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ARTHROPOD MANAGEMENT

Occurrence, Impact, and Management of *Kurtomathrips morrilli*: A New Pest of Cotton on the Texas High Plains

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ABSTRACT

***Kurtomathrips morrilli* Moulton is a thrips that occasionally attacks and severely damages cotton in the southwestern U.S., but there is little information available regarding this pest. In 2011, the south plains region of Texas was severely impacted by drought, which might have been a key factor resulting in an outbreak of *K. morrilli*. This outbreak encompassed an estimated 133,550 hectares of cotton (33% of total acreage in region), approximately 33,600 hectares of which received insecticide applications for this species. The outbreak resulted in an estimated loss of 24 million pounds of cotton lint, resulting in more than $20 million in damage and control costs. Water-deficit stressed cotton appeared to be most severely affected by *K. morrilli*, whereas cool temperatures (≤ 30°C) and precipitation appeared to mediate the outbreak. Regression analyses suggest that as few as 173 thrips-cumulative-insect-days per leaf during boll filling might be economically sufficient to justify an insecticide application targeting *K. morrilli*. Insecticide efficacy tests determined that the neonicotinoid insecticides acetamiprid, imidacloprid, and thiamethoxam, and the organophosphate insecticide, acephate, were highly effective in mediating *K. morrilli* infestations.**

The thrips species, *Kurtomathrips morrilli* Mouton, family Thripidae, was originally collected in Gila Bend, AZ from cotton, where it was recorded as causing severe damage (Moulton, 1927). The second report of this species occurred in 1939 in California where it was reported damaging chrysanthemums and also was collected from southern mule's ear, *Wyethia ovata* (Bailey, 1957). Additional reports indicated that *K. morrilli* has been collected from a number of cultivated hosts, including beans, lantana, locust, snapdragon, and eggplant and from wild hosts including *Datura stramonium* L., *Malva rotundifolia* L., *Wedelia* sp., and *Wisteria* sp. (Bailey, 1961; Bibby, 1958; Hoddle et al., 2008; McKinney, 1939).

K. morrilli is considered native to the western U.S. including California, Nevada, Arizona, New Mexico, and Texas, but also has been collected in Florida, Jamaica, and India (Hoddle et al., 2008). *K. morrilli* and three other species of the same genera are all reported as minute in size, usually wingless, sluggish in movement, and seem to be associated with the plant genus *Parthenium*. In India, *K. morrilli* has been collected from *Parthenium hyterophorus* L., which is also common along the U.S. Gulf Coast and central Texas (de Borbon, 2004). Similar species of plants can serve as a reservoir for *K. morrilli* in the southwestern U.S. including *P. confertum* Gray and *P. argentatum* Gray. *P. argentatum*, or guayule, is cultivated in the desert southwest for rubber. However, there are no documented collections of *K. morrilli* from either *P. confertum* or *P. argentatum*. Thus, the natural reservoir for *K. morrilli* in West Texas is uncertain. *K. morrilli* has been reported also in Hawaii infesting the exotic weed *Pluchea odorata* (L.) Cass., where it was considered as a possible biological control organism because it often quickly killed the weed (Bianchi, 1956; Sakimura, 1956).

Little is known concerning the biology of *K. morrilli* outside of previously mentioned taxonomic records, collections, and descriptions. However, it appears that most, if not all, of these collections occurred where warm, dry conditions prevail (Bianchi, 1965). *K. morrilli* was considered strictly apterous until alate forms were collected in Hawaii (Bianchi, 1965). In this paper we report observations, insecticide efficacy, and pest management tactics for *K. morrilli* in Texas cotton in 2011.

