Influence of Insects on Mesquite Seed Production

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Highlight: *In field sleeve cage studies we found that conchuela [*Chlorochroa ligata *(Say)] reduced mesquite seed production at least 70% at all population densities studied by sucking juices from immature seeds. The seed beetle* Algarobius prosopis *LeConte reduced production of viable mesquite seeds at least 22% at the population densities studied by consuming, during its larval stage, the seed cotyledons. A seasonal insect control program on mesquite revealed that the native insect populations generally reduced 1) the numbers of mesquite pods produced per tree, 2) the total numbers of seeds per pod, and 3) the percentage of good seeds.*

Honey mesquite [*Prosopis glandulosa* Torr. var. *glandulosa*] occurs on 56.2 million acres in Texas (Smith and Rechenthin, 1964) restricting livestock movement in the dense stands and reducing productivity where preferred plants must compete for moisture, light, and space. Control of mesquite by chemical or mechanical methods is often unsatisfactory because of inadequate kill, high cost, or need for treatment repetition. Because of the successful biological control of other noxious perennial plants, such as *Opuntia* spp. and *Hypericum perforatum* (Holloway, 1964), the use of insects to inhibit mesquite reproduction has been suggested. Typically when biological control of a weed is attempted, alien insects are imported into a country to combat an introduced plant, which being essentially free from its natural enemies has increased in abundance to such an extent that it is declared a noxious weed. However, many noxious plants such as mesquite are native and may not always lend themselves to typical biological control techniques. Andres (1971) has suggested the conservation of existing weed-feeding insects as a method of controlling native weeds, by allowing native insects to increase in numbers and by utilizing these insects in controlling native weeds. The literature related to natural control of native weeds in this country has been reviewed by Ueckert (1973).

Since mesquite produces large quantities of seeds, it has been suggested that natural enemies which reduce viable seed production may be significant factors in reducing the biotic potential and rate of ecesis of this noxious plant (Ueckert, 1973). Swenson (1969) considered the leaf-footed bug *Mozena obtusa* Uhler and the seed beetle *Algarobius prosopis* LeConte as the insects most detrimental to seed production of mesquite. Ueckert (1973) reported that leaf-footed bugs reduced viable seed production from 65% in a control to 4.3% at a population density of four per pod. Werner and Butler (unpublished report) found western flower thrips [*Franklinella occidentalis* (Pergande)] to be abundant on mesquite flowers in Arizona. Glendening and Paulsen (1955) considered the huisache girdler [*Oncideres putator* Thomson] to be detrimental to seed production because it girdled small pod-producing branches.

The most extensive studies of mesquite seed insects have been concerned with seed beetles. Many species of seed beetles are reported from the genus *Prosopis* (Bridwell, 1918; 1920a; 1920b; Hills et al., 1968; Kingsolver, 1972; Swezey, 1928). Female seed beetles deposit their eggs on mesquite seeds or pods, and the young larvae enter the pod and feed on the mesocarp tissue until the seed is fully grown and the cotyledons are hard; then they enter the seed and consume the cotyledons (Bridwell, 1919; 1920b). According to Kingsolver (1972), the seed beetle genus *Algarobius* is assumed to be host specific to mesquite. The range of *A. prosopis* is generally west of the Edwards Plateau in Texas, coinciding with the range of *P. glandulosa* var. *torreyana*. The range of *A. bottimeri* Kingsolver coincides closely with that of *P. glandulosa* var. *glandulosa*, which extends to the western edge of the Edwards Plateau. The ranges of these two species overlap in a narrow band extending from the middle of the Texas panhandle to the Big Bend, roughly along the Edwards Plateau limits (Kingsolver, 1972).

Swenson (1969) indicated that infestation of mesquite pods by seed beetles varies greatly with location. Glendening and Paulsen (1955) observed that 70 to 80% of the mesquite seeds in an Arizona study were destroyed by the beetles.

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The paper is Texas Tech University College of Agricultural Sciences Publication No. T-9-118.

Manuscript received March 19, 1973.

