LONGEVITY, PUNCTURING, AND OVIPOSITION OF THE PECAN WEEVIL ON THREE VARIETIES OF PECANS

By

JIM T. CRISWELL

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Thesis Approved:

R. D. Eikenbary
Thesis Adviser

Richard G. Price

Herman A. Hinrichs

Robert D. Morrison

N N Durham
Dean of the Graduate College

891288

PREFACE

Since basic knowledge of a pest is needed to develop an economic threshold, studies were initiated to obtain a better insight on the biology of the pecan weevil, Curculio caryae (Horn).

The author would like to express his sincere appreciation to his major adviser, Dr. Raymond D. Eikenbary, whose assistance, suggestions, and encouragement were ever present in the course of the study. Special appreciation is extended to Dr. Robert D. Morrison, Professor of Statistics, for his assistance with the analyses of the data. Also, I would like to extend my gratitude to Dr. Richard Price and Professor Herman A. Hinrichs, Department of Entomology and Horticulture, respectively, for their suggestions and criticisms in reviewing this manuscript.

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CHAPTER I

INTRODUCTION

The pecan weevil, Curculio caryae (Horn), is one of the most damaging insects to pecans. Gill (1924) reported losses due to the weevil as high as 90%, while Moznette (1948) stated losses of 75% and Osburn (1950) reported losses of 50-75%. Information concerning the longevity, nuts punctured, and oviposition of the pecan weevil is mainly based on unquantitative data.

There are few studies concerning the longevity of the pecan weevil. Van Cleave and Harp (1971) in 2 separate studies reported male longevity of 17.59 and 8.6 days and female longevity of 23.05 and 14.59 days. Tedders and Osburn (1971) stated 9 and 13 days as average longevity for weevils from control areas in an insecticide evaluation experiment but gave no reference to sex.

The time of oviposition is determined by nut maturity. Swingle (1935), Moznette (1948), Dupree and Bissell (1965), and Van Cleave and Harp (1971) stated weevils would not deposit eggs until the kernel became hard. According to Gill (1924), Moznette et al. (1940), and Osburn (1950) females deposited 3 eggs/nut. Martin (1952) and Hinrichs and Thomson (1955) reported 2-4 eggs/nut, while Price (1939) stated the number ranged from 3 to 5 eggs/nut. Swingle (1935) and Chau (1949) reported each female required 10-30 nuts in which to deposit eggs.

With knowledge of the longevity, puncturing, and oviposition capabilities of the pecan weevil, one could better construct and implement management programs for the weevil. Also, this information would be vital in determining an economic threshold. For these reasons a study was undertaken to determine the effect nut maturity had on the number of nuts punctured, number of nuts that contained eggs, and number of eggs deposited.

CHAPTER II

MATERIALS AND METHODS

Studies were conducted in a laboratory at $21 \pm 1\,^{\circ}C$, 50% RH, and 12:12 photoperiod. Three varieties of pecans were used: Starks' Hardy Giant (an early maturing variety), Mahan, and Nugget (late maturing varieties), (Hinrichs personal communication). The nuts were collected by selecting stems that contained nut clusters with at least 2 nuts/cluster. The stems were removed from the tree manually or with a pole pruner. To insure weevil-damaged nuts were not used, the nuts were inspected for puncture marks. Punctured and excess nuts were removed until only 2 nuts/stem cluster remained. The stem cluster then was taken to the laboratory and the stem inserted into soil in a 6" pot. A cellulose nitrate cage, similar to the one described by Raney et al. (1970) but enlarged to 12.7 cm x 12.7 cm x 25.4 cm, was placed over the stem cluster. The soil in the pots was kept moist by adding water to prevent wilting of the stem cluster.

Weevils were collected in pyramid traps (Raney and Eikenbary 1969) in a pecan orchard near Stillwater, Oklahoma from July through September, 1972. The traps were checked every morning to insure all weevils used were not more than 24 h. old. Each weevil was placed in a 1 oz. cup and taken to the laboratory where they were sexed, as described by Chittenden (1927), paired (♂-♀), and placed on one of the stem clusters.

After the first pair's starting date, the stem clusters were removed every 2 days and replaced with a stem cluster of the same variety and from the same tree. The new stem cluster was more mature than the one replaced. The removed nuts were inspected; and if puncture marks were present the nuts were dissected with the aid of a scalpel and a dissecting microscope to confirm oviposition and to record the total number of eggs deposited in the 2 nuts. Longevity of the pecan weevils was measured from the day of emergence from the soil to the day of death. Thus longevity in days, number of nuts punctured, number of nuts that contained eggs, and number of eggs deposited were recorded for each pair of weevils.

The season was divided into 3 periods to study longevity: (1) early (July 21 - August 8), (2) middle (August 12 - 26), and (3) late (September 1 - 17).

Nut maturity was noted and divided into 2 categories: (1) water stage, and (2) firming stage, according to Woodroof and Woodroof (1927). Statistical analyses were made on the data, recorded at a 2 day interval, on each pair of weevils. A pair must have had at least 4 observations in a stage to be included in the analyses. Some pairs were used in both stages.

The analyses on number of nuts punctured, number of nuts that containd eggs, and number of eggs deposited were made in a rather unique way. Let Y_i = the accumulated number of nuts punctured by a pair of weevils during the first X_i days, where $i = 1, 2, 3, 4, \ldots$. A least squares regression, $\hat{Y}_i = \hat{\beta}_0 + \hat{\beta}_1 X_i$, was fitted for each pair of weevils in one of the stages of kernel development. The $\hat{\beta}$'s then were considered as the random variables and used as the response variables in an analysis of variance to test whether or not there was difference due to varieties on these regression values. It was assumed the variances of the $\hat{\beta}$'s within varieties for each stage of kernel development were equal.

