Effect of Sweet Potato Cultivars and Pathogens on Ipomeamarone Content of Diseased Tissue

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ABSTRACT

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Diseased tissue from the roots of 21 sweet potato cultivars that were inoculated artificially with each of three pathogens, *Ceratocystis fimbriata*, *Sclerotium rolfsii*, and *Diplodia tubericola* were analyzed for ipomeamarone content. The data from three replications of each cultivar-pathogen combination were analyzed statistically. Differences in ipomeamarone content were significant among cultivars ($P = 0.01$), among pathogens ($P = 0.05$), and for cultivar × pathogen interaction ($P = 0.01$). Weight of diseased tissue and amount of ipomeamarone (mg/g) were significantly correlated ($P = 0.01$) with *D. tubericola* ($r = -0.47$) and with *S. rolfsii* ($r = -0.44$), but not with *C. fimbriata* ($r = +0.16$). The diameter of lesions caused by *C. fimbriata* was not significantly correlated with amount of ipomeamarone ($r = +0.12$).

Ipomeamarone, a hepatotoxic furanoterpenoid found in diseased sweet potatoes, has been investigated extensively by Uritani and his coworkers in Japan since they first reported it in sweet potatoes in 1943 (7). They have associated ipomeamarone and related compounds with resistant reactions in sweet potatoes (3). The toxicity of mold-damaged sweet potatoes has been investigated by Wilson and his coworkers in this country (8). Martin et. al. (4) showed that little or no ipomeamarone was present in apparently healthy tissue surrounding diseased tissue, and suggested that this might explain why no authentic cases of human poisoning from eating sweet potatoes have been recorded.

It was reported (4) that some sweet potato pathogens are very effective and others are relatively ineffective, in inducing ipomeamarone production in the cultivar Centennial. However, relatively little is known about the influence of the host (sweet potato cultivars) on the production of ipomeamarone, except that ipomeamarone production is more abundant in a black rot-resistant than in a black rot-susceptible sweet potato cultivar (1). The influence, if any, of sweet potato cultivars on ipomeamarone production should be an important consideration in a sweet potato breeding program like the one at Louisiana State University. The research reported here shows that there is considerable influence of sweet potato cultivars on ipomeamarone accumulation in sweet potato tissues infected by any of three pathogens that effectively induce ipomeamarone in the cultivar Centennial. A preliminary report of these results was published (5).

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MATERIALS AND METHODS

Twenty-one sweet potato [*Ipomoea batatas* (L.) Lam.] cultivars (Table 1), selected for genetic diversity, were planted and harvested on the same dates in silt loam soil at Baton Rouge, Louisiana. The sweet potato roots were cured to reduce the possibility of unwanted contamination and stored under the same conditions. Four wk after harvest, nine sweet potato roots 5 to 7 cm in diameter and free from diseases and blemishes were selected from each of the 21 cultivars. Three sweet potatoes of each cultivar were inoculated with each of three fungal sweet potato pathogens: the black rot pathogen, *Ceratocystis fimbriata* Ell. and Halst., the circular spot pathogen, *Sclerotium rolfsii* Sacc., and the Java black rot pathogen, *Diplodia tubericola* (Ell. and Ev.) Taub.. *Ceratocystis fimbriata* is found only rarely in sweet potato plantings in Louisiana, but the other two pathogens occur commonly. Cultures of the three pathogens used in this research were all isolated from diseased sweet potatoes in Louisiana and were maintained as stock cultures at Louisiana State University. The fungi were grown for inoculum on potato-dextrose agar plates for 5 days. The sweet potatoes were inoculated by introducing approximately 4 mm^2 of the surface mycelium into each of two punctures, made with a small flame-sterilized scalpel, about 5 cm apart in the center of each potato. Since the sweet potatoes had been properly cured and aseptic procedures were used in introducing the inoculum, they were not surface sterilized. The inoculated sweet potatoes were placed in moist, paper-lined plastic bread boxes. The sweet potatoes inoculated with *C. fimbriata* and *S. rolfsii* were kept at 23 C, and those inoculated with *D. tubericola* were incubated at 32 C. No contaminations were observed in the inoculated areas of any of the sweet

TABLE 1. Ipomeamarone concentration in diseased tissue of 21 sweet potato cultivars inoculated with three pathogens

Sweet potato cultivars	Ipomeamarone[a] in diseased tissue infected by: *Ceratocystis fimbriata* (mg/g)	*Diplodia tubericola* (mg/g)	*Sclerotium rolfsii* (mg/g)	Average (mg/g)
L0-323	3.2	3.0	6.8	4.3
L4-186	5.5	4.5	4.1	4.7
L7-182	5.7	5.3	6.6	5.9
Porto Rico	3.2	4.9	10.2	6.1
L1-207	11.2	0.5	9.3	7.0
L1-306	16.5	5.5	4.5	8.8
L7-177	10.6	10.8	6.3	9.2
Goldrush	10.9	2.9	18.1	10.6
White Star	15.4	7.9	9.7	11.0
L4-89	2.7	10.2	20.1	11.0
Jasper	9.4	8.4	17.1	11.6
L0-196	6.5	15.2	16.0	12.6
L0-162	17.3	13.6	12.9	14.6
L0-360	25.6	11.9	11.3	16.3
L9-163	29.3	6.0	14.6	16.6
L4-73	7.7	26.4	19.3	17.8
Heartogold	30.9	5.2	18.3	18.1
Centennial	14.4	29.4	13.5	19.1
Julian	24.2	23.6	10.5	19.4
Jewel	24.0	23.7	14.6	20.8
Pelican Processor	24.4	22.9	15.8	21.0
Average of cultivars	14.2	11.5	12.4	12.7

[a]Average of three replications in diseased tissue of each cultivar-pathogen combination. The diseased tissue infected by *C. fimbriata* was frozen at −20 C 13 days after inoculation and that of *D. tubericola* and *S. rolfsii* was frozen at −20 C six days after inoculation. The tissue was thawed before extraction procedures were started. The samples were analyzed over a period of about 6 wk.

