FHP Technology Development Project Proposal

PROJECT STATUS: New, not previously funded

PROJECT NUMBER: R05-1999-04

PROJECT TITLE: Evaluation of Technologies to Distribute in Hawaii Forests Two Fungal Biological Control Agents of Introduced Weeds.

SUBJECT: Biological control of non-indigenous plants in Hawaii

PROJECT OBJECTIVES:

1: Evaluate application technologies at different sites of Hawaiian forests to establish Septoria passiflorae on Passiflora tripartita var. tripartita and Septoria sp. on Lantana camara.

2: Monitor the effects of these pathogens on the target weeds' populations.

BRIEF DESCRIPTION OF THE PROJECT:

This project develops and puts to use technology for improving release methodology and evaluation of control effectiveness of two fungal biological control agents of two noxious forest weed species in Hawaii. The agents considered are foliar pathogens of Banana Poka (Septoria passiflorae) and Lantana (Septoria sp.). Both fungi have gone through rigorous host-specificity tests and have been approved for release by the Hawaii Board of Agriculture and USDA-APHIS. Technology development will focus on methodologies to improve rapid establishment and wide spread distribution for these agents, and for the design and implementation of post-release monitoring of weed populations controlled by each agent.

FHP PERSON WHO WILL LEAD THE PROJECT: Duane Nelson, Forest Health Coordinator, Institute of Pacific Islands Forestry, USDA Forest Service, Hilo, Hawaii.

JUSTIFICATION: Banana poka is the most aggressive introduced weed of high elevation forest areas in Hawaii (Trujillo & Norman, 1994). More than 500 km2 of forest on Kauai and Hawaii were affected in 1981 (Warshauer, et al, 1983). This species has also spread to the Makawao
Forest, in Maui. The most serious infestation is in the Hilo Forest Reserve of Hawaii. In this Reserve the vine covers the canopy of more than 15,000 ha of native Koa forest. In the last 10 years DLNR-Division of Forestry and Wildlife (DOFAW) expended more than $130,000 annually in manual and mechanical control of the vine without success (Steve Bergsfeld, 1998 personal communication). Lantana is a serious threat to the

survival of the native Hawaiian flora in the Kokee forest (Trujillo & Norman, 1995), where more than 10,000 ha. are affected. Its distribution is dependent on fruit-eating birds (Wagner, et al, 1990). This weed is also a deterrent to hikers because of its sharp spines that cause painful skin lacerations.

URGENCY:

The Hilo Forest Reserve is the most heavily infested native koa forest with banana poka. Clearing this forest of banana poka by mechanical or chemical means will cost millions of dollars, and the task will take years. The Kokee State Park has the largest infestation of bush lantana. The cost of controlling this plant by hand or mechanical means is prohibitive. Thorough distribution of inoculum of both pathogens may provide adequate control of these species in 4-5 years.

Both pathogens have been field sprayed on their host leaves in distilled water solution of 2% sucrose and 0.5% gelatin at 1 X 106 spore/ml. Solutions have been applied to wetness with hand spray bottles. Monitored data indicates these pathogens may produce ascospores (sexual stage) on diseased fallen host leaves found on the forest floor. Therefore, collection of fallen diseased leaves for distribution throughout infested areas of these weeds could induce massive disease epidemics and accelerate their control.

LINK TO NATIONAL FHP TECHNOLOGY DEVELOPMENT PRIORITIES

· Develop or refine biocontrol methods for established species (native and non-native) and established pest populations: Application technologies refined in this study will facilitate control of two alien weed species threatening the ecological integrity of sub-tropical forests throughout Hawaii and other Pacific islands. Without effective biological control, populations of these two invasive forest weeds continue to expand in Hawaii.

· Proposals that deal with detection, analysis, and management of exotic pests including exotic weeds that result in technologies or methods that contribute to our ability to prevent introductions or to detect and eradicate new introductions. The two species targeted for biocontrol in this proposal are invasive non-indigenous weeds of Pacific high islands. If effective, the methods investigated will provide low-cost, low-tech solutions for the introduction and spread of fungal biocontrol agents that can be used locally with small investment and minimal training.

SCOPE OF APPLICATION: The scope of application for this project includes the State of Hawaii and U.S. territories of Guam and American Samoa, and high islands of FSM e.g Kosrae and Pohnpei, where Lantana is an invasive weed. Biological control technology developed in this proposal will be applicable to other Pacific Island nations. Development of infected dry host leaves as inoculum of fungal bioherbicides could facilitate distribution of biocontrol agents to areas that lack laboratory facilities for the mass production of inoculum using fermentation technology (Churchill, 1982).

RESEARCH BASIS: Each of the two weeds considered in this proposal are targets of ongoing classical-bioherbicide (Freeman et al., 1976; Templeton & Trujillo, 1981) biocontrol program of the Hawaii Department of Land and Natural Resources (DLNR) in cooperation with the University of Hawaii (UH). The two fungal biocontrol agents proposed for study has been thoroughly tested by UH and confirmed host specific. Both Septoria spp. have been approved for release by the Hawaii Board of Agriculture and USDA-APHIS, and reviewed by USFWS (Trujillo & Norman, 1994 and 1995).

Technology developed for increasing the efficacy of "mycoherbicides" in agricultural systems (Boyette et al 1991) can be applied in classical biological control of forest weeds to increase the establishment of fungal pathogens and accelerate their spread. In previous biocontrol programs, Norman & Trujillo (1995) developed spore preservation and application procedures that enhanced infectivity of both Septoria passiflora and Colletotrichum gloeosporioides f.sp. clidemiae, fungal pathogens of banana poka and Clidemia. Extension of the shelf life of a "mycoherbicide" by producing spores on solid substrates was demonstrated by Hildebrand and McCain (1978), which used wheat straw infested with Fusarium solani f.sp.cannabis to control marijuana, and Boyette (1982) that used oat seed infested with F. solani f.sp. cucurbitae to control Texas gourd.

