UNITED STATES DEPARTMENT OF AGRICULTURE OMB Approved 0524-0039
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE Expires 03/31/2004

PROPOSAL COVER PAGE

1. LEGAL NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE
University of Georgia Research Foundation, Inc.

3. NAME AND TITLE OF AUTHORIZED ORGANIZATIONAL REPRESENT
Gordhan L. Patel

2. ADDRESS (Give complete mailing address and Zip Code)
621 Boyd Graduate Studies Research Center
Athens, GA 30602

4. a. Telephone No.: 706-542-5939
b. Fax Number: 706-542-5946
c. E-mail Address: sponprog@ovpr.uga.edu

5. ADDRESS OF AOR (If different from Item 2.)

6a. TYPE OF PERFORMING ORGANIZATION (Choose 1 only)
01 USDA Agency
02 Other Federal Agency/Department
03 x 1862 Land-Grant University
04 1890 Land-Grant University (including Tuskegee Univ.)
05 1994 Land-Grant University
06 Private University or College
07 Non-Land-Grant Public University or College
08 Private For-Profit
09 Private Non-Profit
10 State, Local or Tribal Government
11 Individual
12 Other ____________

6b. In addition, PLEASE CHECK ANY OF THE FOLLOW
x Cooperative Extension Service
Hispanic-Serving Institutions
Historically Black College or University (other than 1
School of Forestry
x State Agricultural Experiment Station
Tribal College (other than 1994)
Veterinary School or College

7. TITLE OF PROPOSED PROJECT (140-character maximum, including spaces)
Assessing the Pre-Season Risk of Thrips Vectors of Tomato Spotted Wilt Virus In Solanaceous Crops

8. PROGRAM TO WHICH YOU ARE APPLYING (Include Program Area and Number. Refer to Federal Register announcement or program solicitation where applicable)
Southern IPM Center

9. TAX IDENTIFICATION NO. (TIN)
58-1353149

10. CONGRESSIONAL DISTRICT NO.
12

11. DUNS NO. (Data Universal Numbering System)
00-431-5578

12. PROPOSED START DATE
07/01/04

13. DURATION REQUESTED (No. of mo
12 months

14. TYPE OF REQUEST (Check only one)
X New   Renewal   Supplement   Resubmission   Resubmitted Renewal
Continuing Increment   PD Transfer   [PRIOR USDA Award No. ____________]

15.FEDERAL FUNDS REQUESTED (From CSREES-2004)
$ 27,902

16. PROJECT DIRECTOR (PD)
David G. Riley

17. PD BUSINESS ADDRESS (INCLUDE DEPARTMENT/ZIP CODE)
P.O. Box 748
Department of Entomology
Coastal Plain Experiment Station
Tifton, GA 31793

18.a. PD Phone No.: 229-386-3374
b. PD Fax No.: 229-386-3086
c. PD E-mail Address: dgr@tifton.uga.edu

19.CO-PD(s) NAME	TELEPHONE NUMBER	E-MAIL ADDRESS
Robert M. McPherson	229-386-3374	pherson@tifton.uga.edu
Alex S. Csinos	229-386-3370	csinos@tifton.uga.edu
Stanley Culpepper	229-386-3194	stanley@uga.edu

20.IF THIS IS A RESEARCH PROJECT, WILL IT INVOLVE RECOMBINANT DNA, HUMAN SUBJECTS, OR LIVING VERTEBRATE ANIMALS?
X No   Yes (If yes, complete Form CSREES-2008)

21. WILL THIS PROJECT BE SENT OR HAS IT BEEN SENT TO OTHER F INCLUDING OTHER USDA AGENCIES?
X No   Yes (If yes, list Agency acronym(s) & program(s))

By signing and submitting this proposal, the applicant is providing the required certifications set forth in 7 CFR Part 3017, as amended, regarding Debarment and Suspens and 7 CFR Part 3018 regarding Lobbying. Submission of the individual forms is not required. (Please read the Certifications included in this booklet before signing this form contained herein is true and complete to the best of its knowledge and accepts as to any award the obligation to comply with the terms and conditions of the Cooperative State Research, Education and Extension Service in effect at the time of the award.

SIGNATURE OF PROJECT DIRECTOR(S) (All PDs listed in blocks 16 or 19 must sign if they are to be included in award documents.) DATE

David G. Riley   Robert McPherson   Alex Csinos   Stanley Culpepper

SIGNATURE OF AUTHORIZED ORGANIZATIONAL REPRESENTATIVE (Same as Item 3) DATE

SIGNATURE (OPTIONAL USE) DATE

OMB Approved 0524-0039
Expires 03/31/2004

Place this form after the last page of the signed original proposal only. Do not attach to the copies of the proposal!!!

PERSONAL DATA ON PROJECT DIRECTOR

The Cooperative State Research, Education, and Extension Service (CSREES) has a continuing commitment to monitor the operation of its review and award processes to detect--and deal appropriately with--any instances of real or apparent inequities with respect to age, sex, race, or ethnicity of the proposed project director.

