EVALUATION OF THE EFFECT OF MICROCLIMATE DIFFERENCES ON ACTIVITY OF CODLING MOTH, CYDIA POMONELLA (LEPIDOPTERA : TORTRICIDAE), USING PHEROMONE TRAP CAPTURE DATA COLLECTED IN APPLE AND PEAR ORCHARDS IN THE LANGKLOOF REGION.

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Declaration

I, the undersigned, hereby declare that the work contained in this assignment is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

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ABSTRACT

Catches of male codling moth, Cydia pomonella (L.), using 400 pheromone-baited sticky traps in 200 orchards in the Langkloof during 1992 - 1995 were associated with four geographically distinct areas. These were Misgund in the west, Nuweplaas, Louterwater and Joubertina in the east. Within each area cool and warm slopes as well as dry and moist areas were identified. In Joubertina, the area with the lowest average altitude, high numbers of moths were caught in dry, cool areas. High moth catches were associated with warm, dry microclimates at Nuweplaas and Louterwater, while the least number of moths was caught in cool, moist microclimates at Misgund, the area with the highest average altitude. In view of the variability of the data there does not appear to be much scope for reducing the number microclimates in which representative traps are placed.

UITTREKSEL :

Vangste van mannetjie kodlingmotte, Cydia pomonella (L.) met 400 taai feromoonlokvalle in 200 boorde in die Langkloof gedurende die 1992 – 1995 seisoene is in verband gebring met vier geografies verskillende gebiede. Hulle was Misgund in die weste, Nuweplaas, Louterwater en Joubertina in ooste. Binne elke gebied is koel en warm hellings sowel as droë en vogtige areas geïdentifiseer. By Joubertina, die gebied met die laagste gemiddelde hoogte bo seespieël, is hoë getalle motte in droë, koel areas gevang. By Nuweplaas en Louterwater is hoë motvangste met warm, droë mikroklimate geassosieer, terwyl die minste motte gevang is in koel, klam mikroklimate by Misgund, die gebied met die hoogste gemiddelde hoogte bo seespieël. In die lig van die wisselvalligheid van die data, wil dit voorkom as of daar nie veel ruimte is vir die vermindering van die aantal mikroklimate waarin verteenwoordigende lokvalle geplaas word nie.

CONTENTS

INTRODUCTION

Activity of the codling moth, Cydia pomonella (L), in South African apple orchards is monitored using pheromone baited traps (Madsen *et al.* 1974; Myburgh *et al.* 1974). The recommendation is that these traps be hung at a density of one trap per two hectares for pest management decision making (Myburgh *et al.* 1974; Myburgh & Madsen 1976). However, if such trapping systems are to be used and serviced by extension personnel for area wide recommendations to be made, data collection and information dissemination would be too time consuming for recommendations based on sufficiently recent data. For the practical implementation of such systems, traps therefore need to be hung in selected indicator orchards, which include all the most important microclimate variations represented in the area.

The Langkloof is an important apple producing area in South Africa. It is a long, narrow valley situated mainly in the Western Cape Province of South Africa, but with the eastern tip extending into the Eastern Province. The present study focused on the lower region of this valley from Misgund in the west to Joubertina in the east (see Table 1 for co-ordinates). The objective was to use historical data from pheromone baited codling moth traps, each covering two hectares, to decide where a reduced number of strategically placed traps should be hung in future area wide pest management systems.

MATERIALS AND METHODS

From 1992 through 1995 about 800 hectares of commercial apple and pear orchards in the Langkloof fruit growing area were monitored for male C. pomonella moths. Pherocon 1C traps, baited with 1mg pherocon codling moth dispensers were used. They were placed at a density of one per 2ha as recommended for commercial use by the manufacturer's registration in South Africa. Dispensers and bottoms were changed every four weeks throughout the season. Bottoms were changed more frequently if dirty.

Using a 1 : 10 000 contoured relief auto-photomap, an estimate (within 10m) was made of the average altitude of each orchard. Further, the shortest distance between the coastline and each orchard was measured to the nearest 0.5km.

Orchards were classified as dry or moist according to whether or not they were located in a 1.5km wide strip on the northern edge of the crest of the mountains which was often covered in mist. Those that were in this strip were classified as moist and those that were not, were classified as dry. In addition north and west facing slopes were classified as warm and south and east facing as well as orchards in valleys were classified as cool. Each orchard was classified as being close to, or far from an infestation source, such as a pack shed. An orchard was considered to be close to an infestation source, if the orchard edge was within 200 metres of a pack shed, fruit dumping site or bulk bin loading zone. If the distance was

greater than 200 metres from such a source the orchard was defined as being far from an infestation source.

Trap catch data from each orchard were pooled over the three seasons and transformed using log(X+1). They were then analysed using a factorial analysis of variance with four regions (Misgund, Nuweplaas, Louterwater, and Joubertina), two moisture regimes (moist and dry) and two temperature regimes (warm and cool) as main effects. Individual pairs of means were compared using t tests on the transformed data where appropriate.