Janzen (1969) reported that Central American species of legumes had evolved with certain mechanisms to resist seed beetle infestations, including the production of (1) large numbers and a large biomass of seeds per unit of photosynthetic tissue, (2) small seeds, and (3) chemical defensive compounds. Parasites of seed beetles have been described by Bridwell (1918) and Swezey (1928).

The objectives of this study were to investigate the impact of insects on mesquite seed production as an initial step in evaluating the possibilities of manipulating native insect populations to control mesquite biologically. The study was limited to an investigation of (1) the effect of native insect populations on mesquite seed production, and (2) the effects of various population levels of selected species of insects on pod and seed production of mesquite.

Methods and Materials

Three study areas in West Texas included (1) the Texas Tech Research Farm, Lubbock County, (2) the 7-Bar Ranch, Dickens County, and (3) the Post-Montgomery Estate, Lynn County. The study area in Dickens Co. was located in the Rolling Plains; The Lubbock Co. and the Lynn Co. areas were in the southern High Plains.

Collections of insects were made in each study area from March to August, 1972, to determine the species associated with mesquite flowers and pods[1]. Population densities of thrips on mesquite flowers were determined from mid-April through early June. Twenty flowers of approximately equal phenological stage were collected weekly at each study area and the numbers of thrips per flower were recorded.

Two species of insects which were known to feed on mesquite pods and seeds were selected for field sleeve-cage studies. High population densities of conchuela [*Chlorochroa ligata* (Say)] (Fig. 1) occurred on immature pods of mesquite in June and July. Population densities of 0, 0.5, 1, 2, and 3 bugs per pod were used in field sleeve cage studies to determine the effects of conchuela on mesquite seed production. In Dickens County on June 15, 1972, the conchuela were placed in sleeve cages, each containing four immature mesquite pods. Each population density was replicated three times. After abscission, the ripe pods were collected, and the total numbers of seed produced per pod were recorded. The number of viable seeds were determined by hand-shelling the seeds, scarifying the seeds in concentrated sulfuric acid for 30 minutes (Sundararaj, 1966), and maintaining the seeds in a germination chamber between moist paper towels at 35°C. The number of seeds which had sprouted after 72 hours in the germinator were recorded. Seeds were considered sprouted when the radicle was 2 mm long.

Seed beetles [*A. prosopis*] (Fig. 2) reared from mesquite pods collected near Pyote, Texas, in 1971 were used in a sleeve cage study at the Lubbock Co. study area to determine their impact on mesquite seed production. Three replications of five population densities, 0, 0.5, 1, 2, and 3 beetles per pod, were introduced into sleeve cages, each containing four immature mesquite pods, on June 21, 1972. After abscission, the ripe pods were collected, and the total number of seeds produced per pod was recorded. The numbers of viable seeds were determined by the same methods described above.

An insect control program was conducted at each of the three study areas to determine the effect of native populations of insects on mesquite seed production. In early March, 1972, nine groups of 20 randomly selected mesquite trees in each area were flagged and numbered. Beginning April 1, one group of trees in each area was randomly selected and sprayed to dripping weekly with 7.7% A. I. solution of Cythion (0, 0-dimethyl phosphorodithioate of diethyl mercaptosuccinate) to control insects. Spraying was begun on seven additional groups at bi-weekly intervals until July 6; all spraying was terminated by July 20. One group was left unsprayed as a control.

Mesquite pods were collected from each tree in July, immediately before abscission. Pods were oven dried, weighed, and counted, and the mean weight of pods produced per tree was calculated. A random sample of 50 pods from each tree was used for seed analysis. The number of endocarps determined the total number of seeds for each sample. The pods were threshed in a machine similar to the one described by

Fig. 1. *Conchuela [*Chlorochroa ligata *(Say)] (adult shown) sucks juices from mesquite seeds, leaving only a dry seed coat in the encocarp.*

