4 ± 353.66	-440.6 ± 254.02	-169.8 ± 233.96	1640.6 ± 289.1	583.3 ± 141	-106.2 ± 244.
Frames (each)		NS	NS	NS	NS	NS	NS
Control	-	9.6 ± 1.46	-3 ± 1.16	1 ± 1.72	-1 ± 0.58	2.4 ± 0.9	0.6 ± 1.02
Treatment	-	4 ± 0.56	-2 ± 0.92	-0.3 ± 0.95	3 ± 1.28	3.8 ± 1.09	-0.7 ± 0.76
Propolis (g)			**			**	
Control	-	-	10.2 ± 1.08	-	-	12.4 ± 1.93	-
Treatment	24.78 ± 10.8	17.72 ± 4.67	16.68 ± 4.95	12.73 ± 6.7	29.77 ± 9.41	67.32 ± 19.18	86.19 ± 24.3
Resin (%)							
Control	-	-	66	-	-	65	-
Treatment	-	-	79.2	-	-	78.6	-
Income (rand)							
Control	0	35.56 ± 15.13	2.36 ± 0.25	0	0	116.22 ± 9.44	0
Treatment	6.87 ± 3	36.84 ± 14.32	4.62 ± 1.37	3.50 ± 1.85	8.19 ± 2.59	129.82 ± 29.36	22.66 ± 6.39

LEVEL OF SIGNIFICANCE
* ($p < 0.05$)
** ($p < 0.001$)
Negative values which indicates a decline in production