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MATERIALS AND METHODS

Three insecticide efficacy tests were conducted in commercial cotton fields grown near Seminole, TX. The fields were planted on 91.4-cm or 102-cm wide rows, and were irrigated using pivot irrigation systems. In this area during the 2011 cotton growing season, there was no rainfall, and although the crops were irrigated, there was usually insufficient water to meet evapotranspiration demand. All three tests were planted with the same variety, Phytogen 367WRF (Dow AgroSciences, Indianapolis, IN). All the tests were randomized complete block designs with four replications. Plots were 4-rows wide × 15.24-m in length.

At all locations, insecticides were applied with a CO_2-pressurized backpack sprayer equipped with two hollow-cone nozzles per row (TeeJet TX-6 nozzles; Spraying Systems Co., Wheaton, IL). The spray boom was calibrated to deliver 93.53 L ha^{-1} at 276 kPa. Insecticides were applied to all four rows of each plot.

Before the thrips was known to be *K. morrilli*, it was thought that the infestation might have been bean thrips, *Caliothrips fasciatus* (Pergande), which sometimes infests mid to late-season cotton in south Texas. Thus, insecticides that are known to be effective towards bean thrips were selected for evaluation. Insecticides evaluated at test site 1 included: imidacloprid (Trimax Pro; Bayer CropScience, Research Triangle Park, NC) 70 g a.i. ha^{-1}, acetamiprid (Intruder 70WSP; Gowan Company, Yuma, AZ) at 49 g a.i. ha^{-1}, acephate (Orthene 97; Amvac Chemical Corporation, Los Angeles, CA) at 543 g a.i. ha^{-1}, spinetoram (Radiant SC; Dow AgroSciences, LLC, Indianapolis, IN) at 53 g a.i. ha^{-1}, and spinosad (Tracer; Dow AgroSciences, LLC, Indianapolis, IN) at 88 g a.i. ha^{-1}. Because there are no published insecticide efficacy tests with *K. morrilli*, high use rates were used for all products evaluated. Insecticides were applied on 25 July 2011.

The purpose of test site 2 was to evaluate the efficacy of insecticides before the plants were severely damaged and to collect yield data. At test site 2, we eliminated the insecticides that did not appear to offer highly effective control within 7 d (based on test 1), and included lower rates of the effective insecticides as well as an additional active ingredient. Treatments included: imidacloprid at 47 and 70 g a.i. ha^{-1}, acetamiprid at 29 and 49 g a.i. ha^{-1}, acephate at 272 and 543 g a.i. ha^{-1}, and thiamethoxam (Centric 40WG; Syngenta Crop Protection, LLC, Greensboro, NC) at 50 and 70 g a.i. ha^{-1}. Treatments were applied on 17 August 2011.

The purpose of test site 3 was to evaluate the efficacy of oxamyl (Vydate C-LV; Dupont Crop Protection, Wilmington, DE). Oxamyl is commonly used in much of West Texas cotton near the pinhead size square stage for suppression of root-knot nematode, *Meloidogyne incognita* (Kofoid and White) Chitwood. If infestations of *K. morrilli* occur at this time (pinhead size square stage), it is useful to know if oxamyl applications can control or suppress the thrips. Oxamyl was evaluated at the common nematicidal rates of 280 and 560 g a.i. ha^{-1}. Applications were made on 25 August 2011.

Treatments were evaluated by collecting five leaves per plot at test site 1, and 10 leaves per plot at test sites 2 and 3. Leaves were arbitrarily collected from the 4-5 node positions from the middle two rows of each plot and immediately placed into 473-ml glass jars containing approximately 300 ml of a 30% isopropyl alcohol solution. The jars were sealed and samples were taken to the laboratory for processing. The content of each jar was poured into 90-mm diameter Büchner funnels containing 6.99-cm x 7.60-cm coffee filter paper. Each funnel was mounted to 1000-ml Erlenmeyer filter flasks attached to a vacuum pump. Filtered samples were examined using a stereo dissecting scope and the number of immature and adult thrips were counted from each plot (Fig. 1).

Figure 1. Apterous adult (bottom) and late instar (top) *K. morrilli* collected from cotton in Texas in 2011.