CHAPTER III

RESULTS AND DISCUSSION

Table I presents the average longevity in days of weevils that emerged within each period of the season. These periods correspond to the 3 parts of the weevil season. Weevils that emerged during the early period (July 21 - August 8), averaged a greater life span than weevils that emerged in the 2 following periods. Also, those that emerged during the middle period (August 12 - 26) averaged a longer life than weevils that emerged during the late period, (September 1-17). Nut maturity may have had some effect on longevity. The weevils may have gained some type of nutriment and probably exerted less energy while puncturing nuts in the water stage. The contents of the pecan shuck, shell, and kernel change drastically when the nut developes from the water to the firming stage (Hammer and Hunter 1946). This could explain the great difference in longevity for pecan weevils provided with nuts of the early maturing variety (Hardy Giant) and the late maturing variety (Mahan) during the middle period of the season. If the weevils did derive some type of nourishment from nuts in the water stage, the weevils on Hardy Giant during the middle period would have been deprived of it, since Hardy Giant nuts were in the firming stage while Mahan nuts were in the water stage. The averages for longevity of the weevil on the different varieties are closer in the late period when all nuts are in the firming stage. The females lived

TABLE I

AVERAGE LONGEVITY IN DAYS FOR PECAN WEEVILS EMERGING DURING THE THREE PERIODS OF THE SEASON, 1972

Season	Variety					
	Hardy Giant		Mahan		Nugget	
	♀	♂	♀	♂	♀	♂
Early (July 21-August 8)	42.7	17.2 (4)[a]	56.0	40.0 (3)	33.7	37.2 (3)
Middle (August 12-26)	24.4	13.2 (12)	35.6	24.3 (15)	21.6	22.8 (13)
Late (September 1-17)	13.4	8.2 (5)	17.8	9.1 (6)	14.1	10.5 (6)

[a] The value in parentheses indicates the number of weevils of each sex observed to obtain the average.

longer than the males except for the weevils which emerged during the early and middle periods on the Nugget variety. The longevity of the weevils that emerged during the late period agrees with Van Cleave and Harp (1971) 1967 data for weevils that emerged during the last 2 weeks of August at Junction, Texas. Van Cleave and Harp (1971) 1969 female longevity is comparable (except for the females on Mahan) to the longevity of female weevils that emerged during the middle period. The males reared by Van Cleave and Harp (1971) in 1969 lived 5 days less than male weevils on Nugget and a week less than males on Mahan, but 5 days longer than males on Hardy Giant. Male weevils lived from 1 to 66 days and the females lived 2-75 days. Van Cleave and Harp (1971) reported ranges of 3-12 days in 1967 and 7-30 days for males in 1969 while the females ranged 7-20 days in 1967 and 9-37 days in 1969. Perhaps the laboratory environment accounted for the increased ranges in the present studies.

Nuts on the Hardy Giant variety began firming on August 11, Mahan and Nugget on September 3 (Fig. 1). For statistical analysis the data was recorded and plotted on an accumulated basis. A straight line could be fitted to the data points and thus linear regression was used to obtain the $\hat{\beta}$ values. Analysis of variance was conducted on the $\hat{\beta}$ values to derive the average rate of the number of nuts punctured, the number of nuts that contained eggs, and the number of eggs deposited. Since the data was analyzed on an accumulated basis, the first observation had a greater effect on the slope of the regression line than observations occurring later in the life of the weevils. Therefore it was concluded that a high numerical intercept would indicate the weevils began damaging the variety early and a low numerical intercept would indicate the weevils did not initially damage the pecan nuts. The slope of the lines represents the rate of damage by the weevils and hereafter rate refers to the slope of the line. The rate of nuts punctured/pair per day in the water stage is represented in Fig. 2(A). The rates did not differ drastically indicating the weevils punctured nuts on the 3 varieties in the water stage about the same. Fig. 2(B) presents data from the firming stage for nuts punctured/ pair per day. Weevils on Hardy Giant and Nugget almost parallel each other indicating similar rates, while weevils on Mahan punctured at a