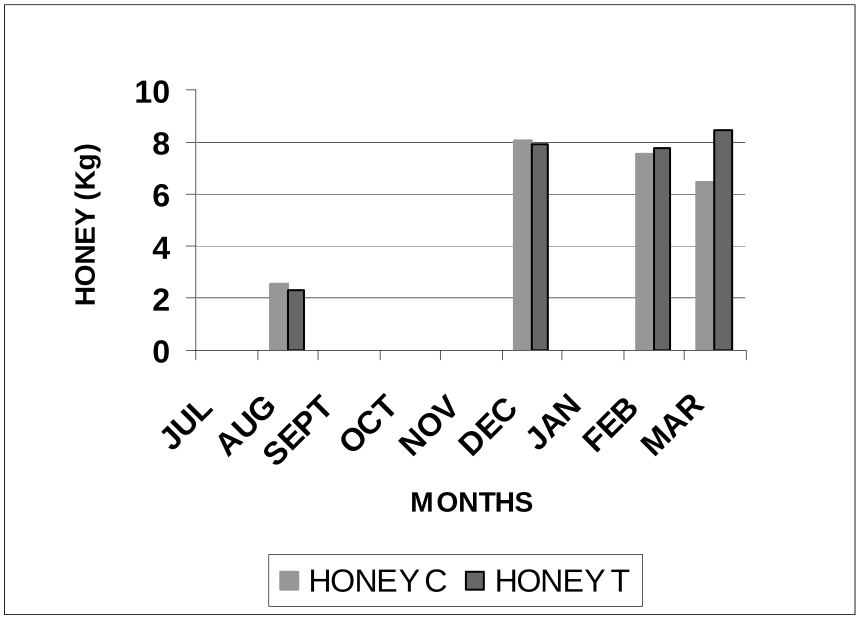

Figure 4.1: Monthly trends in honey production for control and treatment groups

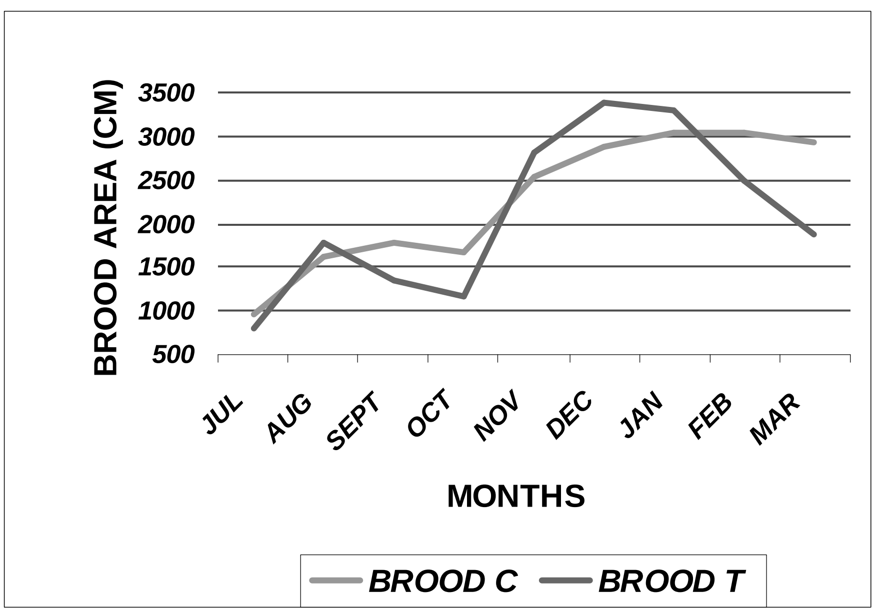

Figure 4.2: Monthly trends in brood production in control a treatment groups

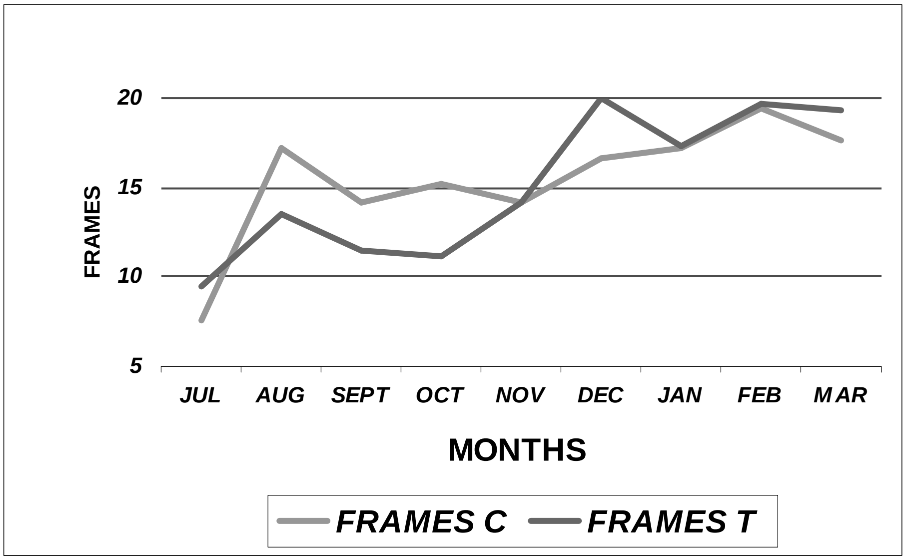

Figure 4.3: Monthly trends in frames containing bees for control and treatment groups

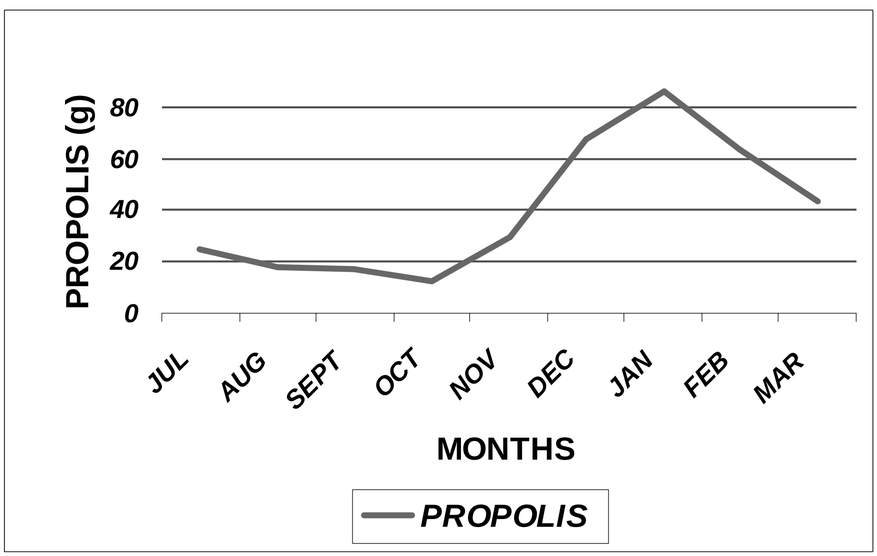

Figure 4.4 Monthly trends in propolis production for hives inserted with propolis traps