At test site 1, pretreatment collections and counts were conducted on 25 July 2011, and subsequent evaluations were made on 1 and 9 August. In addition to thrips, at test site 1 the eggs, immature, and adult forms of carmine spider mites, *Tetranychus cinnabarinus* (Boisd.), were counted on 9 August to determine if any of the treatments had the potential for increasing mite density. At test site 2, pretreatments collections and counts were conducted on 17 August, and subsequent evaluations were made on 24 and 30 August, and 8 September. Pretreatment collections and counts were conducted at test site 3 on 26 August, and treatment evaluations were made on 1 and 8 September.

At test sites 2 and 3, the middle two rows of each plot were harvested on 7 November and 11 October respectively, using a mechanized cotton stripper (International Harvester Model 95) with integrated scales. The weight of bur cotton harvested was recorded for each plot. An approximate 1-kg sample of bur cotton was taken from each plot during harvest and placed in 16.5-cm x 29.2-cm x 58-cm brown paper bags for storage and transport to the gin. Samples were ginned at the Texas AgriLife Research and Extension Center in Lubbock, TX on 10 November. Lint yield was calculated based on bur cotton plot weights adjusted for ginned lint turnout values.

All data were analyzed using ANOVA and means were separated using an F-protected Tukey's HSD ($P \leq 0.05$) (SAS Enterprise Guide, 2010). Thrips-to-yield correlation at test sites 2 and 3 was analyzed with simple linear regression (SigmaPlot 12: User's Guide, 2010), where thrips (adults + immatures) cumulative insect days were calculated (Ruppel, 1983) from each plot as the independent variable, and yield from each plot was the dependent variable. Data from test sites 2 and 3 were pooled for further analysis; yield data were normalized between test sites by transforming the data to proportion of the highest yielding plot within each test. Regression analyses were tested for assumptions of linearity using the Spearman rank correlation between the absolute values of the residuals and the observed value of the dependent variable, normality was tested using Saprio-Wilk's test ($P < 0.05$), and outliers were detected and eliminated based on Studentized residuals, and disproportional influence using DFFTTS, Leverage and Cook's distance tests (SigmaPlot 12: User's Guide, 2010).

RESULTS AND DISCUSSION

Observations on *K. morrilli* Biology. In 2011, a severe outbreak of *K. morrilli* was experienced in cotton in the south plains region of Texas. This outbreak encompassed an estimated 133,550 hectares of cotton, approximately 33% of the total cotton on the south plains at the time (Williams, 2012) (Fig. 2). Of the infested hectares, an estimated 33,600 hectares received insecticide applications. Additionally, *K. morrilli* was estimated to have caused the loss of about 11 million kg of cotton lint, resulting in more than \$20 million in losses and control costs (Williams, 2012). The first report of cotton infested with *K. morrilli* in 2011 occurred on 22 July in Gaines County near Seminole, TX. At the time of the initial infestations, most of the cotton was near or had reached cutout (≤ 5 nodes above white flower). Thus most of the cotton crop was filling bolls and few new bolls were being produced. During this physiological time in the cotton plant's development, water demand is near its peak (Loka et al., 2011).