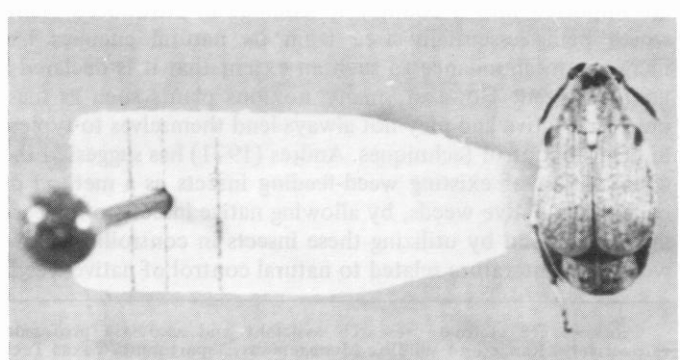

Fig. 2. *Adult seed beetle [*Algarobius prosopis *LeConte]. The larvae of this beetle enters mature mesquite seeds and consumes the cotyledons.*

[1]The following insect taxonomists of the U.S. Department of Agriculture, Agr. Research Service, Systematic Entomology and Beneficial Insect Introduction Laboratory are acknowledged for determinations of specimens: R. D. Gordon, J. L. Herring, J. M. Kingsolver, T. J. Spilman, R. E. Warner, R. E. White, R. J. Gagne, L. V. Knutson, C. W. Sabrosky, J. P. Kramer, P. M. Marsh, A. S. Menke, and F. D. Parker.

Flynt and Morton (1969). Seeds passing through the thresher were designated "good seeds," as insect-damaged seeds were destroyed by the machine. The number of good seeds produced by each tree was estimated by dividing the mean weight per seed into the total weight of all seeds recovered. There was little variation of seed weights within the individual trees; therefore 20 seeds per tree was an adequate sample to determine the mean seed weight. Mean number and percentage of good seeds per pod after shelling were calculated for statistical analyses.

Germination percentages were determined from 400 randomly selected seeds from each of the nine treatment groups in each study area. Seeds which were scarified during threshing were maintained at 35°C between moist paper towels in a germination chamber for 72 hours and recorded; then the sprouts were oven dried and weighed.

Chi-square analysis (Cochran and Cox, 1957) was used to determine differences in viable seed production from pods infested with various population densities of conchuela and seed beetles. Data from the insecticide-check study were analyzed as a completely randomized design with co-variance to determine differences between treatment dates for (1) total number of pods produced per tree, (2) mean weight per pod for each tree, (3) mean number of seeds produced per pod for each tree, and (4) percentage of good seeds per pod for each tree. Basal diameter and estimated canopy volume (Janzen, 1969) were used as covariants in the analysis to eliminate variation due to tree size. Duncan's multiple range test (LeClerg, 1957) was used where appropriate to separate treatment means. Data from the germination trials of seeds from the insecticide-check study were analyzed with Chi-square analysis (Cochran and Cox, 1957).

Results and Discussion

Identification of Insects Associated with Mesquite Flowers and Pods

Thrips and soldier beetles [*Chauliognathus basilis* LeConte] were the insects most frequently encountered on mesquite flowers. Mean population densities of thrips on mesquite flowers during late April, May, and early June at the Dickens Co., Lubbock Co., and Lynn Co. study areas were 43.0, 14.6, and 30.7 per flower, respectively. A preliminary sleeve-cage study indicated that the soldier beetles might favor seed production. Insects collected that were considered most important in reducing mesquite seed production included a leaf-footed bug [*M. obtusa*], conchuela [*C. ligata*], and a seed beetle [*A. bottimeri*]. More than 50 different species of insects were collected from mesquite flowers and pods from the three study areas (Table 1).

Fig. 3. *Mesquite seeds damaged by seed beetle larvae.*

Effects of Conchuela and Seed Beetles on Germination of Mesquite Seeds

In the sleeve cage studies we learned that conchuela destroys mesquite seeds by sucking juices from the seed, leaving only a dry seed coat in the endocarp. Pods in the control cages produced seeds with a much higher germination percentage (76%) than those produced in cages containing conchuela. Seeds produced from cages infested with conchuela

Table 1. Insects collected from mesquite flowers and pods in Dickens Co., Lubbock, Co., and Lynn Co., Texas.