METHODS:

Objective 1: Biocontrol agents application using mass produced inoculum obtained through microconidiation technology (Norman & Trujillo, 1995) will be compared to inoculum produced on host infected foliage after leaves drop from diseased plants. Disease incidence will be measured by counting lesions/newly-infected leaf, and the average number of lesions/leaf for different treatments will be the variable used in one-way ANOVA analysis to determine treatment effectiveness. Inoculum production on diseased abscised leaves will be determined for leaves at different storage temperatures and times. Factors involved in the production of the perfect stage of both pathogens will be elucidated. Rotorod samplers (Metronomics Associates, Inc, 3201 Porter Drive, Palo Alto, CA) will be used to trap airborne spores to determine what role the sexual and asexual spores play in disease epidemics.

Objective 2: Effects of pathogen on weed population will be measured bi-monthly by using the reference marker photopint system of Case, et al, 1982. Biomass reduction will be determined by estimating percentage of plant defoliation at selected forest sites. Data compiled will be statistically analyzed by using one-way ANOVA , and comparison of means will be made using Tukey's LSD.

MEASURES OF SUCCESS:

1) Development of widespread epidemics of both diseases throughout target weeds infested forests.
2) Massive defoliation of target weeds.
3) Measurable weed population decline.

4) Development of a new technology for field application of biocontrol agents, which will be effective, low cost, and can be put to use by forest personnel.

COOPERATORS:

Name
Affiliation
Role
Eduardo Trujillo
University of Hawaii- Manoa
Principal Investigator, 10% time (UH will also supervise a full-time post-doctoral position for the project)
Victor Tanimoto
Hawaii DOFAW
Coordinating field study locations and operations
Duane Nelson
USDA-FS, Institute of Pacific Island Forestry
FS project coordination.

PRODUCTS: 1) Low cost, effective and practical procedure for application of fungal biocontrol agents to forest weeds. 2) Significant reduction of target weeds. 3) Publications documenting results.

PUBLICATION: Project participants will aim for publications in Plant Disease, and Conservation Biology.

TECHNOLOGY TRANSFER: These products will have general applications, not limited to these particular biocontrol agents or their weed hosts. American Samoa, and nations in the Pacific e.g. Fiji, New Zealand, Western Samoa, can benefit from technology developed in this project.

PROJECT DURATION: Establishment and initial monitoring will be completed in FY 1999. Follow-up monitoring will be completed in 2000. Additional STDP fund will be needed.

LONG TERM BUDGET: Two-year project, see below

BUDGET REQUEST:

	FY-1999	FY-2000
ITEM		
FHP		
OTHER SOURCES		
FHP		
OTHER SOURCES		

Admin Items:

Salary
Postdoc
22,760
14,600
23,428
15,200

Student help

1,600

2,000

Travel
4,000

4,000

Procurement:

Equipment
Spore traps
Hygrothermographs
2,000
1,400

Digital camera

800

Other
Misc. Supplies

2,000

1,000

3,000

1,000
TOTALS

32,160
18,000
32,428
16,200
Other sources: Cash contributions through UH-Manoa
In-kind services will be provided through DOFAW for project site selection and field coordination

Citations:
Boyette, C. D. 1982. Evaluation of Fusarium solani f.sp. cucurbitae as a potential bioherbicide for controlling Texas gourd. PhD, Dissertation, UA, Fayetteville.
Boyette, C. D., Quimby, Jr., P. C., Connick, Jr., W. J., Daigle, D. J., and Fulghm, F. E. 1991. Progress in the production, formulation, and application of mycoherbicides. Pages 209-222 in: Microbial Control of Weeds, D. O. TeBeest, ed. Chapman Hall, New York.
Churchill, B. W. 1982. Mass production of microorganisms for biological control. Pages 139-156 in: Biological Control of Weeds with Plant Pathogens, R. Charudattan and H. L. Waker, eds. Wiley, New York.
Freeman, T. E., Charudattan, R. and Conway, K. E. 1976. Status of the use of plant pathogens in biological control of weeds. Pages 201-206 in: Proc. IV Int. Symp. Biol. Contr. Weeds, T. E. Freeman, ed. Inst. Food and Agric. Sci., University of Florida, Gainesville.
Hildebrand, D. C., and McCain, A. H. 1978. The use of various substrates for large-scale production of Fusarium oxysporum f.sp. cannabis inoculum. Phytopathology 68:1099-1101.
Norman, D. J., and Trujillo, E. E. 1995. Development of Colletotrichum gloeosporioides f.sp. clidemiae and Septoria passiflorae into two mycoherbicides with extended viability. Plant Dis 79:1029-1032.

Templeton, G. E., and Trujillo, E. E. 1981. The use of plant pathogens in the biological control of weeds. Pages 345-350 in: CRC Handbook of Pest Management in Agriculture, Vol II, D. Pimentel, ed. CRC Press, Inc. Boca Raton, Florida.
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Trujillo, E. E., and Norman, D, J. 1995. Septoria leaf spot of lantana from Ecuador: a potential biological control for bush lantana in forest of Hawaii. Plant Dis. 79:819-821.
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Warshauer, F. R., Jacobi, J. D., LaRosa, A. M., Scott, J. M., and Smith, C. W. 1983. The distribution, impact, and population management of the introduced vine Passiflora mollisima (Pacifloraceae) in Hawaii. Tech. Rep. 48, Univ. Hawaii Coop. Natl. Park Resour. Stud. Unit. University of Hawaii, Honolulu.