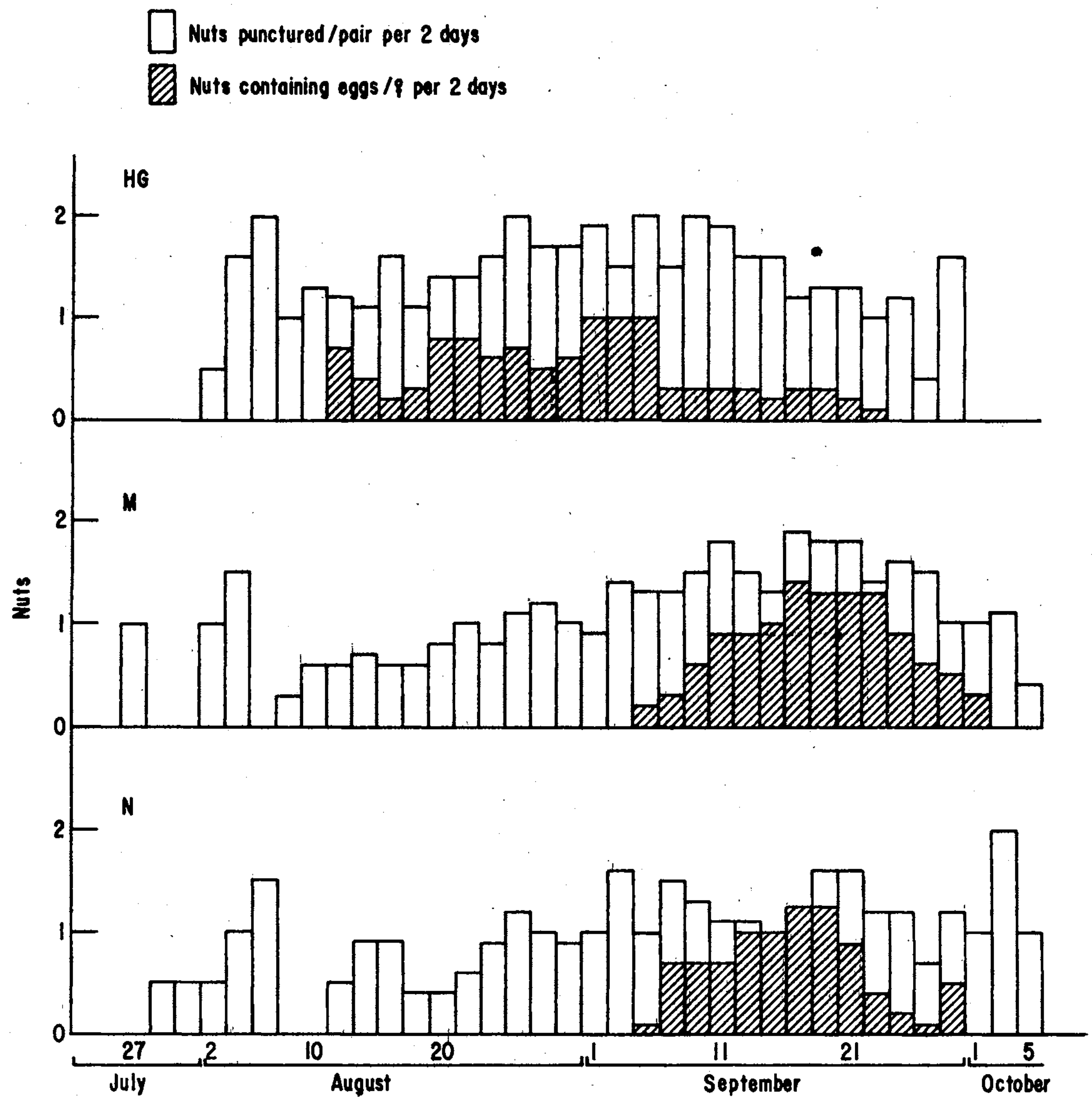

Figure 1. Laboratory Studies Determining the Average Number of Nuts Punctured/2 Days Per Pecan Weevil Pair and Average Nuts Containing Eggs/2 Days Per ♀ (HG = Hardy Giant, M = Mahan, and N = Nugget).

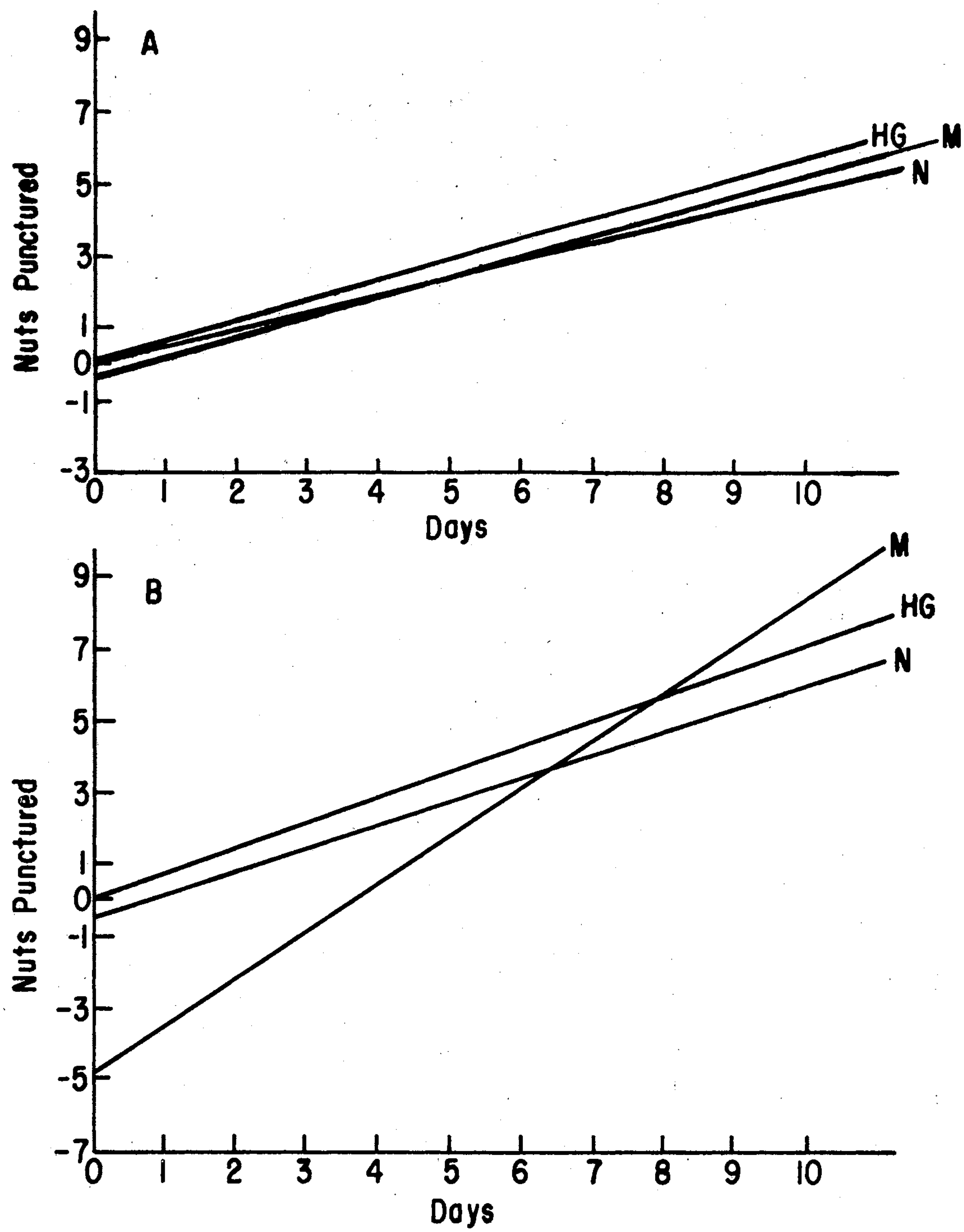

Figure 2. (A) Laboratory Studies Determining the Number of Nuts Punctured/Pecan Weevil Pair During the Water Stage.
(B) Number of Nuts Punctured/Pair During Firming Stage (HG = Hardy Giant, M = Mahan, and N = Nugget).

much faster rate. From this, it appears that Mahan (a late maturer) did not receive damage initially as did Hardy Giant and Nugget, but was punctured at a greater rate later in the firming stage. Since the nuts were in the firming stage, there was probably little droppage as a result of punctures; but the kernel may have suffered damage due to feeding.