Order	Family	Species
Coleoptera	Bruchidae	*Algarobius bottimeri* Kingsolver
		Mimosestes amicus (Horn)
	Buprestidae	*Acmaeodera gibbula* LeConte
		Agrilus palmicollis Horn
	Cantharidae	*Chauliognathus basilis* LeConte
	Cerambycidae	*Batyle ignicollis* (Say)
		Crossidius pulchellus LeConte
		Stenaspis solitaria (Say)
	Chrysomelidae	*Altica* sp.
		Babia sp.
		Chrysolina sp.
		Colaspoides or near
		Coscinoptera sp.
		Diabrotica undecimpunctata howardi Barber
		Phyllotreta sp.
		Saxinis knausi Schaeffer
	Coccinellidae	*Hippodamia convergens* Guerin
		Olla obdominalis (Say)
		Scymnus loewi Mulsant
	Curculionidae	*Compsus auricephalus* (Say)
		Colecerus marmoratus Horn
	Melyridae	*Dasytinae*, genus not determinable
	Meloidae	*Epicauta nigritarsis* (LeConte)
Diptera	Asilidae	*Efferia* sp.
	Calliphoridae	*Phaenicia sericata* (Meigen)
	Muscidae	*Orthellia caesarion* (Meigen)
	Tachinidae	*Euclytia flava* (Townsend)
		Nemorilla pyste (Walker)
Hemiptera	Anthocoridae	genus not determined
	Coreidae	*Mozena obtusa* Uhler
	Lygaeidae	*Neacoryphus bicrucis* (Say)
		Oncopeltus fasciatus (Dallas)
	Miridae	*Lygus* sp.
		Neurocolpus arizonae Knight
		Rhinacloa forticornis Reuter
	Pentatomidae	*Chlorochroa ligata* (Say)
		Podisus acutissimus (Stallings)
		Thyanta accerra McAtee
Homoptera	Cicadellidae	*Gypona* (Obtusana) *paupercula* Spangberg
		Norvellina texana (Ball)
	Cicadidae	*Pacarina puella* Davis
	Flatidae	*Ormenis saucia* (Van Duzee)
	Membracidae	*Stictopelta marmorta* Goding
		Tylocentrus recticulatus (Van Duzee)
		Vanduza sp.
	Psyllidae	*Heteropsylla texana* Crawford
	Rhopalidae	*Niesthrea sidae* (Fabricius)
Hymenoptera	Apidae	*Apis mellifera* L.
		Melissodes sp. near *ochraea* La Berge
	Braconidae	*Iphiaulax* sp.
	Colletidae	*Colletes hyalinus* Provancher
	Eumenidae	*Euodymerus annulatus* (Say)
	Halictidae	*Agapostemon texanus* Cresson
	Vespidae	*Polistes apachus* Saussure
Thysanoptera	Thripidae	Genus not determined

Table 2. Percent germination of seeds from mesquite pods infested at five population densities by *Chlorochroa ligata* (Say) and *Algarobius prosopis* LeConte.

Number of insects per pod	Percent germination	
	C. ligata	*A. prosopis*
0	76 a[a]	52 a
0.5	4 b	23 b
1.0	0 c	31 b
2.0	1 bc	30 b
3.0	0 c	29 b

[a]Values followed by the same letter within a column are not significantly different at the 95% probability level as determined by Chi-square analysis.

at 0.5 per pod were 4% germinable, while those from cages with one or three per pod were 0% germinable (Table 2).

Significantly more viable seeds were produced in the control cages than in the cages infested with seed beetles (Fig. 3). Differences in percent viable seeds among various population densities of seed beetles were not significant (Table 2). The low germination percentage, 52%, from pods in the control cages was attributed primarily to the natural population of seed beetles that had oviposited before the sleeve cages were attached. The seed beetle used in the cage study–*A. prosopis*–was not collected from either of the study areas, but we presume that the seed beetle endemic to the three areas [*A. bottimeri*] would have a similar influence on mesquite seeds.