4.3 DISCUSSION

Honey production was not influenced by the inclusion of propolis traps into the hives. Although not significant the hives containing traps produced 8% more honey (16.3 kg) from February to March than hives without propolis traps producing 14.02 kg (Figure 4.1). This can be ascribed to the fact that propolis traps provide better ventilation during the hot summer months (Anderson *et al*., 1993). By providing extra ventilation in the hive for the bees, the removal of moisture-laden air will facilitate rapid honey ripening will be facilitated. During August there was no difference in honey production between control and treatment groups (2.54 kg and 2.28 kg).

Honey flow had a significant influence on propolis production by means of a propolis trap (p = 0.027). Propolis production was found to increase during times of honey production when collected via the traps (Figure 4.4 and Figure 4.1). Maximum propolis (28 g and 260.2 g) and honey production (22.12 kg and 24.25 kg) was obtained from December to March for both control and treatment groups, which corresponds to the summer months when the nectar flow is at its peak. These findings can be ascribed to the increased activity of the bees during the warmer summer months due to an increase in day light length and the availability of bee forage. A direct correlation between honey production and air temperature was found by Jorgensen and Markham (1953); Kierulf (1957); Ukkelberg (1960) and Anderson *et al.* (1993). Literature regarding the influence of propolis production on honey production is scarce. The findings of this study are contradictory to the results obtained by Root (1947) who found that very little propolis is produced in hives during honey production. However, McAdam (2000) and Mann Lake Ltd. (2000) observed a positive correlation between honey production and propolis production. Krell (1996) recommends the collection of propolis should be done after the major nectar flow, as quality of propolis tends to improve towards the end of the nectar flow. This may be true in temperate climates where the bees have to over-winter and therefore collect more propolis to protect them from the extreme winter element. This tendency was not observed in the results of this study as most of the propolis was collected in the nectar flow. A possible reason for the difference in results could be the small difference in temperatures between summer and winter experienced in the Southern Cape.

Propolis production had no significant influence on the worker brood area ($p > 0.05$). and the number of frames containing bees. However, propolis and honey production increased as worker brood area increased during the summer months (Figures 4.4, 4.1 and 4.2). A positive correlation ($r = 0.73$) was found to exist between the number of frames containing bees and the worker brood area. Worker brood area increased on average from 671.3 cm^2 and 986.4 cm^2 at August to reach a total production of 1967.3 cm^2 and 1085.4 cm^2 for the control and treatment group respectively. From the results obtained in this study it is evident that the major honey flow takes place during the summer months which explains the increase in brood area for both control and treatment groups. Root (1947) found that it takes a cell of honey to produce a cell of brood and the egg laying activity of the queen decreases after the major nectar flow. However, Root (1947) also found that there is a negative correlation between colony population and the amount of sealed brood present. Ribbons (1953) noted that in springtime colonies with plentiful honey stores (20 lb.) reared 50% more brood than those supplied with 6 lb. honey stores. According to Ribbons (1953) Nolan's (1925) results do not indicate that the initial expansion of brood rearing was associated with a nectar flow, but brood rearing was well maintained during the subsequent main flow and fell off at the end of the nectar flow. Anderson *et al*. (1993) found that colony size increase from the winter (off season) to the summer or honey flow season. Flowering is the impetus for colony renewal and provides the intense flow of fresh pollen that drives brood production in the ascended phase of the colony cycle. Thereafter, flowering intensity declines and both adult and worker populations gradually diminish throughout the summer to reach an ebb in the winter (Allsopp and Hepburn, 1997). McLellan (1978) established a positive correlation between adult bees and brood until late summer when brood numbers began to decline.

The treatment group declined more in worker brood area during February (- 782 cm^2 vs. –5 cm^2) and March (-624 cm^2 vs. –108.8 cm^2). The difference in brood area between the groups can be ascribed to the two queen cells that developed in the control hives causing supersedure and swarming. The result was a drastic increase in worker brood area preceding the swarming process in the control group. However, this process did not affect the number of frames containing bees in the control group. Although Allsopp and Hepburn (1997) found that in the Cape honeybee supercedure is statistically independent of changes in brood production, which ultimately results in changes of adult worker population.