Even though the nuts would not drop, the fact that the weevils punctured the nuts sooner on Hardy Giant and Nugget would make these varieties more susceptible to egg deposition than Mahan. The rate of nuts that contained eggs is represented in Fig. 3(A). Again Hardy Giant had a low rate while Nugget had a higher rate. Mahan had the greatest rate. While the rate of nuts punctured did not differ greatly between Hardy Giant and Nugget, the rate of nuts that contained eggs did. The long period that Hardy Giant was in the firming stage as compared to Nugget (Fig. 1) probably accounted for this. The difference in rate of egg deposition in the nuts on Nugget and Mahan may have resulted from Mahan's size. Mahan is a large pecan, as compared to Nugget and should require more time for the kernel to complete filling. Egg deposition/♀ would be expected to follow a similar rate as nuts that contained eggs and did as shown in Fig. 3(B). The average number of eggs/♀ deposited in Hardy Giant nuts was 25.1; in Mahan nuts, 36.5 eggs/♀; and 22.1 eggs/♀ in Nugget nuts. These figures are lower than Van Cleave and Harp (1971) field studies that produced averages of 34.7 eggs/♀ in 1967 and 54.7 eggs/♀ in 1969. Of the nuts that contained eggs, females deposited an average of 4.7, 4.4, and 6.4 eggs in nuts of Hardy Giant, Mahan, and

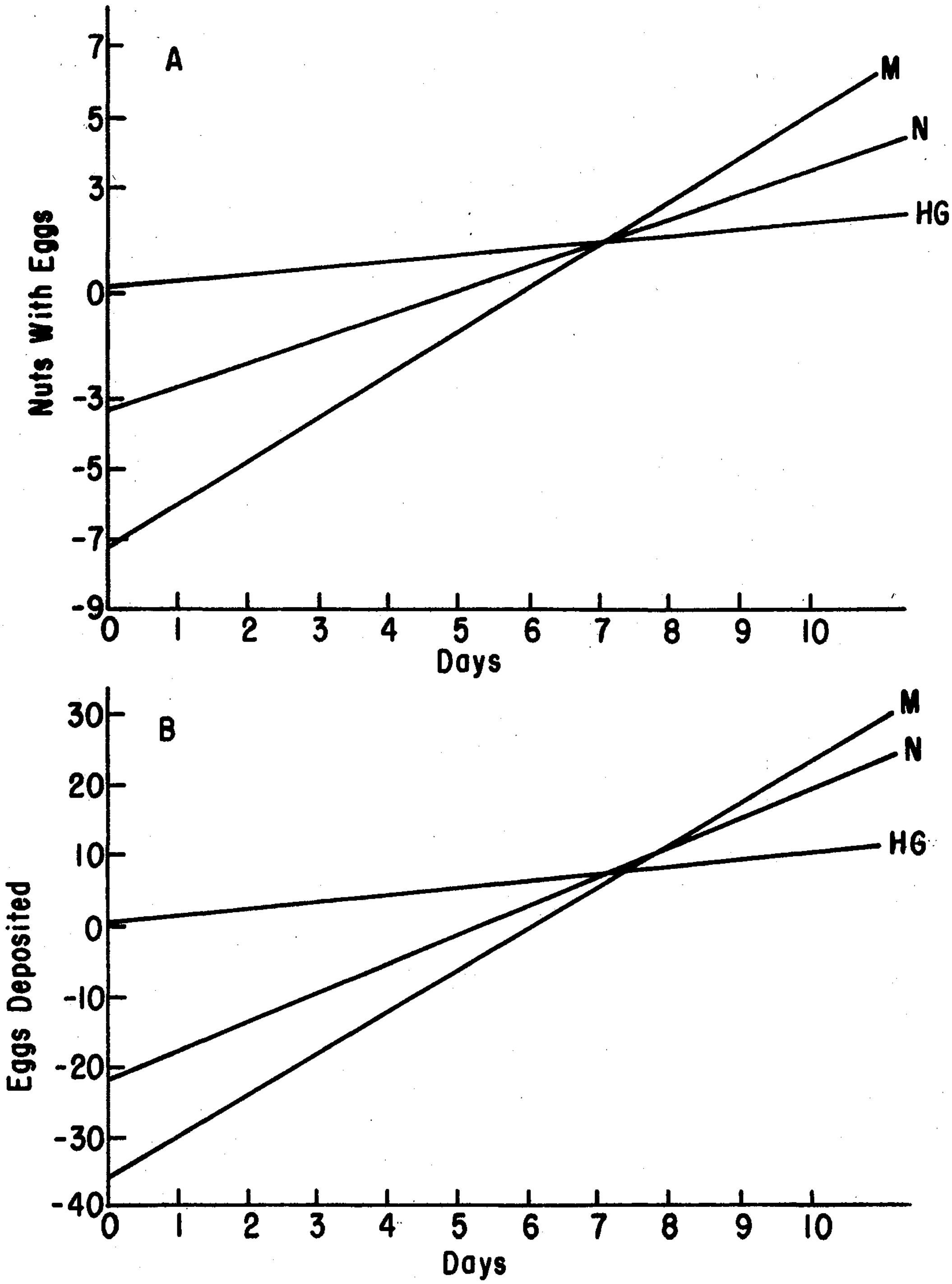

Figure 3. (A) Laboratory Studies Determining the Number of Nuts Containing Eggs/Pecan Weevil ♀ During the Firming Stage.
(B) Number of Eggs Deposited/♀ During Firming Stage (HG = Hardy Giant, M = Mahan, and N = Nugget).

Nugget, respectively. These values represent the higher range of the number of eggs deposited/nut per female previously reported.

