EFFECTS OF SPRINKLE IRRIGATION ON THE OCCURRENCE AND ABUNDANCE OF *PSOROPHORA COLUMBIAE* EGGS IN RICELANDS[1]

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ABSTRACT. Low-pressure sprinkler irrigation was investigated as to its potential influence on the frequency of occurrence and relative abundance of *Psorophora columbiae* eggs in Texas ricelands. Analysis of egg sampling data collected from soybean, rice and sorghum field sites subjected to either sprinkle or flood irrigation practices during 1982–83 indicated no significant differences in either the frequency of occurrence or relative abundance of *Ps. columbiae* eggs in the various sites. Data collected during 1984 indicate that the amount of water applied to a field by a sprinkler system will have some influence on the numbers of *Ps. columbiae* eggs occurring in the field. The frequency of occurrence and relative abundance of *Ps. columbiae* eggs occurring in field sites sprinkle-irrigated at full-pan evaporation rates (i.e., all moisture in the soil lost to evaporation was replenished via irrigation) were significantly higher than was the case in the sites irrigated at half-pan and quarter-pan rates.

INTRODUCTION

Flood irrigation practices currently used by farmers in the Texas rice-belt region and in other southern rice-producing states tend to be very supportive of the biological needs of the floodwater mosquito, *Psorophora columbiae* (Dyar and Knab) (Horsfall 1942, 1955; Meek and Olson 1976, 1977; Olson and Meek 1980; Olson and Newton 1973). Flood irrigating practices are also becoming much less economical for the farmer to use due to sharp rises in water and fuel costs during recent years (Mullins et al. 1978, Holder and Grant 1979). In this regard, scientists at the Texas A&M University Agricultural Research and Extension Center-Beaumont, TX have been evaluating low-pressure sprinkle irrigation systems as a possible alternative to flood irrigation for the production of rice and other crops in southern riceland areas. Such systems appear to be more economical (Wall 1980). However, the potential impact of these systems on mosquito populations in riceland areas is virtually unknown.

The purpose of our study was to begin gathering information on the influence of sprinkle irrigation practices on the dynamics of riceland populations of *Ps. columbiae*. The primary objectives of this initial study were to determine (1) the occurrence and abundance of *Ps. columbiae* eggs deposited in sprinkle irrigated fields and fields subjected to conventional flood irrigation practices and (2) the effects of different water application rates on the general distribution of *Ps. columbiae* eggs occurring in sprinkle irrigated fields.

METHODS AND MATERIALS

The 5 field sites used in this investigation were located at the TAMU Agricultural Research and Extension Center-Beaumont (Jefferson Co.), TX. These sites included non-irrigated soybean, flood irrigated rice, and examples of sprinkle irrigated rice, soybean and sorghum. The sprinkle irrigated crops were all grown in one field over which passed the experimental sprinkler system being investigated by TAES scientists. The experimental sprinkler system was the Zimmatic®[3] lateral-move system shown in Fig. 1.

The occurrence and abundance of *Ps. columbiae* eggs in different field-types subjected to conventional and sprinkle irrigation practices was studied over a 2-year period. Nine soil samples (15 × 15 × 2.5 cm) were taken from each of the 5 sites in the spring (before planting), midsummer (as the crops were maturing), and fall (after harvest) of 1982 and 1983. The soil samples were taken from each site at locations where *Ps. columbiae* females would most likely lay their eggs in the given field-type as indicated by previous studies (Meek and Olson 1976, Olson and Meek 1980, Welch[4]).

Each soil sample was removed with a mortar

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[3] Mention of a commercial or proprietary product does not constitute an endorsement by the USDA, TAES or Texas A&M University.

[4] See Welch, J. B. 1983. The use of aerial color infrared photograph as a survey technique for *Psorophora columbiae* (Dyar and Knab) (Diptera: Culicidae) oviposition habitats in Texas riceland agroecosystems. Ph.D. Dissertation. Texas A&M Univ., College Station, TX. 226 pp.