To provide CSREES with the information it needs for this important task, complete the form below and attach it after the last page of the signed original of the application. **Do not attach copies of this form to the duplicated copies of the application.**

Upon receipt of the application by CSREES, this form will be separated from the application. This form will **not** be duplicated, and it will **not** be a part of the review process. Data will be confidential. CSREES requests Social Security Numbers for accurate identification, referral, and for management of CSREES programs. Provision of the Social Security Number is voluntary. No individual will be denied any right, benefit, or privilege provided by law because of refusal to disclose his or her Social Security Number. All analyses conducted on the date of birth and race and/or ethnic origin data will report aggregate statistical findings only and will not identify individuals. CSREES requests the Social Security Number under 7 U.S.C. 3318.

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Your cooperation will be appreciated.

Project Director/Co-Project Director(s) (Last, First, Middle):	Date of Birth	Gender	Social Security No.
RILEY, DAVID G.	06/08/57	MALE	253-11-7624

If additional space is needed for more co-PDs, please attach an additional sheet.

The following information refers only to the primary Project Director.

Race of PD - Check all that apply *(for statistical purposes only).*	Ethnicity of PD *(for statistical purposes only).*
__ American Indian or Alaska Native __ Asian __ Black or African American __ Native Hawaiian or Other Pacific Islander X White	__ Hispanic or Latino X Not Hispanic or Latino
Check here if you do not wish to provide some or all of the above information.	

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

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	PROPOSAL TYPE
Project Director(s) (PD): PD David G. Riley — Institution University of Georgia Co-PD Robert M. McPherson — Institution University of Georgia Co-PD Alex S. Csinos — Institution University of Georgia Co-PD Stanley Culpepper — Institution University of Georgia	**Regional IPM** [x] Special Projects Proposal
Project Title: Assessing the Pre-Season Risk of Thrips Vectors of Tomato Spotted Wilt Virus In Solanaceous Crops **Key Words:** Frankliniella fusca, tobacco thrips, Virus, Weeds, Integrated Pest Management	**For Higher Education Program Proposals Only:** Need Area: _________ Discipline: ___________

(Approximately 250 words) **PROJECT SUMMARY**

Project Title: *Assessing the Pre-Season Risk of Thrips Vectors of Tomato Spotted Wilt Virus In Solanaceous Crops*

Tomato spotted wilt virus (TSWV), which is vectored by several species of thrips, e.g. *Frankliniella fusca* and *F. occidentalis*, causes severe yearly losses ($100 million in certain years) to crops in the Southeast including tomato, pepper, potato, tobacco, peanut, and ornamentals. Similar losses occur in many Southeastern States. Management of TSWV has proven difficult because both the virus and its thrips vectors have broad and overlapping host ranges and our knowledge of TSWV epidemiology prior to the cropping season is fragmentary. Management of TSWV in susceptible vegetable crops requires multiple, expensive tactics, many of which have to be selected pre-season.

The goal of this project is to develop a system for predicting the timing and relative intensity of TSWV spread from overwintering hosts into susceptible crops in the spring. Such a preventative system would allow growers to adjust their selection of TSWV management tactics to the intensity of the TSWV problem and thereby avoid incurring unnecessary management expenses. We propose the following objectives. **1)** Conduct an extensive survey of thrips vectors of TSWV around commercial tomato and pepper field sites in Georgia with the intent of identifying pre-season risk to the crop. **2)** Develop a standard sampling technique that can be used by crop consultants and extension agents to assess a modified Relative Inoculum Potential (RIP) Index for TSWV developed by North Carolina State University for Georgia conditions. Although various surveys for TSWV have been reported for the Southeast in the last decade, only the RIP index survey provided an assessment of relative risk. This proposed survey will be the first attempt to predict TSWV severity based on a modified RIP index and other factors. It will concurrently provide this information in the form of a pest advisory to commercial growers as the data are gathered.

maintaining the data needed, and completing and reviewing the collection of information.

Form CSREES-2003 (12/2000)

UNITED STATES DEPARTMENT OF AGRICULTURE

COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

Southern Region Integrated Pest Management Center Proposal For FY2004-5

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Southern Region Integrated Pest Management Center Proposal - 2004

Assessing the Pre-Season Risk of Thrips Vectors of Tomato Spotted Wilt Virus In Solanaceous Crops