Although the treatment group produced less brood than the control group it produced more frames of bees and honey from February to March (2 frames and 16.3 kg vs. 0.4 frames and 14.02 kg). Similar results were obtained by Harbo, (1986) who found that more crowded bees produced more honey than less crowded bees and that less crowded bees produced more brood. He further states that increased honey consumption was caused by the increase in brood rearing. However, crowded colonies ate more honey when no brood was produced. Although propolis production was not significantly influenced by frames containing bees, lannuzzi (1983) found a positive correlation between the amount of propolis produced and the size of the swarm.

Propolis gathering by means of a propolis trap significantly influenced propolis yield ($p< 0.001$). Hives with propolis traps produced (361.87 g) 323.67 g propolis more than hives not fitted with propolis traps (38.2 g). This is supported by Iannuzzi (1983) and Krell (1996), who found that trap harvesting is faster and more productive than scraping propolis from frames, entrances of hives and hive covers. The trap causes environmental factors such as temperature, moisture and light to affect the bees. Iannuzzi (1993) and Orgen (1990) found that in cooler temperatures propolis collection increase. However, Iannuzzi (1995), Mcaddam (2000) and Mann Lake Ltd. (2000) also observed that increased light flow stimulates propolis production.

Some colonies fitted with traps consistently produce more propolis than others. Over the nine-month period the colony with the lowest production yielded 62 g propolis vs. 720 g propolis produced by the colony with the highest production. These findings are supported by Krell (1996) who also found that some colonies are more avid collectors of propolis, indicating that bees, which produce larger quantities of propolis, could be selected if required.

Propolis production with propolis traps influenced the resin percentage. Propolis produced by means of a trap had an 11 % higher resin percentage (75.6 %) than propolis produced in the control hives (64 %). The findings of this study are in agreement with those obtained by Iannuzzi (1983) and Krell (1996), which stated that the cleanest collection methods employ special traps placed on top of the hive, below the covers or next to the lateral walls inside the hive. Bees do not mix as much wax with the propolis and no contamination occurs during harvesting when this method is used. This results in a cleaner resin yield as contamination of propolis with wax, pieces of wood, paint and other debris reduces quality and should be avoided. Bees collect resins from a large variety of plants. A greater diversity of plant growth will result in greater diversity of resin production, which influences the chemical composition and quality of the propolis. According to Woisky and Salatino (1998), the chemical composition of propolis varies greatly and depends directly on the local flora and penology of the host plants, and indirectly on the locality and time of collection. Bees gather resins for propolis production from a variety of tree species. The species composition often differs in different geographic localities. Bonney (1995) found that bees preferred the resins from Eucalyptus, Pine, Poplar, Oak and Willow trees. The amount of propolis produced depended on the density of resin producing trees (Mann Lake Ltd., 2000). Mcaddam, (2000) observed increased resin and subsequent propolis production in the vicinity of pine trees.

CHAPTER 5

GENERAL CONCLUSION

The aim of this study was to investigate a method for stimulating increased propolis production in the Cape honeybee. The introduction of a propolis trap into the hive increased the amount and quality of propolis produced. This effect was mainly caused by exposing the hive to environmental factors such as light and airflow, which can result in rapid changes in temperature. The environmental factors apparently stimulate propolis collection by bees in order to seal the hive so as to maintain a constant environment inside the hive. The better quality from trap-harvested propolis can be ascribed to the fact that less contamination with wax, wood and other particles occurred.

It is recommended that propolis production takes place during times of a honey flow since propolis production was found to increase during times of a honey flow when collected by means of a propolis trap. These findings can be ascribed to the increased activity of the bees during the warmer summer months as well as an increase in worker population.

Although no significant difference was found in honey production between hives with propolis traps and hives without propolis traps, hives with traps produced more honey. This was possibly due to better ventilation, which facilitates rapid honey ripening during periods of warm temperatures. However, further research on the effect of ventilation on honey production and ripening is needed.

Propolis production did not adversely affect colony size over the period. Therefore, commercial propolis production seams to be a viable practice in the Southern Cape for the commercial beekeeper as total hive income increased substantially with out affecting total hive productivity.