TABLE 2. Weight of diseased tissue infected by *Ceratocystis fimbriata*, *Diplodia tubericola*, and *Sclerotium rolfsii*, and the diameter of lesions caused by *Ceratocystis fimbriata*

Sweet potato cultivars	Weight of diseased tissue[a] infected by: *C. fimbriata* (g)	*D. tubericola* (g)	*S. rolfsii* (g)	Diameter of lesions caused by *C. fimbriata*[a] (mm)
L0-323	1.1	11.1	5.0	17.3
L4-186	2.3	5.5	8.6	24.0
L7-182	1.1	9.4	2.4	21.0
Porto Rico	1.1	15.0	1.6	20.3
L1-207	2.2	33.0	3.5	18.0
L1-306	1.8	23.6	4.4	21.0
L7-177	1.5	1.9	5.4	22.3
Goldrush	1.4	4.8	1.1	17.0
White Star	2.8	1.1	1.9	29.3
L4-89	1.1	3.6	2.5	16.7
Jasper	1.7	6.0	2.2	25.0
L0-196	1.6	8.3	3.0	22.0
L0-162	2.0	8.6	5.1	22.3
L0-360	1.2	20.9	4.4	19.0
L9-163	1.7	23.4	1.5	23.0
L4-73	3.7	1.8	3.6	33.0
Heartogold	2.3	10.2	2.1	23.0
Centennial	1.6	2.1	3.5	20.7
Julian	1.7	2.8	2.8	22.7
Jewel	2.0	5.2	3.6	22.0
Pelican Processor	1.8	2.6	2.7	21.7
LSD 5%	0.67	17.34	2.18	3.50

[a]Averages of three replications. All macroscopically visibly-diseased tissue was excised and weighed.

potatoes. Six days after inoculation with *S. rolfsii* and *D. tubericola*, diseased tissue from each potato was excised, weighed, and stored in a plastic bottle at −20 C. Thirteen days after inoculation with *C. fimbriata*, the lesions were measured and the diseased tissue was excised, weighed, and stored in the same manner until it way analyzed for ipomeamarone content.

The diseased tissue was prepared for analysis by extracting each sample with a mixture of chloroform, methanol, and water (2, 9). Extracts were filtered and evaporated to dryness. The residue was dissolved in chloroform and analyzed quantitatively for ipomeamarone by gas-liquid chromatography (2, 9).

RESULTS AND DISCUSSION

The data (Table 1) were expressed as milligrams of ipomeamarone per gram fresh wt of diseased tissue and were analyzed statistically. Differences were significant ($P = 0.01$) among cultivars and among pathogens ($P = 0.05$). There was a significant ($P = 0.01$) interaction between cultivars and pathogens. Striking examples of this interaction were found among several cultivars, including L1-207 and L4-73 (Table 1).

When the data on weight of diseased tissue from each cultivar infected with each pathogen were analyzed statistically, the results showed significant differences among cultivars infected by each of the three pathogens. This can be interpreted as significant differences among cultivars in their reaction to each of these pathogens. Thus, a resistant cultivar is expected to have less diseased tissue than a susceptible one. Weight (g) of diseased tissue and milligrams of ipomeamarone per gram of diseased tissue were compared in 63 comparisons for each cultivar-pathogen combination; these were negatively correlated ($P = 0.01$) for both *D. tubericola* ($r = -0.47$) and *S. rolfsii* ($r = -0.44$), but not for *C. fimbriata* ($r = +0.16$).

The lesions caused by *C. fimbriata* were measured as an index of cultivar reaction to black rot of sweet potatoes (Table 2) as previously reported (6). Statistical analysis of these data showed significant differences ($P = 0.01$) among cultivars. The diameter of black rot lesions was not correlated significantly with milligrams of ipomeamarone per gram of diseased tissue ($r = +0.12$). This was unexpected in view of the report that ipomeamarone production was more abundant in a resistant Japanese cultivar than in one susceptible to black rot (1). Thus, it seems likely that the difference in ipomeamarone production of the two Japanese cultivars (1) is not related to their relative resistance or susceptibility to black rot.

The sweet potato cultivars were listed in ascending order of the amount of ipomeamarone per gram of diseased tissue induced by the three pathogens (Table 1). Cultivar L0-323 accumulated the least amount of ipomeamarone when infected with the pathogens used in this study. Infected Pelican Processor, a white-fleshed cultivar, accumulated the most ipomeamarone; White Star, the only other white-fleshed cultivar that was included, and Jasper, the new soil rot-resistant cultivar, were intermediate in ipomeamarone accumulation. The two cultivars, Centennial and Jewel, which are planted on over half of the sweet potato acreage in the United States, had high concentrations of ipomeamarone in diseased tissue following infection by the three pathogens.

The results of this investigation suggest that it is possible to select and release sweet potato cultivars with less potential to produce ipomeamarone than some of the cultivars presently planted in this country. The data also indicated that resistance to Java black rot and to circular spot in sweet potatoes is significantly correlated with ipomeamarone accumulation. Resistance to black rot among the sweet potato selections used in this study was not significantly correlated with accumulation of ipomeamarone.

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