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EVALUATION OF TOMATO BREEDING LINES FOR RESISTANCE TO **Sclerotium rolfsii** AND CONTROL OF SOUTHERN BLIGHT OF VEGETABLES

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ABSTRACT

Results of experiments conducted to evaluate several tomato breeding lines for resistance to **S. rolfsii** showed that tomatoes carry very little resistance to this pathogen. However, **Lycopersicon pimpinellifolium** and some of its breeding lines were found to be resistant. Crop rotation using resistant or tolerant bell and hot pepper and bambara groundnut varieties significantly reduced the incidence of disease on subsequent tomato crop. Foliar applications of Bravo at 1 or 2 l ha^{-1} and Dithane M-45 at 1.2 and 2.4 kg ha^{-1} to control early blight reduced the disease incidence of southern blight and significantly increased yields of tomatoes. Applications of Tilt, 1-[[2-(2,4-dichlorophenyl)-4-propyl-1,3-dioxolam-2-yl]methyl]-lH-1,2,4-triazole) in both greenhouse and field studies reduced the incidence and severity of the disease on sweet banana peppers. Although plants showed phytotoxicity when dipped in solutions of Tilt, fairly good control was achieved if plants were inoculated 2 or more weeks after dipping in the fungicide solution before transplanting.

INTRODUCTION

Sclerotium rolfsii, the causal agent of southern blight, is one of the most important pathogens of vegetables in warm and humid countries. It causes great economic losses and has a wide host range. Southern blight is an economically serious disease of peppers, tomatoes, eggplants, cowpeas, sweet potatoes, carrots, beans and many other vegetable crops (Aycock, 1966; Dukes and Fery, 1983; Dukes, Fery and Jones, 1983; Jenkins and Avery, 1986). **S. rolfsii** is widely distributed in the tropics and subtropics where there are high temperatures during the rainy season. It is common in Africa, Australia, India, the Caribbean, Central and South America and Southern United States (Aycock, 1966; Punja, 1985). Because of its wide host range, control of this pathogen in a small limited resource vegetable farm and in home gardens is of prime importance in the vegetable crop programme at Tuskegee University.

Since one control method is hardly good enough, studies were conducted to evaluate several methods of control in an attempt to develop an integrated control of southern blight of vegetables.

METHODS OF CONTROL

Plant Resistance

About 300 breeding lines, five varieties and four wild species of tomato (**Lycopersicon** spp.) were evaluated for resistance to **S. rolfsii.** Four and eight week old tomato plants growing in 46 cm x 46 cm x 8 cm cavity seedling trays were inoculated with 1 cm agar plugs of actively growing **S. rolfsii.** Each cavity was 8 cm^3. Two grams of 'grits' (cornmeal) were added to the inoculum and then covered lightly with soil. The plants were placed on a bench in the greenhouse (28-31ºC), watered daily, and fertilized with 20-20-20 NPK solution weekly. Each treatment consisted of 16 plants.

Wilt symptoms were observed about 5 days after inoculation. In highly susceptible tomato varieties and breeding lines total death of plants was observed in 10 days. The experiments were terminated three weeks after inoculation. The per cent incidence of the disease was determined by the number of plants killed/total number inoculated x 100.

Results of this experiment indicated that tomatoes carry very little resistance to **S. rolfsii** (Table 1). **L. pimpinellifolium** and some of its offsprings were, however, found to be resistant. Generally the older the plants at the time of inoculation the greater the tolerance shown to the incidence of disease.

Table 1. Reaction of tomato cultivars and breeding lines to **Sclerotium rolfsii** inoculation four and eight weeks after planting

Cultivar	Disease incidence (%) 4 weeks	8 wks
Homestead	100	84
Better Boy	98	87
Floradade	100	89
Floradel	100	78
TI - 103	100	73
TI - 115	100	75
TI - 130 1/	30	12
TI - 277 1/	45	20
TI - 116 1/	25	20
TI - 120 1/	15	15
TI - 107	100	87
TI - 108	84	88
TI - 239	100	77
TI - 293 1/	10	8
S - 674	100	84
S - 677	100	87
S - 678	85	77
S - 684	97	86
S - 683	100	87
L. hirstum	67	54
L. pinmpinellifolium	5	0
L. chesmanii	87	84

1/ Breeding lines from **L. pimpinellifolium.**

Crop Rotation

Crop rotation has been used in many disease management strategies for pathogens with limited host range. However, because **S. rolfsii** has a wide host range, the chances of success in using crop rotation to control **S. rolfsii** are less than for those pathogens with limited host range. Also **S. rolfsii** can persist in the soil saprophytically on plant debris. Therefore, crop rotation, even with the use of non-hosts or of resistant varieties, becomes difficult in achieving good disease control on a subsequent susceptible variety. The difficulty in controlling this pathogen by crop rotation in a small limited resource vegetable farm can therefore not be overemphasized.