RESULTS AND DISCUSSION

The onset of moth activity was very similar in the four regions while fewer moths were caught in Misgund and more in Louterwater than in the other two regions (Table 2). There did not appear to be a relationship between the average number of moths caught per trap per season and the distance from the sea (Table 1 and 2), altitude (Table 1 and 2) or percent orchards close to sources of infestation (Table 2).

There were differences between the three main effects, namely region, temperature and moisture, (Table 3). However, because of the third order interactions (Table 3), the data pertaining to the four regions were analysed separately.

Misgund. The average altitude of orchards and their distance from the sea was greater than those of the other regions (Table 1). The interactions between the effects of moisture and temperature regimes on moth trap catches (Table 4) were also greater than in the other areas. In the dry areas more moths were caught in cool orchards than in warm orchards ($t_{483} = 4.41$; $P < 0.001$), while in the moist areas more moths were caught in warm orchards than in cool orchards ($t_{48} = 3.35$; $P = 0.002$) (Fig. 1). Therefore in the Misgund region traps would need to be placed in all four microclimatic areas.

Nuweplaas. There were no interactions between temperature and moisture (Table 4). More moths were caught in the dry area than in the moist area (Table 4; Fig. 1), while differences between warm and cool slopes (Fig. 1) were not significant (Table 4). Therefore, in this region traps would need to be placed on both dry and moist slopes, but the effects of temperature need not be taken into account.

Louterwater. There were interactions between temperature and moisture (Table 4). On dry slopes differences between warm and cool orchards (Fig.1) were not significant ($t_{239}=0.86$; $P=0.39$) ,while on moist slopes these differences were significant ($t_{48} = 2,63$; $P = 0,012$) with more moths being caught in cool than in warm orchards. Therefore, on dry slopes traps can be placed in warm or cool orchards while on moist slopes traps should be placed in both warm and cool orchards.

Joubertina. There were no cool orchards on moist slopes. Therefore, interactions between warm and cool slopes could not be estimated. In dry areas there were differences between warm and cool slopes

(Table 4) with more moths caught in cool than in warm orchards (Fig. 1). There were also differences between dry and moist orchards ($F_{1,112}$=4.97; P=0.028; Table 4) with more moths being caught in dry than in moist orchards (Fig. 1). Therefore, traps will need to be placed on both moist and dry slopes, and on the dry slopes traps will have to be hung in both cool and warm orchards.

There were significant differences between moist and dry areas in each of the four regions. In two of the regions, Misgund and Joubertina, dry cool slopes had higher moth trap catches than dry warm slopes, whereas at both Nuweplaas and Louterwater there were no differences between warm and cool slopes in dry areas. Only in Misgund were significantly more moths caught on moist warm slopes than in moist cool slopes. Russ (1961) observed that the appearance of ocean fog caused a drop in temperature and stopped moth flights. However, in the present study consistently more moths were caught on dry than on moist (misty) slopes in only two (Nuweplaas and Joubertina) of the four regions.

In the Misgund and Joubertina regions traps will have to be placed in representative orchards in all the microclimatic areas, while in the other two regions similarities in codling moth numbers suggests that a reduction in the number of areas in which traps are placed will be possible. In the Nuweplaas region trap catches on warm slopes were similar to those on cool slopes. Therefore, traps will need to be placed in representative dry and moist orchards, but whether the orchards are on warm or cool slopes need not be taken into account. However, in the Louterwater region trap catches were similar on warm and cool slopes only in dry orchards. Therefore, in dry orchards temperature need not be taken into account when deciding on trap placement, but in moist orchards in the mist belt representative orchards on both warm and cool slopes should have traps.

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Table 1. Physical features in the four regions included in the study.

Region	Latitude	Longitude	Aver. Distance from the sea (km)	Aver.altitude (m)	September to April daily Mean maximum temperature (°C)	Mean minimum temperature (°C)
Misgund	33° 45' 09" S	23° 29' 44" E	25	750	17 to 27	7 to 13
Nuweplaas	33° 46' 09" S	23° 34' 44" E	21	690	20 to 25	8 to 14
Louterwater	33° 48' 04" S	23° 39' 50" E	16	680	19 to 24	8 to 13
Joubertina	33° 49' 36" S	23° 51' 16" E	15	580	19 to 26	8 to 13

Table 2. Average moths per trap (±S.E.), average onset of moth activity (Julian day) and percent orchards near a source of infestation for the four regions during the three seasons.

Region	Moths/trap/season (±S.E.)	Onset of moth activity (Julian day) 1992/93	1993/94	1994/95	Percent orchards close to infestation source
Misgund	62.7(±6.87)	259	250 to 252	262	15.7
Nuweplaas	117.65(±10.02)	254 to 259	248 to 251	255 to 257	15.6
Louterwater	140.93(±7.50)	254 to 259	247 to 248	255	7.4
Joubertina	108.82(±8.36)	253 to 257	244 to 248	255	24.7

Table 4. Analysis of variance tables for codling moth trap catches in the four regions, Log(X+1) transformed, for two temperature regimes and two moisture regimes.