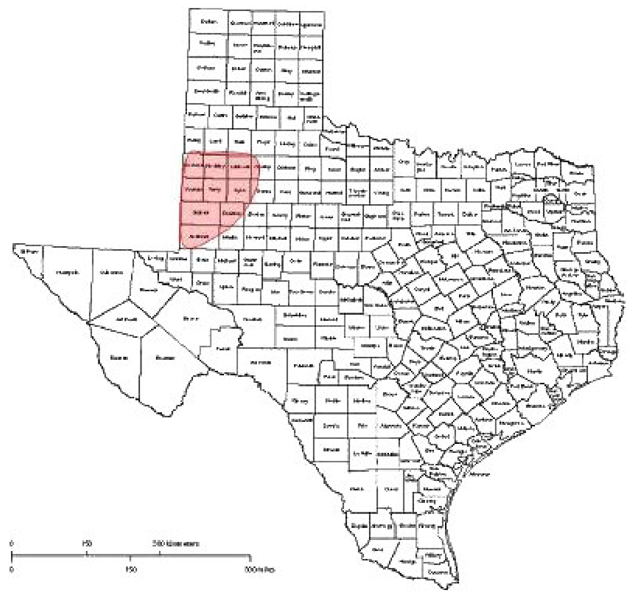

Figure 2. Approximate area of spread of *K. morrilli* outbreak in Texas in 2011.

Concurrently in 2011, Texas experienced the worst drought in the state's history (Nielson-Gammon, 2011). Infestations of *K. morrilli* appeared to be most severe in water-deficit stressed cotton in areas where irrigation was insufficient to completely meet the crop's water demand. Thrips infestation usually began on field edges, but circular patches of thrips-injured cotton could often be found away from the edge towards the fields' centers.

Collections of *K. morrilli* in 2011 suggested that approximately 2% of adult thrips collected were alate (Fig. 3). Whether most infestations were the result of alate migration or wind-blown apertous forms is not certain. Unlike most species of thrips commonly associated with cotton in West Texas, primarily western flower thrips, *Franklinella occidentalis* (Pergande), and onion thrips, *Thrips tabaci* Lindeman, *K. morrilli* is approximately 50% the size of these thrips. *K. morrilli* also was less active and did not quickly move about when disturbed, but was rather lethargic in nature as described by de Borbon (2004). Additionally, unlike western flower thrips, adult and immature *K. morrilli* did not appear to prefer blooms or the plant terminal, but was most common located on the abaxial leaf surface of fully expanded leaves, feeding along the veins. However, when populations were high the entire leaf commonly would be infested resulting in as much as 100% of individual leaves being injured.

Figure 3. Alate *K. morrilli* adult collected from cotton in Texas in 2011.

Injured leaves appeared grayish-silver in appearance, often with a dark speckling due to accumulated thrips feces (Fig. 4). Where water-deficit stress was most severe, easily notable injury from an infestation of *K. morrilli* on a field's edge could spread across as much as 40 hectares in less than 7 d. Injury from *K. morrilli* often occurred quickly; therefore, defoliation and death of plants was mistaken for drought stress. Consequently, curative actions were not applied in a timely manner.

Figure 4. Grayish-silver colored injury to cotton leaves resulting from *K. morrilli* feeding, and dark speckling from feces.

After the initial discovery of *K. morrilli* infesting cotton in Gaines County, infestations were discovered in Terry and Hockley counties within a few days. By mid-August, the infestation had spread through much of the south plains region and the infestation continued to spread north and eastward until cooler temperatures (≤ 30°C) prevailed in mid-September and infestations of *K. morrilli* ceased to be a problem.

Management— Insecticide Evaluations. Test site 1 occurred in the cotton field where the initial infestation of *K. morrilli* was discovered. The thrips population at this location was high relative to commonly occurring thrips species, averaging 136 thrips per leaf prior to spraying on 25 July (Table 1). At 3 d after treatment (DAT), the thrips numbers were highly variable among treatments and there were no significant differences. Although there were no differences among adult thrips at 7 DAT, differences were detected for immature and total thrips (immature + adult) densities (Table 2). Immature thrips were lowest in plots treated with acetamiprid, acephate, and imidacloprid. Neither the spinosad-treated nor the spinetoram-treated plots differed from the untreated in immature or total thrips densities at 7 DAT.