Literature Review, Previous Work and Related Experience: Tomato spotted wilt virus (TSWV), family Bunyaviridae genus *Tospovirus*, is an important plant virus, which in the Southeast is spread by thrips (Ullman et al. 2002), particularly *Frankliniella fusca* and *F. occidentalis* in the Southeast. The disease that this virus causes has a serious, negative economic impact on tomato, pepper, peanut, potato, tobacco, and flowering ornamentals. Populations of *F. fusca* have been associated with TSWV incidences in agronomic crops, such as peanut (Chamberlin et al. 1992, Garcia et al. 2000) and tobacco (McPherson et al. 1999) while *F. occidentalis* populations were highly associated with TSWV incidences in vegetables, such as tomato (Aramburu 1997, Riley and Pappu 2000, Nault et al. 2003), and ornamental crops (Gofflot and Verhoyen 1990). High percentages of *F. fusca* in thrips populations have been observed in pre-flowering tomato over the last several years (Joost and Riley 2004). This suggested that *F. fusca* could be a very important vector species in tomato since the earlier the virus transmission and symptom development, the more severe the crop yield loss that occurs (Aramburu et al. 1998, Moriones et al. 1998, Chaisuekul et al. 2003). TSWV has been increasing in importance in the Southern Region since the mid-1980's where *F. fusca* is prevalent and has resulted in extensive losses in these crops in Alabama, Florida, Georgia, Louisiana, North Carolina, and Texas. In Georgia and North Carolina, annual losses to TSWV have exceeded $100 million. In vegetables, TSWV now occurs consistently throughout the pepper and tomato production areas of North Carolina and Georgia, where 20% or more of plants in individual fields are commonly infected.

Frankliniella fusca overwinter in weed hosts, such as wild radish, *Raphanus raphanistrum* L., and chickweed, *Stellaria media* (L.) Vill., in Southeastern US (Groves et al. 2002). Thus, this thrips species can be important in maintaining TSWV over the winter and vectoring the virus early in the growing season. Brachypterous *F. fusca* are also important as overwintering TSWV vectors (Chamberlin et al. 1992, Wells et al. 2002). However, the specific role of *F. fusca* in vectoring TSWV to tomato crop plants is unclear. *Frankliniella occidentalis* can be present in high number during blossom stage of tomato (Salguero Narvas et al. 1991). This led to the assumption that *F. occidentalis* plays the major role in TSWV infection in tomato. However, the high density of *F. fusca* in early season of tobacco (McPherson et al. 1999), peanut (Chamberlin et al. 1992), and tomato (Joost and Riley 2004), and early inoculation of TSWV to tomato plants resulted in decreased yield compared to inoculation later in the season (Chaisuekul et al. 2003). Thus, the thrips population and reproduction in pre-blossom crop plants as well as winter weed reservoirs may be important to help clarifying the epidemic of TSWV in economically important host plants. *F. fusca* was also implicated in transmission of TSWV from winter weeds to crop plants (Johnson et al. 1995, Groves et al. 2001, and Groves et al. 2002).

Results of recent weed studies in Georgia indicated that thrips populations on weeds peak in late April (Fig 1) just before thrips peak in tomato blossoms in May (Riley and Pappu 2000). Also, the majority of thrips detected throughout the year on weed hosts were immature stages, suggesting that thrips reproduce year around on these hosts. The weed species with the most thrips overall listed in descending order were roadside verbena, Pennsylvania smartweed, various clovers, cudweed, wild mustard, Carolina geranium, and cutleaf evening primrose. In the bulk samples, TSWV was only detected in chickweed, *Stellaria media*, and henbit, *Lamium amplexicaule*, in February and March, and carpet weed, *Mollugo verticillata*, and sicklepod, *Cassia obtusifolia*. Interestingly, much of the henbit and chickweed plants were noted to be at full maturity and even in senescence in late February/early March which would coincide with tomato transplanting. This could explain a possible movement of thrips out of those weed hosts at that time. In individual plant samples totaling 6,030 weeds collected between February and September 2002, Virginia pepperweed, Carolina geranium and common chickweed were the most common weeds infected with TSWV between February and April. Smallflower morning glory, Florida pusley and Florida beggarweed were the most common weeds infected with TSWV between May and September. The weeds in this survey with the most thrips overall in descending order were cutleaf evening primrose, roadside verbena, small leaf morning glory, Florida pusley, carpet weed, tropic croton, and common pigweed. In Georgia, TSWV was much lower in early 2003 than early 2002.

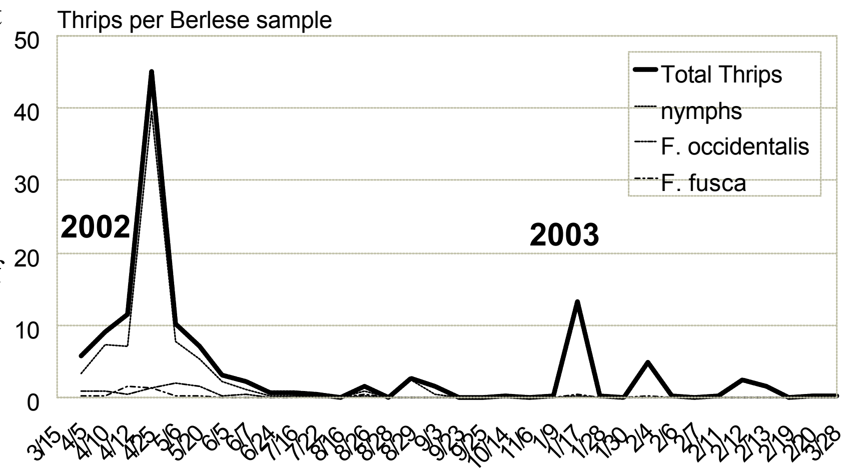

Figure 1. Total thrips from all weed samples extracted with Berlese funnels.

