Distribution of Rice Water Weevil (Coleoptera: Curculionidae) Adult Damage in Florida Rice Fields[1]

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Abstract The rice water weevil, *Lissorhoptrus oryzophilus* Kuschel (Coleoptera: Curculionidae), is the most widely distributed and destructive insect pest of rice, *Oryza sativa* L., in the United States. The objective of this research was to determine the distribution of rice water weevil adult damage in Florida rice fields. Adult leaf scars were used to determine if rice water weevil adult damage was more dense on field edges than farther into fields. Samples were taken from a road midpoint of each field and 10, 50, 100, and 150 m from the road on a transect toward the field center. Leaf scar samples also were taken along 2 transects running parallel to a levee in each field. One transect was 10 m from the levee and the other transect 50 m from the levee. Transect and levee data were remarkably consistent in showing that rice water weevil leaf scars had a uniform distribution into Florida rice fields. Our data suggest that rice water weevil damage may be overlooked by Florida rice growers because it is uniform and not aggregated on field edges where it would become more conspicuous.

Key Words rice, rice water weevil, distribution

The rice water weevil, *Lissorhoptrus oryzophilus* Kuschel (Coleoptera: Curculionidae), is the most widely distributed and destructive insect pest of rice, *Oryza sativa* L., in the U.S. (Bowling 1980, Way 1990). The insect is native to the eastern U.S. and was introduced into California rice fields in the 1950s (Lange and Grigarick 1959). The distribution of rice water weevil damage has been shown to vary in rice fields in different areas. In California, highest populations and most severe damage occur near levee and field margins. Thus, CA rice farmers frequently apply insecticides only to field margins and adjacent to levees of their rice fields (Espino 2012). However, in the southern states the weevil populations and damage are distributed more uniformly throughout rice fields (Way 2003).

The rice water weevil was first reported in Florida in 1916 (Blatchley and Leng 1916). It was briefly noted first occurring in Florida rice by Genung et al. (1979). Other than this latter brief note, there is no published work on this important pest in Florida rice. In recent years, there has been growing concern by Florida rice growers over the pest status of the weevil in Florida rice fields. As Shang et al. (2004) note, rice water weevil biology may differ sufficiently among rice-producing regions so that methods for management used in one region may not be applicable in another, and an understanding of regional differences in the biology of the weevil is needed to predict the

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insect's behavior. The objective of this research was to determine the distribution of rice water weevil adult damage in Florida rice fields which is critical to monitoring programs and managing the pest.

Materials and Methods

Rice production in Florida occurs in the southern part of the state in the Everglades Agricultural Area (EAA). Commercial rice fields in 4 rice paddies in the EAA were sampled during 2012. These 4 paddies were located at 4 different locations throughout the EAA to give a representation of Florida's rice production area. A rice paddy is the typical rice production unit in Florida. The paddy contains several contiguous rice fields of the same variety, planting date, etc. Each paddy is surrounded by slightly elevated roads to contain water, and levees separate fields within the paddy. Agronomic data for the 4 paddies are given in Table 1. Adult foliar damage caused by rice water weevil produces translucent, longitudinal scars (Boyd 2005) which are used for scouting purposes. Rice water weevil adult feeding scars were found to be associated with increasing larval infestations by Grigarick (1965) and Tugwell and Stevenson (1974). Adult feeding scars have been used to estimate subsequent larval infestations by Tugwell and Stephen (1981) and Morgan et al. (1989). More recently, use of this method has been reported in population dynamic studies of rice water weevil (Shang et al. 2004) and for scouting (Boyd 2005, Bernhardt 2012). Leaf scars were used in this study to determine if adult feeding scars were more dense on field edges than farther into the fields. Adult rice weevils were observed in fields sampled in this study, but other insects producing leaf scars similar to rice water weevil were rarely seen.

Florida rice fields are scouted for rice water weevil scars by scouts entering fields from roads around the paddy. To determine if leaf scars were more abundant on field edges by the roads than farther into fields, leaf scar samples were taken in one

Table 1. Agronomic data for rice fields sampled for adult leaf scars of rice water weevil.

	Paddy			
	Farm F	King	Knight	Tennant
Hectares	73	89	77	150
Total Fields	5	6	6	12
Fields Sampled	4	4	6	4
Variety	Cypress	Jupiter	Wells	Cypress
Organic*	No	No	Yes	Yes
Planting Date	May 25	March 8	March 14	March 15
Month Sampled	June	May	April	May
Insecticide Used**	Yes	No	No	No

* No pesticides used during entire crop cycle.