By 15 DAT, the thrips population had declined across the entire test and all the insecticide treatments had fewer immature thrips than the untreated. This decline in thrips was probably due to the severe deterioration of the plants. The producer of this field ultimately abandoned the one-half of the field where the infestation began. At 15 DAT, plots treated with acetamaprid and spinetoram had fewer adult thrips than the untreated. All of the treatments except the imidacloprid-treated plots had fewer total thrips than the untreated. Although thrips densities in the spinosad and spinetoram-treated plots were similar to other insecticide treatment at 15 DAT, because of the general decline in thrips densities throughout the test, and because these treatments appeared to lack efficacy at 7 DAT, they were not immediately identified as recommended treatments.

At test site1, spider mites were evident in low numbers prior to the insecticide applications. At 15 DAT, carmine spider mites were counted with the thrips; treating with acetamiprid increased the incidence of mites compared to all of the other treatments (Table 3). Thus, it might be advisable to use an alternative to acetamiprid for *K. morrilli* control if mites are present.

Table 1. Mean number of *K. morrilli* thrips prior to insecticide treatment and 3 d after treatment (DAT) at test site 1.

Treatment	Rate g a.i. ha^{-1}	Thrips per 5 leaves					
		25 July (pre-treatment)			28 July (3 DAT)		
		immatures	adults	total	immatures	adults	total
Untreated	--	377.75 a	167.50 a	545.25 a	293.75 a	51.25 a	345.00 a
Imidacloprid	70	665.00 a	110.50 a	775.50 a	90.00 a	5.25 a	95.25 a
Acephate	543	424.50 a	61.00 a	485.50 a	145.25 a	13.00 a	158.25 a
Acetamiprid	49	716.00 a	136.50 a	852.50 a	77.75 a	10.50 a	88.25 a
Spinetoram	53	545.00 a	113.75 a	658.75 a	154.75 a	14.50 a	169.25 a
Spinosad	88	509.25 a	242.25 a	751.50 a	227.25 a	17.75 a	245.00 a

Values in a column followed by the same letter are not significantly different based on an F-protected Tukey's HSD ($P > 0.05$).

Table 2. Mean number of *K. morrilli* thrips at 7 and 15 d after insecticide treatment (DAT) at test site 1.

Treatment	Rate g a.i. ha^{-1}	Thrips per 5 leaves					
		1 August (7 DAT)			9 August (15 DAT)		
		immatures	adults	total	immatures	adults	total
Untreated	--	334.00 a	61.25 a	395.25 a	139.00 a	56.00 a	195.00 a
Imidacloprid	70	55.50 b	5.75 a	61.25 b	21.25 b	22.00 ab	43.25 ab
Acephate	543	45.50 b	9.00 a	54.50 b	10.75 b	13.75 ab	24.50 b
Acetamiprid	49	23.00 b	1.75 a	24.75 b	0.50 b	1.75 b	2.25 b
Spinetoram	53	177.50 ab	14.50 a	192.00 ab	2.25 b	4.00 b	6.25 b
Spinosad	88	230.00 ab	18.75 a	248.75 ab	15.50 b	18.50 ab	34.00 b

Values in a column followed by the same letter are not significantly different based on an F-protected Tukey's HSD ($P > 0.05$).

Table 3. Incidence of carmine spider mite following insecticide treatments targeting *K. morrilli* at test site 1, on 9 August (15 DAT).

Treatment	Rate g a.i. ha^{-1}	Spider mites per 5 leaves			
		eggs	immatures	adults	motiles
Untreated	--	1.50 a	2.50 a	9.50 ab	12.00 a
Imidacloprid	70	0.00 a	0.00 a	0.00 b	0.00 a
Acephate	543	0.00 a	0.00 a	0.00 b	0.00 a
Acetamiprid	49	3.75 a	19.25 a	53.25 a	72.50 a
Spinetoram	53	0.00 a	0.00 a	0.00 b	0.00 a
Spinosad	88	0.75 a	0.00 a	1.50 b	1.50 a

Values in a column followed by the same letter are not significantly different based on an F-protected Tukey's HSD ($P > 0.05$).