The management of TSWV can be greatly affected by the reproductive success of its thrips vectors. TSWV has spread across many parts of the world in part due to the reproductive effectiveness of its vectors. Thrips can reproduce sexually and parthenogenically, and potentially can double population within a short period (Lowry et al.1992), but many details are still unknown. Life histories of thrips, especially population dynamics of *F. occidentalis*, were reported in several crop hosts, such as chrysanthemum, cotton, cucumber, peanut, pepper, and tomato (Boissot et al. 1998). However, life table parameters were reported in a few selected crops, chrysanthemum (Katayama 1997, De Kogel et al. 1998), peanut (Lowry et al. 1992), and cucumber (Guam et al. 1994, Soria and Mollema 1995, Van Rijn et al. 1995, De Kogel et al. 1997), and a weed, Jimson weed, (Wijkamp et al. 1996). Also, there is a lack of publications on the life history of *F. fusca*, the other major vector of TSWV in southeastern U.S., in other crops besides peanut and mainly general population dynamic data have been reported (McPherson et al. 1999). Thus, a greater understanding of the reproduction of thrips as vectors of TSWV is needed, especially for winter weed hosts.

Management of TSWV has proven difficult because both the virus and its thrips vectors have broad and overlapping host ranges and our knowledge of TSWV epidemiology is fragmentary. No single measure has proven effective in managing TSWV. Sustainable management of TSWV in susceptible vegetable crops will require multiple tactics including weed management to reduce virus sources; adjusted planting dates, plant populations, row patterns, and tillage systems; reflective mulches; and soil applied treatments of imidacloprid insecticide. Cultivars with field resistance to TSWV are important in reducing losses but TSWV-resistant tomato and pepper do not always have the most desirable horticultural qualities. Most available tactics are selected pre-season and require some prediction of the expected severity of TSWV, which currently is just crop history data. Thus, implementing a multifaceted programs is currently expensive and logistically difficult without adequate predictive field scouting data.

The incidence of TSWV in susceptible crops and the associated losses vary greatly from year-to-year and location-to-location, reflecting the amount of TSWV spread from overwintering sources and the timing of that spread. For example, losses to TSWV in NC and GA during 2002 were devastating and unprecedented. In 2002 (Fig 1), populations of thrips and viruliferous weed hosts (Fig 2) were high in late winter and spring, and extensive spread of thrips and TSWV from overwintered weed hosts into crops occurred in April and early May. The year 2002 was considered a high incidence year for TSWV. In contrast, in 2003, populations of thrips vectors were low in February and March (Fig 1) and TSWV in overwintered weed hosts was lower than the previous year (Fig 2). These year-to-year differences in timing and intensity of TSWV create a situation in which growers do not implement expensive TSWV management practices in years when they are needed and unnecessarily implement expensive practices in years when they are not needed. Casual assessment of these data (Fig 2) suggests that TSWV incidence in winter weeds in January-February > 2-8 % is associated with a high incidence year and < 2 %, a low incidence year for TSWV. However, the more significant question is what level of thrips vectors is required at the beginning of the cropping season to result in a high risk to TSWV infection? Groves et al. (2002) were the first to begin answering this question with their Relative Inoculum Potential Index which assigns risk to a field site based on the presence of viruliferous weeds and thrips vectors quantified by percent area infested. The work in North Carolina resulted in the following observations. The timing and magnitude of thrips dispersal and of TSWV spread is determined locally at the field level. Consequently, virus source reduction in and around fields of susceptible crops will reduce the incidence of TSWV in the crop. TSWV

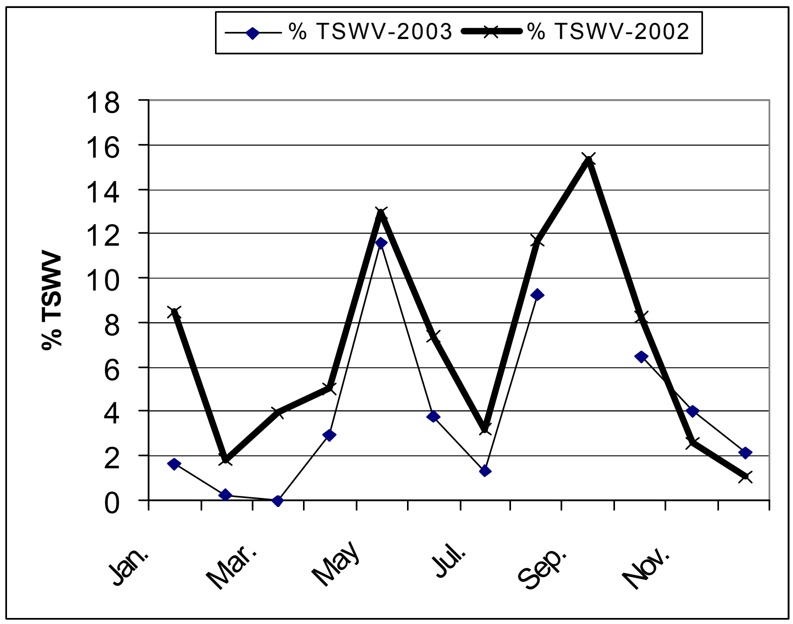

Figure 2. Total incidence of Tomato spotted wilt virus in all weeds sampled 2002-3.