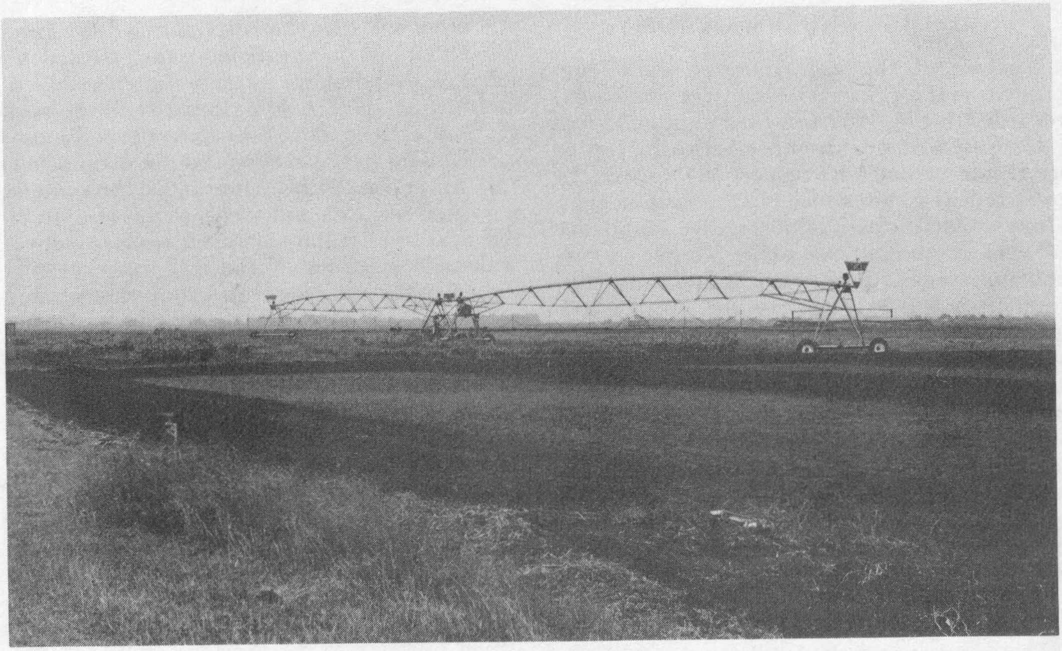

Fig. 1. The Zimmatic® lateral-move sprinkler system used on the sprinkle irrigated test field at the TAMU Agricultural Research and Extension Center near Beaumont (Jefferson Co.), TX during 1982–94.

trowel using techniques described by Horsfall (1956) and placed in a Ziploc® bag (Dow Chemical Co., Indianapolis, IN). Each bag was labeled as to date, field type and sample number. The samples were subsequently returned to the TAMU Mosquito Research Laboratory, College Station, TX and subjected to soil/mosquito egg separation procedures described by Horsfall (1956).

Mosquito eggs collected from each sample were identified to species with the assistance of the keys by Ross and Horsfall (1965) and counted. The egg sampling data were subsequently analyzed with Duncan's statistical analysis of variance (SAS 1979). This analysis compared the various field types to determine if any significant differences existed in the frequency of occurrence and/or abundance of eggs present.

Effects of different water application rates on the occurrence and abundance of *Ps. columbiae* eggs in sprinkle irrigated fields were studied in 1984. During this year, the field subjected to irrigation by the experimental sprinkler system was planted entirely in rice and subdivided into 3 sections based on water application rates. The amount of water applied to each section varied in accordance with the level to which water lost to evaporation from the soil was replaced. For example, in one section of "full-pan evaporation" rate of water application was used (i.e., all the moisture lost to evaporation was replaced via water applied by the sprinkler). Another section was subjected to a "half-pan evaporation" rate (only half the amount of moisture lost was replaced); and the third section was treated to a "quarter-pan evaporation" rate (only a fourth of the amount lost was replaced). At no time was soil moisture content allowed to drop below 50% holding capacity at the root tips of the rice plants. As a matter of reference, water was applied at the full-pan evaporation rate over the entire sprinkle irrigated field used during the studies conducted in 1982–83.

Also during 1984, the sampling effort occasionally was timed to coincide with application of water to the different field sections. On these occasions, soil moisture content of the surface soil was estimated in each section 4 times (0800, 1100, 1500, 1900 hr) on each of several days beginning on the morning of the day when the water was applied. The soil moisture estimates were made using the hand-squeezing technique of Box and Bennett (1959) as adapted for use in determining potential *Ps. columbiae* egg-laying sites by Olson and Meek (1977). Observations on surface crusting and cracking of the soil were also recorded. Records were kept on the time of water application, state of the soil moisture content and surface crusting and cracking conditions over time after water application for each section of the field.