The earliest eggs were recovered was 2 days after the female had been captured. Van Cleave and Harp (1971) stated that the pre-oviposition period was 5 days from emergence. Females on Mahan deposited 0-96 eggs, females on Hardy Giant deposited 0-97 eggs, and females on Nugget deposited 0-105 eggs. Nineteen of 20♀ on Mahan deposited eggs, 14 of 22♀ on Hardy Giant deposited eggs, and 12 out of 23♀ on Nugget deposited eggs. Possible reasons for the zero egg production by some females are: (1) the females died a short time after emergence, and (2) the male died soon after emergence and the female was never fertilized. Females deposited eggs in an average of 5.3, 8.2, and 3.4 nuts on Hardy Giant, Mahan, and Nugget respectively. These averages are below the 10-30 nuts required/female for egg deposition reported by Swingle (1935) and Chau (1949). When only females that deposited eggs were used to compute the averages for nuts that contained eggs/female the results climbed to 10.2, 10.5, and 7.4 nuts/♀ for oviposition on Hardy Giant, Mahan, and Nugget respectively. If more than 2 fresh nuts would have been presented, the females might have deposited the same total number of eggs in more pecans or more eggs but fewer per nut.

Since weevils on the early variety, Hardy Giant, punctured nuts and deposited eggs sooner and for a longer period than weevils on Mahan, it may be concluded that the early maturing variety is susceptible to pecan weevil damage earlier in the season and for a longer time than the late maturing varieties. Even though Nugget was punctured at a similar rate as Hardy Giant, Nugget nuts were not oviposited in by the females as soon as the nuts on Hardy Giant but were oviposited in sooner than nuts of the Mahan variety. Thus in a pest management program, one should keep a closer eye on early maturing varieties to prevent the pecan weevil from depositing eggs throughout the early maturing varieties long susceptible stage. The late maturing varieties would provide the grower with more time to implement control measures as a result of the pecan weevils delay in oviposition.

Further research is needed to better determine how nut maturity effects the weevil's behavior and its ability to build up populations under certain trees. Also, field studies should be conducted to determine if the weevils prefer nuts at a particular level in the tree during the season and if nut cluster size effects the selection of nuts for oviposition.

CHAPTER IV

SUMMARY

Female pecan weevils lived longer than male weevils and weevils that emerged during the early period lived longer than weevils that emerged during the other 2 periods. Also, pecan weevils that emerged during the middle period lived longer than weevils that emerged during the late period. Weevils punctured nuts at about the same rate and time on all 3 varieties, while nuts were in the water stage. During the firming stage weevils on Hardy Giant and Nugget began puncturing nuts earlier, while weevils on Mahan started later. Females deposited eggs sooner and for a longer time in Hardy Giant nuts than the other 2 varieties. Weevils on Mahan had the largest average of eggs deposited/♀ per nut, with weevils on Hardy Giant the smallest. Nugget nuts that contained eggs had the highest average of eggs deposited in them, followed by Hardy Giant. Females on Mahan required the most nuts to deposit eggs in, with Hardy Giant having nearly the same amount.

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APPENDIX A

NUMBER OF NUTS PUNCTURED PER RECORDING DATE FOR EACH PAIR

1	2		1	3	4	5	JULY 23	25	27	29	31	AUGUST 02	04	06	08	10	12	14	16	18	20	22	24	26	28	30	SEPTEMBER 01	03	05	07	09	11	13	15	17	19	21	23	25	27	29	OCTOBER 01	03	05	07	09
H	1	P	1	22	74	9	0	2	1	0	0	0	2	2	2	2	1	0	1	0	2	1	0	2	1	2	0	0	2	1	2	2	2	2	1	2	1	0	2	0	2	0	0	0		
H	2	P	1	29	9	14					1	1	1	2	0																															
H	3	P	1	33	45	31							2	2	1	0	0									2	2	2	2	1	2	0	1	2												
H	4	P	1	38	43	16									0	0	1	2	2	1	2	2	2	2	2	2	2	2	2	1	2	1	1	1	1	0										
H	5	P	1	44	5	14												2	2	1	0	0	0	0																						
H	6	P	1	45	46	18													1	2	2	1	2	1	1	1	2	2	2	1	2	2	0	2	2	2	2	0	1	1	0					
H	7	P	1	46	37	17													2	1	2	2	2	2	2	2	2	2	2	2	2	1	1	0	2	1	0									
H	8	P	1	46	35	5													2	2	0	0	1	2	2	0	2	2	2	2	0	2	2	2	0	0										
H	9	P	1	52	31	18																1	2	2	2	2	2	2	1	2	2	2	1	2	2	1	1									
H	10	P	1	54	15	25																	1	2	1	1	2	2	2	1	0	0	0	0	0											
H	11	P	1	54	35	3																	1	2	2	2	1	2	2	1	1	1	1	1	0	2	2	1	0	0						
H	22	P	1	57	4	13																			0	2	0	1	0	0	0															
H	12	P	1	56	7	3																		1	0	1	1																			
H	13	P	1	57	26	5																			2	2	2	2	2	2	2	2	2	2	1	1	1									
H	14	P	1	57	26	18																			1	2	2	2	2	2	2	2	2	2	1	1	1									
H	15	P	1	57	30	14																			1	2	2	2	2	2	2	2	2	2	2	1	0	0	0							
H	16	P	1	57	20	18																			2	1	2	2	2	1	2	2	2	0												
H	17	P	1	65	26	10																							2	1	2	2	2	2	2	2	2	2	2	0	1					
H	18	P	1	69	12	2																									2	1	1	1	1	2										
H	19	P	1	74	7	5																											0	2	0	1										
H	20	P	1	77	18	2																													0	2	2	2	2	1	2	0	1			
H	21	P	1	77	10	6																													1	0	1	0	0							
N	1	P	1	30	6	53					1	1	1	1	0	1	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0										
N	2	P	1	32	53	15						1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0								
N	3	P	1	36	39	44								2	0	1	1	0	1	1	0	1	0	1	0	0	1	1	0	0	2	0	0	0	0	0										
N	4	P	1	38	37	37									0	1	2	1	1	0	1	1	1	1	1	1	0	1	1	0	0	0	0													
N	5	P	1	41	50	47											1	1	1	1	0	1	0	1	1	1	0	1	1	2	2	2	2	2	?	2	2	2	2	2	1					
N	6	P	1	43	6	28												1	1	0	0	0	0	0	0																					
N	7	P	1	44	27	3												1	1	1	1	0	1	1	1	1	1	1	0	2	1															
N	8	P	1	46	45	33													1	1	1	0	1	0	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0					
N	9	P	1	47	28	32														0	0	1	1	1	1	1	2	2	1	2	2	0	0	0	0											
N	10	P	1	50	39	26															0	0	1	2	1	1	1	2	2	2	2	2	2	2	2	2	2	2	1	0						
N	11	P	1	54	23	27																	1	2	1	2	2	2	2	2	1	1	2	0	0	0										
N	12	P	1	54	35	25																	1	2	1	1	1	1	0	1	2	2	2	2	2	2	2	2	1	0						
N	23	P	1	56	2	20																		0	0	0	1	1	0	0	0	0	0													
N	13	P	1	56	5	27																		1	2	0	1	0	1	0	1	0	0	0	0	0	0									
N	14	P	1	57	4	4																			1	0																				
N	15	P	1	57	14	18																			2	2	2	2	2	1	0	0														
N	16	P	1	57	8	20																			C	2	0	2	0	0	0	0	0													
N	17	P	1	57	42	34																			1	0	1	1	2	2	2	2	2	2	2	2	2	2	2	1	2	1	2	1	0	
N	18	P	1	65	22	16																							1	2	2	2	2	2	2	2	2	0	0							
N	19	P	1	65	12	14																							2	2	2	2	2	0	0											
N	20	P	1	65	22	16																							2	2	2	2	2	2	2	2	2	0	0							
N	21	P	1	74	17	11																											0	0	2	2	2	2	2	1	2					
N	22	P	1	75	10	4																												0	0	0	0	0							