overwinters as co-inhabitants of certain perennial and winter annual weeds but only to a very limited extent in infectious, diapausing thrips. Although over 20 common weed species that support overwintering infections of TSWV have been documented, weed species differ greatly in their ability to support reproducing populations of vectors and in the frequency in which they are infected by TSWV. North Carolina State University developed a *Relative Inoculum Potential Index*, which incorporates weed susceptibility to infection by TSWV and suitability as a host of tobacco thrips into a single index value describing the relative potential of commonly occurring weed species to serve as overwintering sources of TSWV. Weeds with the highest index values have the greatest potential to serve as sources for spread of TSWV in the spring. This index can be used to direct sampling for sources of TSWV. When combined with estimates of weed abundance, it can potentially be used to direct site specific weed management efforts to eliminate local sources of TSWV. Work at the University of Georgia expanded the list of weeds that can be used in this index in the last two years. An additional observation was that infected overwintering weeds growing in and around crop fields occur in patches or "hotspots" and that virus is spread to winter annual weed hosts in early fall, but subsequent spread during late fall and winter is extremely limited. Local spread of TSWV among winter annual weeds in early spring results in a dramatic increase in TSWV inoculum. Subsequent spread from winter annual weeds to crop hosts and early summer annual weeds occurs as infectious thrips disperse from their winter hosts and early spring hosts, primarily in May and early June. The greatest amount of TSWV spread occurs concomitantly with the senescence of TSWV infected weed hosts. We suspect that the spread of TSWV from a patch of infected winter annual weeds decreases with distance from the source but some spread occurs over distances of at least 100 feet. We know that populations of *F. fusca* and *F. occidentalis* on weed and crop hosts and thrips dispersal reach high levels in late spring, decline to low levels during the summer and increase again to intermediate levels in early fall. Thus, bouts of significant TSWV spread are generally limited to spring and fall. Spread in early spring increases the inoculum in weed hosts. Spread in late spring infects crops and summer annual weeds. In fall, virus spreads from summer annual weeds into the winter annual weeds. Because production of infectious thrips on TSWV-infected crops late in the season is very low, infected crops are not likely to be an important source of TSWV spread to winter annual weeds in the fall (peanut is a possible exception).

These findings show that a relatively limited number of weed species play a key role in the year to year persistence of TSWV at a site and its subsequent spread into crops. They provide the basic information needed to develop an efficient procedure for identifying local sources of TSWV inoculum. This information will be used to establish a TSWV risk index for tomatoes and peppers, which will determine in part the level of within season vector control tactics that should be used. Because within season TSWV and vector management procedures (e.g. reflective mulches, intensive chemical control of thrips and resistant cultivars) are costly and management intensive, the availability of a TSWV risk index will enable growers to limit their use to those situations in which they are truly needed. The proposed research will also evaluate ways to reduce or eliminate local sources of TSWV inoculum to prevent or mitigate spread of TSWV into the crop. Because elimination of inoculum may not be possible in all settings, we will also evaluate planting date as a potential tool to minimize crop exposure to TSWV.

In recent studies at Tifton, GA, based on over a decade of field data, we have observed that environmental conditions may play a role in the severity of TSWV in tobacco (Csinos, unpublished data). It appears that low temperatures and heavy rainfall during the early spring lead to a reduction in the disease during the coming growing season. Of the two weather-related factors, rainfall appears to play a greater role in suppression of the disease. Our data suggests that when rainfall levels for the month of March are at least 8 inches, the severity of spotted wilt in a tobacco crop is reduced compared to years in which March rainfall is less than 8 inches. The level of suppression due to rainfall is variable based upon location. For example, from one field to the next, you may have a higher disease incidence during the same year, but TSWV incidence in a particular field will be reduced from one year to the next when that field received 8 inches of rainfall during March. Temperature appears to have an affect on TSWV suppression only during years when March is relatively wet.

The long-term goal of this project is to develop a system for predicting the timing and relative intensity of TSWV spread from overwintering hosts into susceptible crops in spring. Such a system would allow growers to adjust their selection of TSWV management tactics to the intensity of the TSWV problem and thereby avoid incurring unnecessary management expenses. Although the development of a predictive system is beyond the scope of this one-year project, the objectives of the proposed research are designed to generate the information necessary to develop such a system. At the same time, these data will be used to alert growers to the risk of TSWV based on the parameters in the Relative Inoculum Potential (RIP) Index (Groves et al. 2002) and a tablulated risk associated with the inputs previously described (summarized in Table 1).