RESULTS AND DISCUSSION

Analysis of the egg collection data (egg-positive and egg-negative samples combined) recorded during 1982 and 1983 indicated there was no significant difference between crop or irrigation method with respect to frequency of occurrence or abundance of *Ps. columbiae* eggs. However, on the basis of the relative abundance of eggs present in just those samples which contained eggs, there was a significance difference (p = 0.047) between the sprinkle irrigated soybean field (22 eggs/sample) and the sprinkle irrigated sorghum field (3.5 egg/sample). These particular data are summarized in Table 1. It appears, therefore, that the use of sprinkle irrigation systems will not have a major impact on the occurrence or abundance of *Ps. columbiae* eggs in Texas ricelands; but, the crop grown on sprinkle irrigated fields may influence these factors. More research on this aspect is indicated.

Rate at which water was applied to the sprinkle irrigated field during 1984 influenced *Ps. columbiae* egg population dynamics. Both the frequency of egg occurrence (0.89) and the relative abundance (1.78 eggs/sample) were significantly higher (p-value range: 0.001–0.0045) in the experimental rice field section subjected to full-pan evaporation rates of water application than in the other 2 sections. The frequency of occurrence and relative abundance of mosquito eggs in the field section irrigated at the half-pan evaporation rate were 0.11 and 0.11 eggs/sample, respectively. No eggs were obtained from any of the samples taken in the quarter-pan evaporation rate section of the field. Analyses of these latter data indicated no significant differences between the field sections subjected to the lower water application rates.

Observations made on soil moisture content and other soil characteristics during 1984 indicated that soil in the field section treated to full-pan evaporation rates of water retained moisture at 100% holding capacity for at least 12 hr after irrigation. Subsequently, soil moisture content in this section did not drop below 75% for at least 24 hr. After 36 hr, the content was often still 75% and stayed at this level until the next application of water. No dry soil or noticeable cracking of the soil was ever observed in the full-pan evaporation rate section of the experimental field.

In contrast, soil moisture content in the section subjected to half-pan evaporation rates dropped below 75% within 24 hr. Dry soil, crusting and large cracks (> 0.5 cm) were observed within 36 hr after irrigation. Some of the large cracks appearing in the soil of this section of the field never sealed over during irrigation. This situation was even more pronounced in the section subjected to quarter-pan evaporation rates of water. In this section, soil moisture content would drop below 50% at the surface within 12 hr. Crusting over and drying of the surface soil was sometimes observed within 8 hr after irrigation. Large and small (<0.5 cm) cracks developed in the soil and some cracks were again continually present.

It thus appears that if water is applied to fields at rates equivalent to that of full-pan evaporation, the soil moisture content in these fields stands to be maintained at levels (75–100%) considered to be the most attractive to gravid *Ps. columbiae* females seeking oviposition sites (Olson and Meek 1977). Therefore, fields subjected to full-pan evaporation rates of sprinkled water should be expected to support higher numbers of mosquito eggs than fields irrigated at the lower rates. The results of our study tend to bear this out.

We conclude from this initial study that conversion or irrigation practices from flood to sprinkle irrigation will not significantly change the occurrence or abundance of *Ps. columbiae* eggs in fields located in the Texas riceland area. The distribution pattern of egg populations in sprinkle irrigated fields may be altered from that currently observed in flood irrigated fields (Meek and Olson 1976) since greater total surface area of moist, exposed soil will be available to ovipositing *Ps. columbiae* females. This would be particularly true in the case of fields sprinkled at full-pan evaporation rates. Also, the crop grown on such a field may have some influence on the numbers and distribution of the eggs deposited.

Regardless of the status of the *Ps. columbiae* egg populations occurring in the various types of sprinkle irrigated fields, the impact of the conversion to this system of irrigation should be

Table 1. Mean number of eggs occurring in positive soil samples taken from field study units sampled for *Psorophora columbiae* eggs during 1982 and 1983 in Jefferson Co., TX.

Field units	Eggs collected per positive sample	
	1982*	1983
Sprinkle irrigated soybean	22.00	1.50
Non-irrigated soybean	7.86	2.86
Sprinkle irrigated rice	9.33	2.50
Flood irrigated rice	4.54	2.16
Sprinkle irrigated sorghum	3.50	1.25

* A significant difference was found only between the sprinkle irrigated soybean and the sprinkle irrigated sorghum of 1982, p = 0.0473.

positive in terms of riceland mosquito control. This is because, in order for crops (particularly rice) to be successfully grown under a sprinkle irrigation system, water (regardless of its source) must not be allowed to stand on a field for more than 3 days.[5] Thus, if such good drainage can be established, larvae hatching from eggs deposited in sprinkle irrigated fields when the fields are flooded by rain water would not have time to complete their development (McHugh and Olson 1982) before the water is removed from the fields. If such were actually to happen, sprinkle irrigated fields might be viewed as "traps" for *Ps. columbiae* populations choosing to use them.

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