S	S	1	P	1	21	74	66	0	0	1	0	0	2	2	0	1	0	1	1	1	0	2	1	1	2	1	1	1	1	0	2	2	2	2	2	2	2	2	2	2	2	2	2	1			
S	S	2	P	1	32	49	2						1	1	0	0	0	0	0	0	1	0	1	1	1	1	1	0	1	2	1	2	2	1	2	2	1										
S	S	3	P	1	38	45	52									0	0	0	0	0	1	1	2	1	1	1	2	1	0	2	2	2	2	2	2	2	2	1	0	1	0	0					
S	S	4	P	1	45	46	32													1	2	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	1	1	1	1					
S	S	5	P	1	45	30	38													1	1	1	2	1	2	1	1	1	2	2	2	2	2	2	0	0	0	0									
S	S	6	P	1	48	19	7														0	0	0	0	1	0	1	1	2	2																	
S	S	7	P	1	50	45	1															1	1	1	0	1	0	0	1	1	2	2	2	2	2	2	2	1	2	1	1	2	2	0			
S	S	8	P	1	54	43	37																	0	2	1	2	1	1	2		1	2	1	1	2	2	2	2	2	2	2	0	2	0		
S	S	9	P	1	55	38	22																		2	1	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1	0				
S	S	10	P	1	56	45	39																		1	2	1	1	1	2	2	2	2	2	2	2	2	2	1	2	2	1	2	2	1	1	0
S	S	11	P	1	57	42	21																			1	1	2	1	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	1	1	
S	S	12	P	1	57	34	18																			1	2	2	2	0	2	2	2	2	2	2	2	2	2	2	1	0					
S	S	13	P	1	57	38	32																			2	1	0	2	1	1	2	2	2	2	2	2	2	2	2	2	1	1	1			
S	S	14	P	1	57	18	20																			1	1	1	1	1	1	0	1	0	0												
S	S	15	P	1	65	26	16																							0	1	2	2	2	2	2	2	2	2	2	2	0					
S	S	16	P	1	65	6	6																							1	0	0															
S	S	17	P	1	69	26	20																									2	2	2	2	2	2	2	1	2	2	2	1	1			
S	S	18	P	1	69	28	8																									1	2	2	2	2	2	1	2	2	2	2	2	1	0		
S	S	19	P	1	74	7	3																											2	2	2	2										
S	S	20	P	1	79	14	2																														2	2	1	2	2	2	0				

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[1] Variety, H = Hardy Giant; N = Nugget; S = Mahan.

[2] Pair Number.

[3] Starting Date.

[4] Longevity of Female.

[5] Longevity of Male.