Conchuela and seed beetles appeared to be effective in reducing the reproductive potential of mesquite. However, the history of conchuela as an economic pest of cotton (Frohlich and Rodewald, 1970) would probably preclude attempts to manipulate its population in many areas of the southwest where cotton is cultivated. Seed beetles of the genus *Algarobius* are believed to be host specific to mesquite (Kingsolver, 1972), and additional study should be conducted to determine the possibility of manipulating seed beetle populations in a biological control program for mesquite.

Effect of Insect Control on Mesquite Seed Production

The insecticide-check study was designed to determine the seasonal impact of insects on mesquite pod and seed production. Only general observations were made of relative insect population densities, and specific insects responsible for differences in viable seed production between treatments are not known.

Table 3. Adjusted means of four variables measured on mesquite trees initially sprayed on eight different dates, and a control, Dickens Co., Texas.[a]

Initial spray date	Total no pods/tree	Mean wt pod (g)	Mean no seeds/pod	Mean % good seeds
April 1	150.5 a	2.16 a	15.1 ab	50.6 b
14	151.5 a	2.06 a	16.4 a	50.9 b
28	157.0 a	2.17 a	15.8 ab	62.1 a
May 11	133.5 a	1.83 a	16.1 ab	48.2 bc
25	48.8 b	1.94 a	14.0 ab	44.1 bc
June 8	62.4 b	2.31 a	13.5 bc	38.8 c
22	81.6 b	2.13 a	13.6 bc	44.0 bc
July 6	40.1 b	1.73 a	11.3 cd	24.6 d
Control	40.5 b	1.80 a	10.3 d	21.4 d
Residual variance	9358.1	.544	15.08	246.7

[a]Values followed by the same letter vertically are not significantly different at the 95% probability level as determined by Duncan's multiple range test.

Total pod production varied significantly between dates of initiation of insect control (treatments) at the Dickens Co. (Table 3) and Lubbock Co. (Table 4) study areas. Most flower production at the Dickens Co. study area had ceased prior to May 25, and insect control initiated during the flower stage resulted in significantly higher pod production than insect control initiated during pod development (Table 3). The trend at the Lubbock Co. study area was also toward higher pod production from trees with insects controlled early in the season than from trees sprayed later in the season (Table 4). Differences in pod production between dates at the Lynn Co. study area were not significant (Table 5). Pod production was greater in Lynn Co. than in the other areas, probably because of lower population densities of insects.

Mean pod weights did not vary significantly between treatments at the Dickens Co. study area (Table 3). However, significant differences in mean pod weights between treatments were observed at the Lubbock Co. location (Table 4). Pod weights were generally lower for those trees sprayed later in the growing season at the Lubbock Co. study area. However, the trend at the Lynn Co. study area was toward higher pod weights from trees which were sprayed later in the season (Table 5).

The numbers of seeds per pod for the Dickens Co. and Lubbock Co. study areas varied significantly between treatments, with a trend toward production of fewer seeds per pod at the later dates of initiation of insect control (Tables 3 and

Table 4. Adjusted means of four variables measured on mesquite trees initially sprayed on eight different dates, and a control, Lubbock Co., Texas.[a]

Initial spray date	Total no pods/tree	Mean wt pod (g)	Mean no seeds/pod	Mean % good seeds
April 1	103.9 a	1.80 ab	12.8 ab	46.0 a
14	102.8 a	1.65 abc	12.4 ab	51.8 a
28	98.8 a	2.02 a	14.2 a	52.8 a
May 11	68.3 ab	1.69 abc	12.7 ab	53.3 a
25	72.5 ab	1.51 bcd	11.5 bc	51.7 a
June 8	95.0 a	1.69 abc	9.9 cd	51.2 a
22	35.7 b	1.38 cd	8.3 de	42.9 ab
July 6	68.4 ab	1.24 d	7.1 e	34.0 bc
Control	64.5 ab	1.57 bcd	9.8 cd	24.5 c
Residual variance	2814.5	.316	7.94	251.19

[a]Values followed by the same letter vertically are not significantly different at the 95% probability level as determined by Duncan's multiple range test.