The occurrence of damaging levels of TSWV spread into susceptible crops is related to: a) the population size of thrips vectors developing on non-crop hosts of TSWV during late winter and spring; b) the abundance of sources of TSWV inoculum; and c) the presence of highly susceptible stages of crops at the time large numbers of infectious thrips are dispersing from sources of TSWV. The following objectives are designed to elucidate the determinants of each of these critical elements of TSWV spread into crops. This knowledge is essential to identifying conditions that are conducive to damaging incidences of TSWV and to predicting the timing and relative intensity of TSWV spread into crops in spring. To begin acquiring these types of data, the following objectives are proposed.

Objectives

Objective 1: Conduct an extensive survey of thrips vectors of TSWV around commercial tomato, pepper and other Solanaceous crop field sites in Georgia with the intent of identifying pre-season risk to the crop.

Objective 2: Develop sampling procedures / guidelines for identifying local, overwintering sources of TSWV inoculum near tomato and pepper and calculating a relative TSWV risk index that can be done by consultants and farmers.

These objectives will be accomplished using a coordinated series of field studies on commercial pepper and tomato field sites in Georgia in collaboration with the Ga. Cooperative Extension Service. The proposed study builds upon information being developed under the USDA-SRIPM grant "Identification and Mitigation of Overwintering Sources of Tomato Spotted Wilt Virus Infecting Vegetable Crops" to North Carolina State University and University of Georgia, which runs from Sept 2002 to Sept 2004.

Table 1. Georgia TSWV risk assessment program developed by Brown et al. (1999) for peanuts

compared to similar risks in solanaceous crops estimated from multiple sources.

A. Established TSW of Peanut Risk Index parameter (shaded) - assigned values		B. Newly proposed TSW Risk Index for solanaceous crops	
Cultivar	20 (resistant)-50 (susceptible)	Cultivar	10 (resistant)-40(susceptible)
Planting Date	5 (May 1-15)-25 (<April 11)	Transplant Date	not established
Plant Population	5 (>4 plants/ft)-25 (<2/ft)	Plant Population	not established
At-Plant Insecticide	5 (phorate)-15 (none)	Insecticide Program*	10 (program)-20 (none)
TSWV History	-10 (min.) - +10 (severe)	TSWV History	not established
Row Pattern	5 (twin)-15 (single)	Plastic Mulch	0 (reflective) - 20 (black)
Tillage System	5 (conventional)-10 (residue)	Tillage System	not established
Rainfall in March	currently not used	Rainfall in March	0 (>8") - 25 (<8")
modified RIP Index	currently not used	modified RIP Index	-10 (<1) 15 (1-5) 30 (>5)

*Insecticide program consists of imidacloprid to reduce thrips feeding and an early 4-week control schedule with efficacious thripicides, such as methamidophos and lambda-cyhalothrin, applied foliarly or Actiguard treatments.

The most fundamental and effective approach to managing insect transmitted plant viruses is through prevention, that is, the elimination of the virus source or isolation in space or time of the susceptible crop from the virus source. The use of this approach to manage TSWV will likely prove to be both effective and durable. However its application requires knowledge of the important sources of TSWV inoculum. We propose to begin assessing risk of TSWV and validation studies in commercial tomato and pepper fields. In peanut, a Georgia TSWV risk assessment program has been developed (Brown et al. 1999) to reduce crop production risks associated with this pest complex and we would like to try a similar approach in Solanaceous crops (Table 1). An integrated approach will make the best use of all existing control tactics, but we need to begin identifying the relative importance of individual control tactics in tomato as has been done in peanuts. The current peanut index and the proposed tomato index are summarized in Table 1 (total points<65=low risk, >115=high risk). We will do on-farm comparisons of a best TSWV-thrips management program compared to a typical management program and record treatments and results for each. The number of thrips by species, incidence of TSWV in host plants, and crop yield will be the main parameters measured. We will correlate pre-season risk factors for thrips vectors of TSWV and within season practices to reduce TSWV impact on the crop using the risk values in Table 1 with measured yield loss associated with TSWV damage.

Procedures

The two main vector species to be sampled include tobacco thrips, *Frankliniella fusca* and western flower thrips, *F. occidentalis,* but other species will be be monitored as well. In the field, TSWV is spread only by adult thrips that have acquired the virus by feeding on an infected host plant as larvae. Thus, for a plant to serve as a source of inoculum for spread of TSWV, the plant must not only be susceptible to TSWV infection via thrips inoculation, but it also must be capable of supporting thrips reproduction and the production of significant populations of infectious adult thrips. The proposed procedures will provide the means to identify and potentially predict local sources of TSWV inoculum so that growers can act to prevent or minimize spread into susceptible crops.