At test site 2, the thrips population averaged approximately 23 thrips per leaf when the test was initiated on 17 August (Table 4). At 7, 13, and 22 DAT, all of the products and rates evaluated had fewer thrips than the untreated, but there were no differences among the insecticides (Tables 4 and 5).

Significant differences in yield were detected at test site 2 (Table 5). Thiamethoxam applied at 50 g a.i. ha^{-1} had the highest yield but was not statistically greater than either rate of acetamiprid, the higher rate of thiamethoxam, or the high rates of acephate and imidacloprid. Both rates of thiamethoxam and acetamiprid, and the high rate of acephate were the only insecticide treatments that yielded significantly more than the untreated.

Table 4. Mean number of *K. morrilli* thrips prior to insecticide treatment and 7 d after treatment (DAT) at test site 2.

Treatment	Rate g a.i. ha^{-1}	Thrips per 10 leaves: 17 August (pre-treatment)			24 August (7 DAT)		
		immatures	adults	total	immatures	adults	total
Untreated	--	172.00 a	51.25 a	223.25 a	217.00 a	57.75 a	274.75 a
Imidacloprid	47	154.88 a	225.71 a	380.60 a	42.25 b	10.00 b	52.25 b
Imidacloprid	70	158.25 a	29.75 a	188.00 a	22.75 b	6.75 b	29.50 b
Acephate	272	54.25 a	38.25 a	92.50 a	13.50 b	6.50 b	20.00 b
Acephate	543	168.88 a	51.05 a	219.93 a	13.00 b	13.00 b	26.00 b
Acetamiprid	29	204.50 a	57.25 a	261.75 a	13.00 b	12.50 b	25.50 b
Acetamiprid	49	154.50 a	41.75 a	196.25 a	15.75 b	14.75 b	30.50 b
Thiamethoxam	50	171.00 a	41.75 a	212.75 a	30.50 b	24.00 ab	54.50 b
Thiamethoxam	70	175.00 a	66.00 a	241.00 a	12.50 b	10.00 b	22.50 b

Values in a column followed by the same letter are not significantly different based on an F-protected Tukey's HSD (*P* > 0.05).

Table 5. Mean number of *K. morrilli* thrips at 12 and 21 d after treatment (DAT), and yield at test site 2.

Treatment	Rate g a.i. ha^{-1}	Thrips per 10 leaves: 30 August (13 DAT)			8 September (22 DAT)			Yield (lint-kg ha^{-1})
		immatures	adults	total	immatures	adults	total	
Untreated	--	227.00 a	52.25 a	279.00 a	53.00 a	30.00 a	83.00 a	483.12 b
Imidacloprid	47	13.00 b	15.75 b	29.00 b	2.00 b	2.25 b	4.25 b	508.78 ab
Imidacloprid	70	1.00 b	3.00 b	4.00 b	0.50 b	2.50 b	3.00 b	757.03 ab
Acephate	272	0.75 b	3.50 b	4.00 b	1.00 b	0.50 b	1.50 b	638.87 ab
Acephate	543	4.75 b	15.50 b	20.00 b	1.00 b	2.25 b	3.25 b	814.30 ab
Acetamiprid	29	0.00 b	0.50 b	1.00 b	0.75 b	0.75 b	1.50 b	798.43 ab
Acetamiprid	49	0.75 b	7.00 b	8.00 b	1.25 b	0.25 b	1.50 b	858.96 ab
Thiamethoxam	50	0.75 b	6.50 b	7.00 b	1.00 b	3.25 b	4.25 b	962.09 a
Thiamethoxam	70	0.75 b	4.25 b	5.00 b	1.00 b	0.25 b	1.25 b	770.13 ab

Values in a column followed by the same letter are not significantly different based on an F-protected Tukey's HSD (*P* > 0.05).