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THE EFFECT OF INCREASED PROPOLIS PRODUCTION ON THE PRODUCTIVITY OF A HONEYBEE FARMING SYSTEM

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ABSTRACT

This study was conducted to investigate a method for stimulating increased propolis production in Cape honeybee hives. The study took place near George situated in the Southern Cape region of South Africa. Standard Langstroth hives were used (n = 12) containing honeybee colonies of equal strength from the species *Apis mellifera capensis*. Propolis production in colonies equipped with commercial propolis traps (n = 6) was compared to propolis production in control colonies (n = 6). The strength of the colonies was determined by calculating the area of worker brood cells and the number of frames containing bees. For a nine-month period propolis production, honey production, brood area, resin percentage, frames containing bees and income generated were measured on a monthly basis with the removal of the traps. There were no significant difference ($p > 0.5$) in honey production (24.66 ± 1.19 kg and 26.53 ± 1.31 kg), worker brood area (1967.3 ± 258.61 cm^2 and 1085.4 ± 312.99 cm^2) and frames containing bees (10 ± 1.13 frames and 9.8 ± 1.2 frames) between the hives with traps and hives without traps. However, propolis production was significantly influenced ($p < 0.01$) by the propolis traps, with the hives containing traps producing 361.87 ± 8.78g propolis compared to 38.2 ± 2.17g propolis in the control group. Propolis production in both control (28 g) and treatment groups (260.2 g) was significantly influenced by honey flow ($p = 0.027$). From December to March the production of honey was 22.12 (control) and 24.25 kg (treatment). A positive correlation was also found between frames containing bees and worker brood area ($R = 0.73$). Hives containing propolis traps were more profitable than the control group when honey and propolis income were pooled (467.17 ± 19.47 Rand vs. 353.8 ± 17.03 Rand). Therefore, the increased propolis production significantly improved profitability of the hive without affecting overall hive productivity.

DIE EFFEK VAN VERHOOGDE PROPOLIS PRODUKSIE OP DIE PRODUKTIWITEIT VAN ‘N BYE BOERDERY STELSEL

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UITTREKSEL

Die studie is uitgevoer om ‘n metode te ondersoek vir die stimulering van verhoogde propolis in Kaapse heuningby swerms. Die studie het plaasgevind naby George in die Suid Kaap gebied van Suid-Afrika. Standaard Langstroth korwe was gebruik (n = 12) met heuningby swerms van dieselfde sterkte van die spesie *Apis mellifera capensis.* Propolis produksie in swerms toegerus met komersiële propolis valle (n = 6) is vergelyk met propolis produksie in kontrole swerms (n = 6). Die sterkte van die swerms is bepaal deur die berekening van die werkerbroed area en die hoeveelheid rame wat bye bevat. Vir ‘n nege maande periode is propolis produksie, heuning produksie, broed area, hars persentasie, rame bye en inkomste gegenereer bepaal op ‘n maandelikse basis met die vervanging van die valle. Daar is geen betekenisvolle verskil ($p > 0.5$) in heuning produksie (24.66 ± 1.19 kg en 26.53 ± 1.31 kg), broed area (1967.3 ± 258.61 cm^2 en 1085.4 ± 312.99 cm^2) en rame bye (10 ± 1.13 rame en 9.8 ± 1.2 rame) tussen korwe met valle en korwe sonder valle. Propolis produksie is betekenisvol hoër ($p < 0.001$) in korwe met valle wat 361.87 ± 8.78 g propolis geproduseer het teenoor 38.2 ± 2.17 g propolis in die kontrole groep. Propolis produksie in beide kontrole (28 g) en behandelde groepe (260.2 g) is betekenisvol beïnvloed deur heuningvloei. Heuning geproduseer van Desember tot Maart was 22.12 (kontrole) en 24.25 kg (behandelde groep). ‘n Positiewe korrelasie is ook gevind tussen rame met bye en werkerbroed area $R = 0.73$. Korwe met valle was meer winsgewend as die kontrole groep toe inkomste uit heuning en propolis saamgevoeg is (467.17 ± 19.47 Rand vs. 353.8 ± 17.03 Rand). Daarom het verhoogde propolis produksie winsgewendheid van die korf verhoog sonder om korf produktiwiteit te benadeel.