The survey will be initiated on July 1, 2004 by selecting tomato and pepper field sites in the four counties in Georgia where significant acreage of these crops are found, Decatur, Brooks, Colquitt and Tift counties. Each county will have two pepper fields and two tomato fields, each with histories of high and low incidence of TSWV to establish a range of inoculation potential. The sampling at each location will consist of a monthly collection weeds of six one-gallon bags full of one individual weed species from the following lists. *Summer-Fall:* 1) morning glory (small flower or entire leaf), 2) purslane, 3) spiny sowthistle, 4) wild radish, 5) Florida beggarweed and 6) Florida pusley. *Winter-Spring:* 1) chickweed, 2) cudweed, 3) sowthistle, 4) Virginia pepperweed, 5) swinecress, and 6) Carolina geranium. Samples will be brought to the lab and three subsamples from this will be weighed and placed into fine mesh sealed quart containers with beans, i.e. the bean cup method. One sprig or root from each cup will be placed into a coin envelope and sent to the Dept. of Plant Pathology for virus testing using ELISA for TSWV. The remaining sample will be weighed and be placed into Berlese funnels for extraction. The above bean cup samples will be weighed and the thrips extracted by desiccating each sample in the presence of a bean pod using the procedure of Groves et al. (2001). This method allows for the rearing of thrips to adults for species identification. Adult thrips will be removed from the sample after 2 days under desiccating conditions and the immature thrips will be reared to adult on the bean pods. We will modify this procedure slightly by dusting beans with a pollen source to favor flower thrips reproduction. To determine the thrips species present, a composite subsample of up to 100 originally extracted adults and adults reared from immature thrips extracted from the samples from each plot will be identified to species. Thrips populations will be expressed as numbers per 10 grams (fresh wt.) of plant tissue.

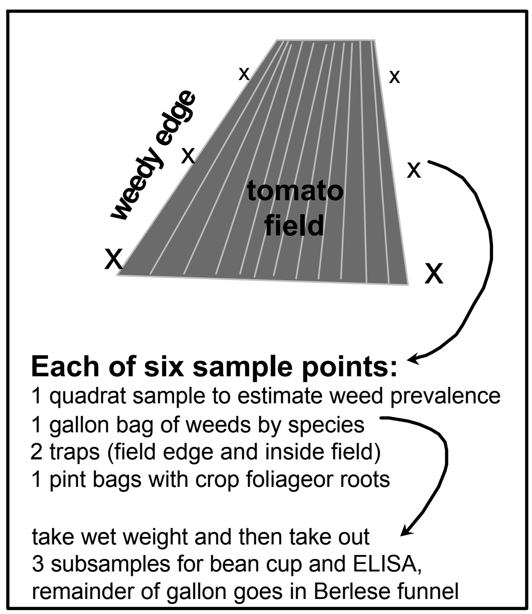

Figure 3. Schematic of site sampling plan.

Yellow sticky traps will be placed in and around the susceptible crop and surrounding weeds to monitor aerial dispersal of *F. fusca* populations. Thrips will be sampled at each site using traps from 6 randomly selected points per field along the field edge with a trap 20 ft within the field and 20 ft outside of the field at each point. Traps will be placed in the field for one week on a monthly basis beginning in July to June with biweekly from mid-February to mid-April for greater resolution for spring migration of thrips.

The disease progress of TSWV among plants within each field site will be measured monthly beginning in February. Leaf tissue from each plant in each plot will be tested for TSWV infection using DAS ELISA and . The proportion of total plants per plot that are infected and the position of each infected plant within each plot will be recorded and pattern of spread within each plot will be determined. The experiment will be repeated in a following year of the project if re-funded to increase the range of temperature regimes experienced. Beginning October 1 and continuing through November, TSWV movement into winter weeds will be monitored by sampling the plants in each chickweed subplot every month using a composite sample of sprig from each plant and then individual plant sprigs if a plot tests positive for the virus. During the period beginning one month prior to transplanting tomato and pepper, TSWV movement will be monitored using *Petunia hybrida* indicator plants in the field margins. This will allow early detection of TSWV spread from the weed source to the surrounding area prior to crop. TSWV will be sampled in identified weed source plants and surrounding weeds monthly during the growing season using the same method as above. Sampling of the crop for TSWV will include foliage or root samples from each plant which will be subjected to ELISA. . Tomato transplant date at each location will be recorded and TSWV incidence in the 18 tomato plants (3 sets of 6 at increasing distance from the 6 established field edge sample sites into the field) will be monitored using ELISA at 1, 8 and 12 (harvest) weeks following transplant and monthly using leaf symptoms. The effect of treatment on timing and amount of TSWV movement into chickweed in the fall, spread among chickweed during the winter and spring, and into pepper and tomato in the spring will be analyzed using analysis of variance. Data on thrips dispersal will be used to aid in interpretation of timing and amount of virus spread. The experimental design will be a randomized complete block (county =block) replicated 4 times. Regression models should prove useful in describing the role of temperature and rainfall in determining thrips populations and inoculum levels of TSWV present in weed hosts in spring, which serve as sources for spread into susceptible crops. Similar regression models developed by Davidson and Adrewatha (1948) proved extremely valuable for predicting outbreaks of *Thrips imaginis* based on temperature and rainfall.