** Cruiser Maxx (AI = Thiamethoxam) seed treatment at planting.

transect into each field. Samples were taken midpoint of each field and 10, 50, 100, and 150 m from a road on a transect toward the field center. Espino (2012) reported that in California rice, rice water weevil populations were generally higher in plots 4.5 or 30 m from the field's edge than in plots 60 m from the field's edge. Hence, our 10 m sample was well within the zone of increased rice water weevil populations in California. At each location, 30 rice plants were randomly selected, and the presence or absence of leaf scars on a plant measured. Bang and Tugwell (1976) reported that adult weevils preferred to feed on young rice leaves. However, we examined all leaves on the plant for presence or absence of feeding damage because we were interested in feeding scars, past and recent, occurring in the area. Each transect was sampled by 1 person at the same time to remove personal or temporal bias within a transect sample. Samples were taken during April-June 2012 in flooded rice approx. 30 - 45 cm above the water level. Eighteen fields were sampled in the 4 paddies (Table 1). Transect data from different fields within each paddy were pooled, and linear regression performed on number of plants showing rice water weevil feeding scars versus distance from roads into the fields in the paddy.

To determine if leaf scars were more abundant on field edges by levees, leaf scar samples were taken along 2 transects running parallel to a levee in each field. One transect was 10 m from the levee and the other transect 50 m from the levee. The first sample was taken 10 m from a road and then 4 more samples along the transect at 10 m intervals. The two parallel transects in each field were sampled by the same person at the same time to remove personal or temporal bias between the two transect samples. At each location, 30 rice plants were randomly selected and the presence or absence of leaf scars on plants measured. Data from different fields within each paddy were pooled. A *t*-test was then performed to compare the mean number of plants with leaf scars at 10 m versus 50 m from levees within the paddy.

Results and Discussion

The 4 paddies sampled in this study varied in rice varieties, planting dates, insecticide usage, etc. (Table 1). However, in spite of these differences, rice water weevil damage distribution data were remarkably similar among the paddies. Linear regression analysis (Table 2) of feeding damage in transects from roads into fields yielded very low r values (range = 0.003 to -0.19) and concomitantly high *P* values (range = 0.47 to 0.99). Values for slopes (range = 0.0002 to -0.012x) were also very low. Essentially, these data show no significant correlation of feeding damage and distance into field for the first 150 m. Moreover, the extreme flat response indicated by the very low slope values highly suggest that this damage extends much farther into fields. This even distribution of feeding damage also was observed at 10 m versus 50 m from levees into fields in all 4 paddies (Table 3). Means of plants with scars at 10 m versus 50 m were similar in each paddy with small t values and concomitantly large *P* values showing no significant differences in all 4 paddies. As with transect data taken from roads, levee data suggest that damage extends farther into fields than our 50-m samples.

Past studies present an inconsistent pattern of rice water weevil spatial distribution in rice. Rolston and Rouse (1964) simply reported that adult weevils in Arkansas

Table 2. Linear regression analysis* of adult feeding scars of the rice water weevil at different distances from roads into rice fields at four paddies.

	equation	N	r	*P*
Farm F	Y = 20.4 - 0.005X	24	–0.11	0.68
King	Y = 15.1 - 0.012X	16	–0.19	0.47
Knight	Y = 11.2 - 0.007X	16	–0.06	0.78
Tennant	Y = 24.7 + 0.0002X	16	0.003	0.99

* Y = number of plants with leaf scars (dependent variable) and X = meters from road into field (independent variable).

were dispersed among large acreages of rice, but provided no data. Sooksai and Tugwell (1978) reported that adults were uniformly dispersed among all quadrats in Arkansas fields, but clumping occurred near levees. Smith et al. (1986) stated numbers of scarred leaves were usually higher along field margins or the first flooded portions of fields in Louisiana. In Japan, Takeda (1993) found immature populations were aggregated along field edges early in the season, but distributed randomly later. Way (2003) reported that rice water weevil populations and damage are distributed rather uniformly throughout rice fields in the southern United States. And, most recently, Espino (2012) noted that in most locations, immature populations were higher 4.5 m or 30 m from a field edge than 60 m from the field edge in California.

As noted earlier, Shang et al. (2004) stressed that regional differences may be very important in the biology and management of rice water weevil. Besides regional differences, it is highly probable that different sampling methods, time of sampling, and cultural practices affect the interpretation of distribution data. Our transect and levee data are remarkably consistent in showing that rice water weevil adult leaf scars had a uniform distribution into Florida rice fields. These data support Way's observation (2003) that in southern states the weevil populations and damage are distributed uniformly throughout rice fields. Our data also suggest that rice water weevil damage may be overlooked by Florida rice growers because it is uniform and not aggregated on field edges where it would become more conspicuous.

Table 3. Adult feeding scars of rice water weevil* at 10 m and 50 m from levees into rice fields at four paddies.

	plants with scars[1]				
	10 m	50 m	N	t	*P*
Farm F	18.2 ± 4.8	19.1 ± 16.3	60	–0.50	0.62
King	13.0 ± 3.7	14.3 ± 11.9	40	–0.89	0.38
Knight	12.0 ± 9.4	13.6 ± 11.3	40	–0.95	0.34
Tennant	27.5 ± 3.0	27.5 ± 2.4	40	0	1.00

* Mean ± SD. Number of plants with leaf scars of 30 plants sampled.

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