APPENDIX B

NUMBER OF EGGS DEPOSITED FOR EACH

PAIR PER RECORDING DATE

							JULY					AUGUST															SEPTEMBER															OCTOBER				
1	2		1	3	4	5	23	25	27	29	31	02	04	06	08	10	12	14	16	18	20	22	24	26	28	30	01	03	05	07	09	11	13	15	17	19	21	23	25	27	29	01	03	05	07	09
H	1	E	1	22	74	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
H	2	E	1	29	9	14					0	0	0	0	0	0	0																													
H	3	E	1	33	45	31							0	0	0	0	8	9	11	11	21	12	4	3	0	0	0	0	2	0	0	0	0	0												
H	4	E	1	38	43	16									0	0	0	0	0	3	4	12	8	9	5	3	0	0	0	0	5	0	0	0	0	0										
H	5	E	1	44	5	14												0	0	0	0	0	0	0																						
H	6	E	1	45	46	18													0	0	0	0	0	0	1	0	0	6	2	0	0	6	0	0	0	0	0	0	0	0	0					
H	7	E	1	46	37	17													0	0	6	12	5	13	9	3	0	0	0	0	0	0	0	0	0	0	0									
H	8	E	1	46	35	5													0	0	0	0	0	6	5	0	8	10	9	0	0	0	1	0	0	0										
H	9	E	1	52	31	18																0	0	0	0	8	14	5	5	0	0	0	0	0	0	0	0									
H	10	E	1	54	15	25																	0	0	2	0	11	3	4	0	0	0	0	0	0											
H	11	E	1	54	35	3																	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
H	22	E	1	57	4	13																			0	0	0	0	0	0	0															
H	12	E	1	56	7	3																		0	0	0	0																			
H	13	E	1	57	26	5																			0	4	18	9	11	3	5	0	8	4	0	0	0									
H	14	E	1	57	26	18																			0	3	7	4	3	0	6	0	0	0	0	0	0									
H	15	E	1	57	30	14																			0	1	7	4	2	0	0	0	0	4	4	0	0	0	0							
H	16	E	1	57	20	18																			0	0	8	7	6	0	0	0	0	0												
H	17	E	1	65	26	10																							4	0	3	26	17	21	7	12	7	0	0	0	0					
H	18	E	1	69	12	2																									0	0	0	0	0	0										
H	19	E	1	74	7	5																											0	0	0	0										
H	20	E	1	77	18	2																													0	0	0	2	0	0	0	0	0			
H	21	E	1	77	10	6																													0	0	0	0	0							
N	1	E	1	30	6	53					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
N	2	E	1	32	53	15						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0								
N	3	E	1	36	39	44								0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
N	4	E	1	38	37	37									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0													
N	5	E	1	41	50	47											0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	12	19	7	13	13	4	5	0	0					
N	6	E	1	43	6	28												0	0	0	0	0	0	0	0	0	0	0	0	0	0	0														
N	7	E	1	44	27	3												0	0	0	0	0	0	0	0	0	0	0	0	0	0															
N	8	E	1	46	45	33													0	0	0	0	0	0	0	0	0	0	0	0	12	18	17	15	10	16	15	2	0	0	0					
N	9	E	1	47	28	32														0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0											
N	10	E	1	50	39	26															0	0	0	0	0	0	0	0	0	0	0	0	5	1	3	0	0	0	0	0						
N	11	E	1	54	23	27																	0	0	0	0	0	0	0	0	1	0	0	0	0	0										
N	12	E	1	54	35	25																	0	0	0	0	0	0	0	1	6	11	9	14	9	10	2	0	0	0						
N	23	E	1	56	2	20																				0	0	0	0	0	0	0	0													
N	13	E	1	56	5	27																		0	0	0	0	0	0	0	0	0	0	0	0	0	0									
N	14	E	1	57	4	4																			0	0																				
N	15	E	1	57	14	18																			0	0	0	0	0	1	0	0														
N	16	E	1	57	8	20																			0	0	0	0	0	0	0	0	0													
N	17	E	1	57	42	34																			0	0	0	0	0	3	0	2	8	14	5	14	8	8	10	8	9	0	0	0	0	
N	18	E	1	65	22	16																							0	1	11	7	17	6	0	9	0	0	0							
N	19	E	1	65	12	14																							0	0	11	12	6	0	0											
N	20	E	1	65	22	16																							2	11	8	15	14	15	8	6	0	0	0							
N	21	E	1	74	17	11																											0	0	8	5	10	5	0	0	0					
N	22	E	1	75	10	4																												0	0	0	0	0								

S	1	E	1	21	74	66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5	6	16	5	3	0	8	8	6	0	3	0			
S	2	E	1	32	49	2						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
S	3	E	1	38	45	52									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	7	16	10	7	0	0	0	0	0					
S	4	E	1	45	46	32													0	0	0	0	0	0	0	0	0	0	2	0	6	2	6	10	13	12	5	4	0	0	0					
S	5	E	1	45	30	38													0	0	0	0	0	0	0	0	0	0	0	10	8	1	0	0	0	0	0									
S	6	E	1	48	19	7														0	0	0	0	0	0	0	0	0	0																	
S	7	E	1	50	45	1															0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0			
S	8	E	1	54	43	37																	0	0	0	0	0	0	0	0	0	2	4	1	13	14	7	5	2	0	6	0	0	0		
S	9	E	1	55	38	22																		0	0	0	0	0	5	5	3	3	7	7	8	16	15	6	3	1	0	0				
S	10	E	1	56	45	39																		0	0	0	0	0	1	2	3	5	0	1	3	13	13	4	8	12	0	7	10	0	0	0
S	11	E	1	57	42	21																			0	0	0	0	8	1	0	5	1	7	12	9	11	5	10	11	10	6	0	0	0	
S	12	E	1	57	34	18																			0	0	0	0	0	0	2	6	8	8	8	12	13	8	0	0	0					
S	13	E	1	57	38	32																			0	0	0	0	0	0	1	0	3	5	4	6	7	9	7	4	0	0	0			
S	14	E	1	57	18	20																			0	0	0	0	0	0	0	0	0	0												
S	15	E	1	65	26	16																							0	0	0	1	4	2	13	23	15	12	11	0	0					
S	16	E	1	65	6	6																							0	0	0															
S	17	E	1	69	26	20																									0	0	6	6	6	15	18	7	11	0	1	0	0			
S	18	E	1	69	28	8																									0	0	3	3	10	12	9	8	11	5	8	0	0	0		
S	19	E	1	74	7	3																											0	0	7	0										
S	20	E	1	79	14	2																														2	4	0	9	0	0	0				

[1] Variety, H = Hardy Giant; N = Nugget; S = Mahan.

[2] Pair Number.

[3] Starting Date.

[4] Longevity of Female.

[5] Longevity of Male.