Experiments were conducted to evaluate certain crop species and resistant varieties on southern blight incidence on subsequent susceptible tomato crop in a crop rotation system.

Ten crop species were planted in pots 25 cm in diameter filled with autoclaved soil. These were inoculated with 100 sclerotia per plant. In the fallow pots sclerotia were added to the bare soil in the pots. Twelve weeks after inoculation, the tops of the plants were removed, the soil in each pot was reworked, and six-week old Homestead tomato plants were transplanted into each pot. Plants were watered and fertilized as needed. Disease incidence was determined eight weeks after transplanting.

Table 2 shows the results of this study. Whereas the incidence of disease was high in Homestead tomatoes planted in the rotation system, Golden California peppers, Greenleaf tabasco pepper, sweet potatoes and bambara groundnuts significantly reduced the incidence of southern blight on subsequent tomato plants. Fairly good control was achieved when the tomatoes were planted after Garden eggs, cowpea, resistant tomato TI-120, sorghum and fallow. It must be noted that these results might be different if plant debris had been worked into the soil, as is usually the case in the field, before planting the susceptible tomatoes.

Table 2. Effect of crop rotation on development of southern blight in Homestead tomatoes.

Previous crop	Disease incidence (%)
Homestead tomatoes	78
TI-120 tomatoes	10
Sweet banana peppers	91
Golden California Wonder	1
Greenleaf Tabasco pepper	1
Sweet potato cv Jewel	3
Cowpea cv Pinkeye purple hull	27
Bambara groundnut	2
Garden egg	15
Sorghum	30
Fallow	10
LSD ($P \leq 0.05$)	6

Chemical control

Numerous preplant and postplant chemicals have been used to control southern blight on various crops in the field (Jenkins, 1985; Jenkins and Avery, 1986; McCarter et al., 1976; Punja, 1985). The effectiveness of a chemical in controlling southern blight to a large extent depends on the method or technique of application (Jenkins, 1985; McCarter et al., 1976). In this study two types of application and the efficacy of a triazole derived compound (Tilt) were evaluated for the control of southern blight on sweet banana peppers. Both greenhouse and field experiments were conducted.

In the greenhouse, four benches filled with sterilized sandy loam soil were planted with four week old sweet banana peppers. A randomized complete block design with six treatments, four replications per treatment and 10 plants per replication was used. The inoculum consisted of sclerotia obtained from **S. rolfsii** cultures maintained in the laboratory. Each plant was inoculated with about 15-20 sclerotia mixed with 2 grams of corn meal (grits). The treatments consisted of: (1) Control - no inoculation and no Tilt application, (2) Plants inoculated with **S. rolfsii** but no Tilt applied, (3) Plants not inoculated but Tilt applied at planting, (4) Plants inoculated and Tilt applied 1-2 weeks before inoculation, (5) Plants inoculated and Tilt applied at time of inoculation, and (6) Plants inoculated and Tilt applied 1-2 weeks after inoculation. Tilt was applied as a 25cm surface band treatment at the rate of 0.84 kg ai ha^{-1} using 2.5q formulation. Plants were watered daily and fertilized with 20-20-20 NPK solution every 10 days. The same treatments and design were used for the field study except that plants were spaced 1m between rows and 30cm between plants. Disease incidence (per cent plants killed) and total fruit yield (kg ha^{-1} were measured.

Results show that applications of Tilt reduce the incidence of disease (Tables 3 and 4). In the greenhouse study (Table 3) application of Tilt 1-2 weeks before inoculation significantly reduced the number of plants killed and was comparable to the uninoculated control.

Table 3. Effect of Tilt on survival of sweet banana peppers inoculated with **S. rolfsii** in a greenhouse study.