At test site 3, the thrips population was averaging 32.96 thrips per leaf on 26 August prior to the insecticide applications, and there were no statistical differences among treatments at this time (Table 6). At 7 DAT, oxamyl at 560 g a.i. ha^{-1} had fewer immature and total thrips than the untreated, but did not differ from oxamyl at 280 g a.i. ha^{-1}. By 13 DAT, the thrips population had increased in the untreated plots and both rates of oxamyl had fewer immature and total thrips than the untreated (Table 7). Oxamyl does have some activity on these thrips, but the level of activity does not appear to be as good as what was observed from some of the other insecticides in the other tests. However, oxamyl might offer sufficient control of *K. morrilli* populations if they occur in pre-bloom cotton at the time it is treated for nematodes, but additional supportive data is needed. No significant differences in yield were detected among treatments in test 3, but yields did show a negative trend with increasing thrips densities (Table 7).

Table 6. Mean number of *K. morrilli* thrips prior to insecticide treatment and 7 d after treatment (DAT) at test site 3.

Treatment	Rate g a.i. ha^{-1}	Thrips per 10 leaves					
		26 August (pre-treatment)			1 September (6 DAT)		
		immatures	adults	total	immatures	adults	total
Untreated	--	290.50 a	381.25 a	381.25 a	295.00 a	102.00 a	397.00 a
Oxamyl	280	214.50 a	293.50 a	293.50 a	159.25 ab	27.25 a	186.50 ab
Oxamyl	560	194.25 a	314.25 a	314.25 a	48.25 b	11.25 a	59.50 b

Values in a column followed by the same letter are not significantly different based on an F-protected Tukey's HSD (*P* > 0.05).

Table 7. Mean number of *K. morrilli* thrips at 14 d after treatment (DAT), and yield at test site 3.

Treatment	Rate g a.i. ha^{-1}	Thrips per 10 leaves			Yield (lint-kg ha^{-1})
		8 September (13 DAT)			
		immatures	adults	total	
Untreated	--	409.00 a	173.50 a	582.50 a	715.96 a
Oxamyl	280	141.50 ab	23.75 a	165.25 ab	799.41 a
Oxamyl	560	63.75 b	20.50 a	84.25 b	770.66 a

Values in a column followed by the same letter are not significantly different based on an F-protected Tukey's HSD (*P* > 0.05).

Table 8. Results of regression analyses between the number of cumulative insect days based on adult and immature of *K. morrilli* per leaf (X) and yield lint kg ha^{-1} (Y) at test sites 2 and 3.

Test	*F*	Pr > *F*	r^2	df	Regression equation	Slope SEM
Site 2	6.10	0.011	0.16	33	Y = 795.59 - 0.53X	0.21
Site 3	8.54	0.017	0.25	11	Y = 957.63 - 0.63X	0.22
Pooled[z]	4.97	0.032	0.11	42	Y = 0.73 - 0.0003X	0.0001

[z] Data for sites 2 and 3 pooled into a single set with yield values normalized by proportions.

At test site 2, there was a significant ($P < 0.05$), albeit extremely weak relationship, $r^2 = 0.16$, between thrips-insect days and yield (Table 8). Based on the slope, the cotton suffered a 50 kg ha^{-1} lint loss for every 94 cumulative thrips-insect days per leaf. The regression analysis for test site 3 was similar, showing a 50 kg ha^{-1} lint loss for every 79 thrips-insect days per leaf. Based on data pooled from both test sites, it appears that the cotton lost approximately 1% of its lint yield for every 33 cumulative thrips-insect days. If cotton lint was valued at \$0.31 kg^{-1}, and the cost of an insecticide treatment (insecticide + application) was \$16 ha^{-1}, then a lint loss of 51.8 kg ha^{-1} could be tolerated before economic injury. In cotton with a yield potential of 1000 kg ha^{-1} lint, an approximate 5% lint loss could be economically tolerated, which equates to about 173 cumulative thrips-insect days based on the pooled model. At the time of application, the *K. morrilli* populations were averaging 22 and 33 thrips per leaf at tests sites 2 and 3 respectively. If these populations remained constant, they would exceed the damage threshold at approximately 8 and 5 d respectively, less the number of thrips-insect days that had already occurred. Thus it is probable that both tests were near or had exceeded the thrips density and exposure time necessary to justify an insecticide application. However, *K. morrilli* thrips are minute and difficult to see; it is unlikely that they could be accurately counted using the naked eye or hand lenses. Until an accurate method for sampling and determining density of *K. morrilli* is devised, action thresholds for this pest will have to be based on damage and pest presence.