Region	Source	d.f.	Mean square	F	P
Misgund	Temperature (1)	1	1.397	9.09	0.002
	Moisture(2)	1	0.434	2.86	0.091
	(1) X (2)	1	3.073	2.26	<0.001
	Error	529	0.15		
Nuweplaas	Temperature (1)	1	0.046	0.35	0.55
	Moisture(2)	1	7.025	55.12	<0.001
	(1) X (2)	1	0.035	0.273	0.60
	Error	168	0.127		
Louterwater	Temperature (1)	1	0.019	0.20	0.69
	Moisture(2)	1	5.134	54.87	<0.001
	(1) X (2)	1	0.678	7.34	0.007
	Error	187	0.093		
Joubertina	Temperature (1)	1	0.443	4.44	0.037
	Moisture(2)	1	0.495	4.97	0.028
	Error	112	0.100		

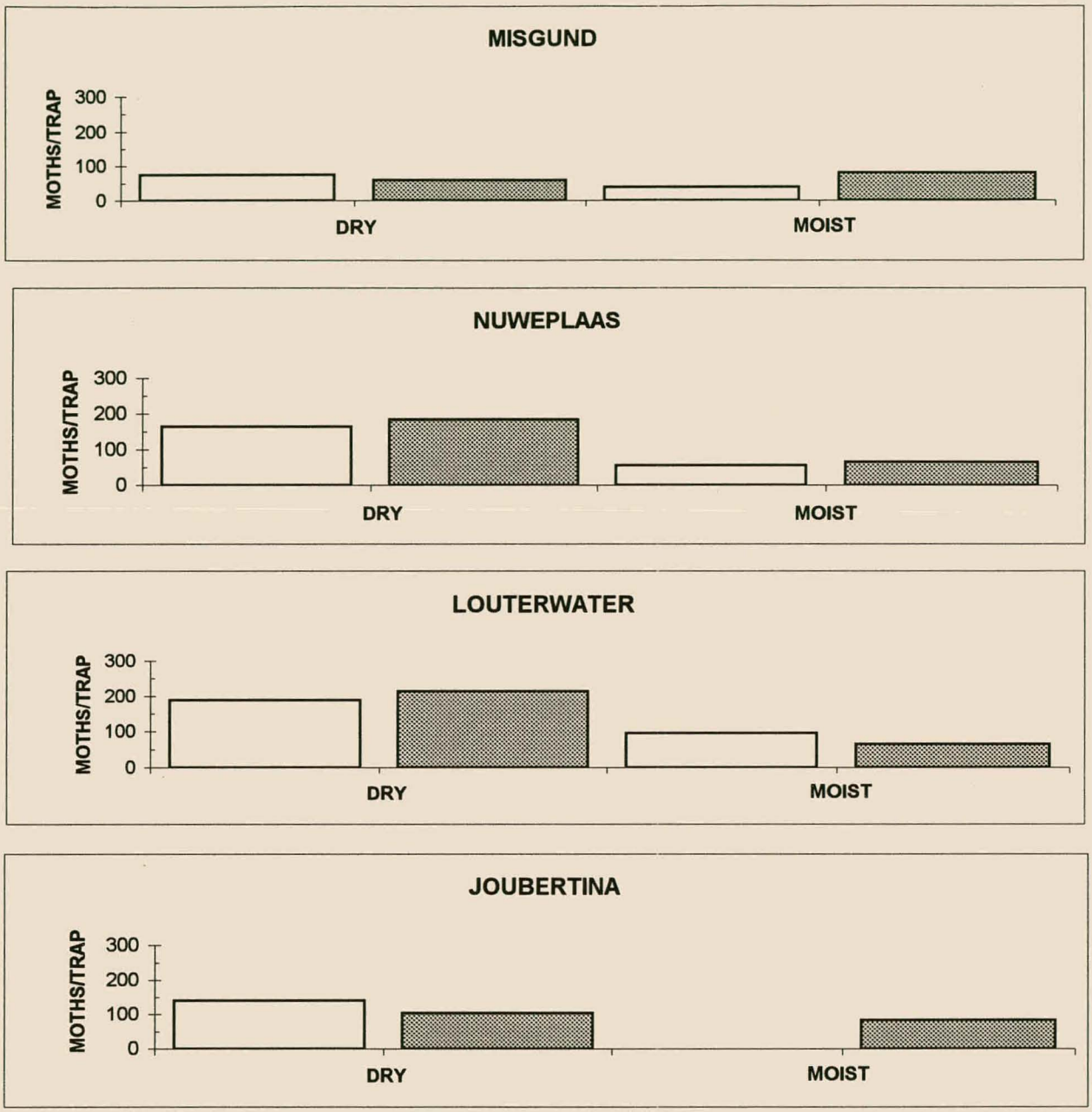

Fig.1 Average moths per trap recorded on dry and moist slopes in cool (clear bars) and warm (shaded bars) orchards situated in Misgund, Nuweplaas, Louterwater and Joubertina .