Treatment **S. rolfsii**	Tilt application	No. of plants killed by **S. rolfsii**/ Total planted
-*	not applied	2/20
+	not applied	20/20
-	applied at time of transplanting	1/20
+	applied 1-2 weeks before inoculation	2/20
+	applied at time of inoculation	7/20
+	applied 1-2 weeks after inoculation	9/20

* + and -: **S. rolfsii** added or not added, respectively.

Table 4. Effect of Tilt on disease incidence, per cent plants killed and total yield of sweet banana peppers inoculated with **S. rolfsii**

S. rolfsii	Tilt Application	Disease Index2/	Plants Killed	Total Yield Kg/ha
-x	not applied	2	7.5c3/	68142ab
+	not applied	4	67.5a	30482c
-	applied at time of transplanting	2	2.5c	77107a
+	applied 1-2 weeks before inoculation	3	11.5b	63968ab
+	applied at time of transplanting	3	32.5b	58476b
+	applied 1-2 weeks after inoculation	3	42.5b	57382b

1/ x + and -: **S. rolfsii** added or ot added, respectively.
2/ Disease index scale of 1-5, where 1 = healthy green plants.
3/ Means with the same Letter are not significantly different according to Duncan's Multiple Range Test ($P \leq 0.05$).

Application of Tilt either at time of inoculation or 1-2 weeks after inoculation significantly reduced the number of plants killed compared to the inoculated control.

Similar results were obtained in the field study (Table 4). Fresh fruit yields of sweet banana peppers were significantly increased when Tilt was applied to inoculated plants. No significant differences were obtained in the per cent plants killed and yield of the peppers with regards to the time of application.

In another greenhouse study, bare roots of 4 week old sweet banana peppers were dipped in various concentrations of Tilt solution planted and inoculated with agar plugs of actively growing **S. rolfsii** mycelia 0,2,4 and 6 weeks after the chemical treatment. Roots were dipped in the solutions for 5 seconds and the plants transplanted into 10cm pots. Plants were kept in the greenhouse (28-31ºC), watered and fertilized as before. Each treatment consisted of 10 plants.

Plants inoculated soon after the chemical treatment showed no control of **S. rolfsii** (Table 5). Significantly lower per cent disease incidence was observed when plants were dipped in Tilt solution and inoculated 2 or mroe weeks after the chemical treatment. The more concentrated the solution, the more the disease control. Severe phytotoxic effects, however, were observed on plants treated at the higher concentrations.

Table 5. Disease incidence of sweet banana peppers dipped in Tilt solutions

Treatment (ml Tilt/L H_2O)	Disease incidence (%) at indicated time of inoculation after tretment			
	0	2 wks	4 wks	6 wks
0.0	100	100	94	98
10.0	98	34	32	27
1.0	100	45	37	33
0.1	97	63	42	43
0.01	99	67	47	46
LSD ($P \leq 0.05$)	3%	4%	3%	5%

Control of Foliar Diseases

It has been postulated and shown that control of other plant pathogens may help lower the incidence of southern blight of vegetables (Jenkins, 1985; Punja, 1985). In a field study using two compounds (Bravo 75W and Dithane M-45) to control early blight of tomatoes, the incidence of southern blight was significantly reduced, and yields were increased, in plots sprayed with the fungicides compared with the control plots (Table 6). The better the control of early blight the lower the southern blight disease incidence and the higher the yield of tomatoes.

Table 6. Effect of control of early blight of tomatoes on southern blight incidence and yield of Floradade tomatoes

Treatment	Disease Incidence %	Yield ($t\ ha^{-1}$)
Control	60	16.5
Bravo 75W 1 ha^{-1}	35	26.3
2 ha^{-1}	7	38.4
Dithane M-45 1.2 kg ha^{-1}	20	31.4
2.4 kg ha^{-1}	8	37.2

LSD ($P \leq 0.05$) was 7% and 58 t ha^{-1} for disease incidence and yield, respectively.

CONCLUSIONS

It is apparent that no single method will consistently control southern blight of vegetables. It is therefore important that a disease management program utilizing all or any available methods of control be employed in controlling this disease. This will involve careful selection of sites and crops in a rotation system, chemical applications, good plant nutrition, good cultural practices, and control of other diseases. This will by no means eliminate the pathogen or give absolute control, but will significantly reduce the incidence of southern blight.

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