Decision Making. *K. morrilli* is an unusual pest of cotton that appears to occur under hot, dry conditions affecting primarily water-deficit stressed cotton. Although this is the first report of this pest damaging cotton in Texas, it is highly probable that this is an endemic species that has simply remained undetected. It is likely that dryland cotton grown in the south plains region of Texas has been affected by this pest in the past, but has gone unnoticed because most dryland cotton is not regularly scouted and because this pest impacts primarily water-deficit plants. Therefore, damage, defoliation, and death might be mistakenly attributed solely to the lack of water. Additionally, most dryland cotton suffering severe water-deficit conditions probably does not have the yield potential to economically justify protecting from *K. morrilli*. However, under conditions similar to those experienced in 2011, irrigated cotton grown under water-deficit conditions might be worth protecting. When making the decision to treat or not to treat consider the following:

1. What stage of growth is the cotton? Check boll maturity. If the bolls are mature (cutting the boll open and seeds have well defined cotyledons and seed coat versus those that are watery seeds), they might not be significantly damaged by the defoliation. If there are numerous bolls to mature, treatment might be justified. Make sure these immature bolls have the potential to yield enough to cover insecticide and the application expenses.
2. Choose the right insecticide. *K. morrilli* does not appear difficult to control with a number of insecticides including acephate, acetamaprid, imidacloprid, and thiamethoxam. The most commonly used insecticides in the 2011 *K. morrilli* outbreak were imidacloprid and acephate. These were the insecticides of choice primarily because they were inexpensive and effective.
3. Consider cost saving methods. Consider multi-target applications to save costs. If *K. morrilli* is present and an over-the-top herbicide application is scheduled, the addition of a relatively inexpensive, yet effective insecticide might save an application trip through the field solely targeting thrips. Spray field edges where *K. morrilli* is abundant and does not appear to be spreading into the field.
4. What is the weather forecast? *K. morrilli* appears adversely sensitive to cool temperatures and precipitation. If these conditions are predicted in the immediate future and you have field edges infested, then an insecticide application might not be necessary.

CONCLUSIONS

The purpose of this study was to record observations, evaluate insecticide efficacy, and devise control recommendations for an obscure pest of cotton, *Kurtomathrips morrilli*. Our observations suggest that *K. morrilli* is most likely to become a pest of cotton during periods of excessive heat and drought. Additionally, our observations suggest that *K. morrilli* is most likely to cause severe damage to water-deficit stressed cotton. Although *K. morrilli* has never before been described as damaging cotton in Texas, because it is an endemic species, it has probably occurred in Texas cotton in the past but gone unnoticed. Our data suggest that it might require no more than 173 *K. morrilli* thrips-insect days per leaf in cotton at the boll filling stage to result in economic loss. However, this thrips is minute in size and difficult to see even with 10X magnification. Thus it would be difficult to devise an action threshold based on accurately counting thrips. Alternatively, curative action should probably be based on damage and the presence of the thrips. Fortunately this species of thrips appears to be fairly sensitive to a number of insecticides including acephate, acetamiprid, imidacloprid, and thiamethoxam, and treating infestations positively impacts yields.

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DISCLAIMER

Trade names of commercial products included only for better understanding and clarity. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by the Texas A&M University System or LSU AgCenter is implied. Readers should realize that results do not necessarily represent conclusive evidence that the same response would occur where conditions vary.

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