APPENDIX C

NUMBER OF NUTS THAT CONTAINED EGGS FOR EACH PAIR PER RECORDING DATE

	1	2	1	3	4	5	JULY 23	25	27	29	31	AUGUST 02	04	06	08	10	12	14	16	18	20	22	24	26	28	30	SEPTEMBER 01	03	05	07	09	11	13	15	17	19	21	23	25	27	29	OCTOBER 01	03	05	07	09
H	1	W	1	22	74	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
H	2	W	1	29	9	14					0	0	0	0	0	0	0																													
H	3	W	1	33	45	31							0	0	0	0	2	2	2	2	2	2	1	1	0	0	0	0	1	0	0	0	0	0												
H	4	W	1	38	43	16									0	0	0	0	0	1	1	2	2	2	1	1	0	0	0	0	1	0	0	0	0	0										
H	5	W	1	44	5	14												0	0	0	0	0	0	0																						
H	6	W	1	45	46	18													0	0	0	0	0	0	1	0	0	2	1	0	0	1	0	0	0	0	0	0	0	0	0					
H	7	W	1	46	37	17													0	0	2	2	2	2	2	1	0	0	0	0	0	0	0	0	0	0	0									
H	8	W	1	46	35	5													0	0	0	0	0	2	2	0	2	2	2	0	0	0	1	0	0	0										
H	9	W	1	52	31	18																0	0	0	0	2	2	2	2	0	0	0	0	0	0	0	0									
H	10	W	1	54	15	25																	0	0	1	0	2	1	1	0	0	0	0	0	0											
H	11	W	1	54	35	3																	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
H	22	W	1	57	4	13																			0	0	0	0	0	0	0															
H	12	W	1	56	7	3																		0	0	0	0																			
H	13	W	1	57	26	5																			0	2	2	1	2	1	1	0	1	1	0	0	0									
H	14	W	1	57	26	18																			0	1	2	2	1	0	1	0	0	0	0	0	0									
H	15	W	1	57	30	14																			0	1	2	1	1	0	0	0	0	1	1	0	0	0	0							
H	16	W	1	57	20	18																			0	0	2	2	1	0	0	0	0	0												
H	17	W	1	65	26	10																							1	0	1	2	2	1	2	1	2	0	0	0	0					
H	18	W	1	69	12	2																									0	0	0	0	0	0										
H	19	W	1	74	7	5																											0	0	0	0										
H	20	W	1	77	18	2																													0	0	0	1	0	0	0	0	0			
H	21	W	1	77	10	6																													0	0	0	0	0							
N	1	W	1	30	6	53					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
N	2	W	1	32	53	15						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0								
N	3	W	1	36	39	44								0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
N	4	W	1	38	37	37									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0													
N	5	W	1	41	50	47											0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2	2	2	2	2	1	1	0	0					
N	6	W	1	43	6	28												0	0	0	0	0	0	0	0	0	0	0	0	0	0	0														
N	7	W	1	44	27	3												0	0	0	0	0	0	0	0	0	0	0	0	0	0															
N	8	W	1	46	45	33													0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	2	2	2	2	1	0	0	0					
N	9	W	1	47	28	32														0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0											
N	10	W	1	50	39	26															0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0						
N	11	W	1	54	23	27																	0	0	0	0	0	0	0	0	1	0	0	0	0	0										
N	12	W	1	54	35	25																	0	0	0	0	0	0	0	1	2	2	2	2	2	2	1	0	0	0						
N	23	W	1	56	2	20																		0	0	0	0	0	0	0	0	0	0													
N	13	W	1	56	5	27																		0	0	0	0	0	0	0	0	0	0	0	0	0	0									
N	14	W	1	57	4	4																			0	0																				
N	15	W	1	57	14	18																			0	0	0	0	0	1	0	0														
N	16	W	1	57	8	20																			0	0	0	0	0	0	0	0	0													
N	17	W	1	57	42	34																			0	0	0	0	0	1	0	1	2	2	1	2	1	1	1	1	2	0	0	0	0	
N	18	W	1	65	22	16																							0	1	2	2	2	2	0	1	0	0	0							
N	19	W	1	65	12	14																							0	0	2	2	1	0	0											
N	20	W	1	65	22	16																							1	2	1	2	2	2	2	2	0	0	0							
N	21	W	1	74	17	11																											0	0	2	2	2	1	0	0	0					
N	22	W	1	75	10	4																												0	0	0	0	0								

S	1	W	1	21	74	66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	0	2	1	1	0	1	0			
S	2	W	1	32	49	2						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
S	3	W	1	38	45	52									0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	2	2	2	0	0	0	0	0					
S	4	W	1	45	46	32													0	0	0	0	0	0	0	0	0	0	1	0	2	1	1	2	2	2	2	1	0	0	0					
S	5	W	1	45	30	38													0	0	0	0	0	0	0	0	0	0	0	2	2	1	0	0	0	0	0									
S	6	W	1	48	19	7														0	0	0	0	0	0	0	0	0	0																	
S	7	W	1	50	45	1															0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0			
S	8	W	1	54	43	37																	0	0	0	0	0	0	0	0	0	1	1	1	2	2	2	2	1	0	1	0	0	0		
S	9	W	1	55	38	22																		0	0	0	0	0	1	2	2	1	1	2	2	2	2	2	1	1	0	0				
S	10	W	1	56	45	39																		0	0	0	0	0	1	1	1	2	0	1	2	2	2	1	2	2	0	1	2	0	0	0
S	11	W	1	57	42	21																			0	0	0	0	2	1	0	2	1	2	2	2	2	2	2	2	2	1	0	0	0	
S	12	W	1	57	34	18																			0	0	0	0	0	0	1	2	2	2	1	2	2	2	0	0	0					
S	13	W	1	57	38	32																			0	0	0	0	0	0	1	0	2	1	1	2	1	2	2	2	0	0	0			
S	14	W	1	57	18	20																			0	0	0	0	0	0	0	0	0	0												
S	15	W	1	65	26	16																							0	0	0	1	1	1	2	2	2	2	1	0	0					
S	16	W	1	65	6	6																							0	0	0															
S	17	W	1	69	26	20																									0	0	2	1	2	2	2	1	2	0	1	0	0			
S	18	W	1	69	28	8																									1	1	2	2	2	2	1	2	1	2	2	0	0	0		
S	19	W	1	74	7	3																											0	0	2	0										
S	20	W	1	79	14	2																														1	1	0	1	0	0	0				

[1] Variety, H = Hardy Giant; N = Nugget; S = Mahan;

[2] Pair Number.

[3] Starting Date.

[4] Longevity of Female.

[5] Longevity of Male.

2

VITA

Jim T. Criswell

Candidate for the Degree of

Master of Science

Thesis: LONGEVITY, PUNCTURING, AND OVIPOSITION OF THE PECAN WEEVIL ON THREE VARIETIES OF PECANS

Major Field: Entomology

Biographical:

Personal Data: Born in Shawnee, Oklahoma, November 18, 1949, the son of J. T. and Pauline Criswell.

Education: Graduated from Prague High School, Prague, Oklahoma, May, 1968; received the Bachelor of Science degree from Oklahoma State University, Stillwater, Oklahoma, in May, 1972, with a major in Entomology; completed requirements for the Master of Science degree at Oklahoma State University in May, 1974.

Professional Experience: Graduate Research Assistant, Department of Entomology, Oklahoma State University, 1972-1974.

Organizations: Entomological Society of America; Alpha Zeta; Phi Kappa Phi.