Data analysis: Population fluctuations over time will be related to temperature and precipitation (amounts, number of precipitation events above yet-to-be-determined minimum levels, and frequency) using multiple regression procedures. Additional regression analyses will be conducted to explore possible relationships between thrips populations and the magnitude and duration of rainfall events. Regression analysis will be used to relate proportion of plants per plot infected with TSWV to thrips populations. However, the immediate use of the data will be to estimate a modified RIP index for each location of low (<1), medium (1-5), or high risk values (>5) to provide back to the county agent and grower cooperators. The RIP index described by Groves et al. (2002) was RIP= (the percentage of the sites in which a weed species occurred that contained one or more TSWV-infected plants of any species) * (estimated percentage of plants of the subject species infected with TSWV) * (proportion of total immatures vector thrips species encountered in samples of all weed species in the survey that occurred on the subject species). This provided relative inoculation potential across weed species. We will focus the survey on weed species that already have relatively high inoculation potential. Thus we propose a modified RIP index that simply accounts for percent viruliferous plants with immature thrips vectors at a location to estimate potential risk.

modified-RIP = <u>(# plants with TSWV and vector immatures)</u> X 100

Total # plants sampled

The modified RIP index above is based on the assumption that only viruliferous plant with vector immatures count toward inoculation potential for the crop and the ranges of <1=low and >5=high is based on historical regional data of the % viruliferous weed hosts associated with low or high TSWV incidence in the month prior to planting in the spring and summer seasons (Fig 2). These data will be summarized and provided back to the growers and extension agents in the same month of collection so that management actions can be decided on for the location and/or the county. Field sites will be monitored for the management practices they employ and the quality of yield by site. The observed thrips populations and TSWV incidence will be compared to model predictions (assigned risk values in Table 1) to determine the accuracy of the model and need for modification.

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Probable Duration:

2004	July	Initiate surveys in the four counties using the summer-fall weed list and selected pepper and tomato commercial field locations. Samples from each county will be processed in the following order: week 1 - Decatur, week 2 - Brooks, week 3 - Colquitt, week 4 -Tift, and each county will be notified the following week of the results along with pest advisories to the GFVGA summarized across locations at the end of the month.
	Oct.	Take yield data from each field location and summarize the resulting data by location and using correlations to estimate value of risk of factors across all locations
2005	Jan.	Continue surveys in the four counties using the winter-spring weed list and selected pepper and tomato commercial field locations. Report on findings from the fall at the Georgia Fruit and Vegetable Association (GFVGA) Annual Meeting
	Feb.	Intensify trap sampling to document spring movement of thrips
	April	Resubmit proposal to the Southern IPM Center for continued funding with updated procedures and information.
	June	Summarize results and submit report to CSREES and the GFVGA quarterly bulletin.

Evaluation Plans

Data will be analyzed to determine the accuracy of predicted risk of TSWV infection to actual rates of infection in the field. County agents will be asked for their evaluation during the GFVGA meeting for the fall season and at the end of the project after viewing the final report for both growing seasons. Grower receiving pest advisories through the GFVGA will be asked via email what the utility of the advisories were for them and how they might be improved in April 2005 so that this response can be included in our request for renewed funding. A meeting will be arranged of scientists, agents, growers and consultants in June in conjunction with a vegetable field day to discuss the data from the previous year and adjust and/or expand risk values in Table 2.

Cooperation and Institutional Units Involved

This research will be a collaboration between tenured faculty in the Departments of Entomology, Plant Pathology, and Crop and Soil Science at the University of Georgia, the GFVGA and the Cooperative Extension Service. TSWV vector incidence curves will be developed for each location based on the respective thrips population dynamics, the over-wintering weeds and crop host for that county location in collaboration with the Georgia Cooperative Extension Service.

Key Personnel

The principal investigator, D. Riley, will serve as the project director for the overall effort. He has 14 years of professional experience in vegetable entomology research, 6 years with Texas A & M University where he attained Associate Professor in a non-tenure track position and 5 years as Assistant Professor in a tenure-track position and 3 years as a tenured Associate Professor at the University of Georgia. He was awarded a College level, Award of Excellence for Junior Scientist in 1997, the Sigma Xi Creative Research Award in 2002, and continues to aggressively research critical pest problem affecting the major vegetable crops in Georgia. Riley at UGA will be responsible for site selection, establishment of experiments, monitoring of thrips dispersal and virus spread. A Csinos at UGA will be responsible for overseeing the ELISA assays and evaluating virus data for the project. He brings years of experience working tomato spotted wilt virus (TSWV) and has been the principle pathology researcher for TSWV management in tobacco. Stanley Culpepper is the extension specialist for weed management in vegetables in Georgia and brings a wealth of information on weed control and plant population dynamics.