Table 5. Adjusted means of four variables measured on mesquite trees initially sprayed on eight different dates and a control, Lynn Co., Texas.[a]

Initial spray date	Total no pods/tree	Mean wt pod (g)	Mean no seeds/pod	Mean % good seeds
April 1	230.0 a	2.00 acd	17.5 a	58.9 abc
14	273.3 a	2.15 abcd	17.2 a	64.7 c
28	169.3 a	1.83 a	17.3 a	65.0 bc
May 11	239.4 a	1.91 ad	17.6 a	59.7 c
25	216.5 a	2.12 abcd	16.6 a	55.6 ab
June 8	157.5 a	2.28 bcd	17.1 a	57.7 ab
22	182.7 a	2.34 bc	17.7 a	56.0 ab
July 6	209.3 a	2.22 abcd	15.5 a	52.5 a
Control	187.2 a	2.43 b	16.6 a	44.5 d
Residual variance	16883.4	.317	5.59	129.39

[a]Values followed by the same letter vertically are not significantly different at the 95% probability level as determined by Duncan's multiple range test.

4). Leaf-footed bugs were probably responsible for the reduced numbers of seeds per pod. The total number of seeds per pod did not differ significantly between treatments at the Lynn Co. study area (Table 5) where lower population densities of leaf-footed bugs were observed.

The percentage of good seeds varied significantly between treatments at all locations. A general decrease in percentages of good seed occurred with later spraying dates at all locations, and a significantly lower percentage of good seeds was produced by the unsprayed trees at the Lynn Co. study area (Tables 3, 4, and 5). Damage to seed by seed beetles, as well as damage to pods and seeds by sucking insects, contributed to a decreasing percentage of good seed throughout the season.

Germination trials on good seeds from the insecticide-check study revealed significant differences between treatments at all locations. However, no particular trends related to the dates of initiation of insect control were obvious or expected, as insect-injured seeds were almost always destroyed during the threshing process. Dry weights of sprouts did not vary significantly between treatments for any of the study areas.

Results of the seasonal insect control study indicate that insects have a definite detrimental effect on mesquite seed production. Native insect populations reduced the total production of mesquite pods from a mean of 131 pods per tree on sprayed trees to a mean of 97 pods per tree on unsprayed trees. The decrease in pod production was attributed to insects which attack mesquite flowers, such as thrips, and to leaf-footed bugs, which often caused premature pod abscission.

Trees subjected to native insect populations produced a mean of 30% good seeds at all locations while sprayed trees produced a mean of 51% good seeds. The pod-sucking insects, conchuela and leaf-footed bugs, and the seed beetles probably were primarily responsible for the 21% decrease in percentage of good seeds.

Trees protected from insects from flower set until pod development produced a mean of 148 pods per tree and a mean of 54% good seeds, whereas trees protected from insects subsequent to flowering (initially sprayed on or after June 8) produced a mean of 104 pods per tree and a mean of 45% good seeds.

Conclusions

Native insect populations have been shown to have a significant detrimental effect on the production of mesquite pods and viable seeds. Insects which attack mesquite flowers and young pods are more destructive than those that attack during the later stages of development of the pods. Both conchuela and seed beetles are effective in reducing percent germination of mesquite seeds; however, conchuela's status as a pest of cotton precludes the feasibility of attempting to manipulate its populations in many areas. Seed beetles of the genus *Algarobius* are believed to be host-specific to mesquite; thus, further study to determine methods of augmenting this insect for reducing production of viable mesquite seeds may be justified. Such studies should be based upon a thorough knowledge of the ecological factors affecting the insect population. Seed beetles overwinter in litter, thus good range management might prove to be effective in augmenting seed beetle populations. Kulman (1971) indicated that some defoliating insects require "physiologically weakened stands" to develop large populations. If this applies to flower- and seed-feeding insects of mesquite, then methods of weakening mesquite, such as perhaps the application of herbicides, might augment these insects. Fire has been shown to favor certain species of insects, while being detrimental to others (Carpenter, 1939; Hurst, 1971; Komarek, 1971); thus fire might provide a means of augmenting mesquite insect populations in some plant communities. Man has made many advances in the science of managing and controlling insect pests of economic crops. Perhaps in time he will adapt the same principles to the management of beneficial insects, such as those native insects which attack noxious plants.

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