



Evaluation of Anthracnose on Leatherleaf Fern Treated with Keyplex®

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Anthracnose disease is a significant limiting factor for Florida leatherleaf fern (*Rumohra adiantiformis*) production. Symptoms of anthracnose are produced by the fungal pathogen *Colletotrichum acutatum* Corda. The damage to the fern fronds can be extensive and unsightly rendering the fronds unsalable. *Colletotrichum acutatum* is also the casual agent of postbloom fruit drop (PFD) in citrus and strawberry anthracnose on strawberry. Keyplex® products have been shown to significantly reduce PFD in citrus (EPA bio-pesticide label 73512-1). A trial was conducted in 2011 to determine if Keyplex® could reduce anthracnose in leatherleaf fern and to determine what rate would be most appropriate. Treatments at 0.5, 1, and 2 pints (0.237 L, 0.476 L, and 0.946 L) per acre resulted in significantly less disease incidence. In 2013 a follow up trial was conducted which reaffirmed there were significant differences in number and severity of infected fronds between treated and untreated areas.

Florida is one of the world's leading areas in production of leatherleaf fern (*Rumohra adiantiformis*) with approximately 1416 ha (3500 acres) in cultivation and a wholesale value of 50 million dollars (Stamps, 2012). Leatherleaf fern is popular with florists due to its cost effectiveness and seasonal availability. The most significant production problem for Florida fern is a fungal disease, anthracnose, caused by *Colletotrichum acutatum* Corda, which damages fronds leaving them unsalable. Florida fern growers typically make weekly fungicide applications and sometimes bi-weekly applications to control this pathogen. The frequency of fungicide applications used in leatherleaf fern production leads to a potential increase for disease resistance.

Keyplex® products (Keyplex®, Winter Park, FL) have been recognized by the Environmental Protection Agency (EPA) as a bio-pesticide (EPA Reg. No. 73512-1) for treatment of post bloom fruit drop (PFD) in citrus production. PFD in citrus is caused by the same fungal pathogen *Colletotrichum acutatum* as anthracnose in leatherleaf fern. Keyplex® contains naturally occurring compounds that function to increase plant defenses by stimulating host plants to produce more pathogenesis-related proteins (Mayer, 1998). These Systemic Acquired Resistance (SAR) proteins are induced and react when a disease-causing pathogen like *Colletotrichum*, invades the plant. Evaluation of Keyplex® product applications in leatherleaf fern production for reduction of anthracnose may help to reduce fungicide applications and potentially save commercial fern growers money.

Materials and Methods

In 2011 the test area was conducted in a fern shed (Fig. 1) located in Barberville, Volusia County, FL. Blocks consisted of treatments of Keyplex® 250DP at 0.237L, 0.476L, and 0.946L (1/2 pint/acre, 1 pint/acre, 2 pints/acre rates) and an untreated check. Applications of these materials were applied with a solo backpack sprayer to plots consisting of 13.72 m (45 ft) in length and approximately 1.22 m (4 ft) wide. Sprays were made weekly for nine weeks. Due to severe anthracnose infection the fern had been mowed in early July, 2011. Treatments began approximately three weeks later on 21 July 2011. All treatment blocks were completely randomized and replicated three times. Three random one foot by one foot squares were selected for quadrat sampling of fern fronds in each of the treatment blocks (A total of 72 quadrants in each treatment block). The percentage of salable fern bunches was calculated in each of the sample quadrants and dollar value assigned. Sampling was done from 21 July thru 21 Sept. In addition to treatments, grower standard production practices were conducted on all treatment plots, which included at a minimum a weekly application of a fungicide and liquid fertilizer. In 2013 a second evaluation of Keyplex® was done for anthracnose control on leatherleaf fern at a different location in Barberville, Volusia County, FL. Two acres of leatherleaf fern were used to assay the effects of Keyplex®. The treatment rate included the addition of two pints to the acre of Keyplex injected weekly through the overhead irrigation system. Four plots were randomly harvested weekly on the non-treated control acre and treated acre. Ten fronds were rated in each plot using the following disease damage key developed by Strandberg, et. al. in 1997. (Fig. 2):

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Fig. 1. Typical leatherleaf fern shed (saran structure) used in production.

- Class 0 = No disease damage
- Class 1 = Very few lesions (3 or less)
- Class 2 = 4-6 lesions
- Class 3 = About 5% Leaf Area Damage (LAD)
- Class 4 = About 10% LAD
- Class 5 = About 20% LAD
- Class 6 = About 40% LAD
- Class 7 = Greater than 40% LAD

Day zero ratings were taken on 10 Apr. 2013 before any application of Keyplex® occurred. Grower standard production practices were conducted on all treatment plots, which included at a minimum a weekly application of a fungicide and liquid fertilizer. Field evaluation dates were: 9 July, 6 Aug., 22 Aug., 4 Sept., 2 Oct., and 28 Oct.

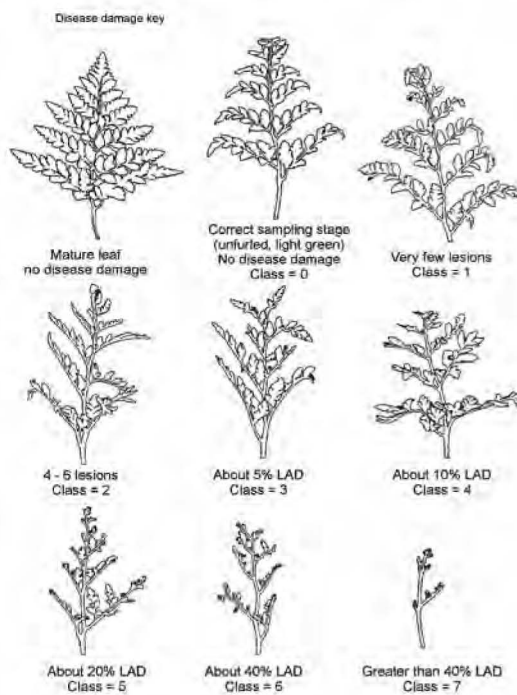


Fig. 2. Disease damage key.

For the 2011 data Area Under the Disease Progress Curve (AUDC) was calculated and treatments were then compared using ANOVA and LSD procedures at both the 90% and 95% confidence level. For the 2013 data ANOVA (t-test) was performed at the 95% confidence level on the means of the two treatments with and without Keyplex®.

Table 1. The Area Under the Disease Progress Curve (AUDC) was calculated for each treatment. Treatments were then compared using ANOVA and LSD statistical procedures at both the 90% and 95% confidence levels ($P = 0.10$, $P = 0.05$). Treatments followed with a different letters are significant at level specified.

Treatments	Untreated control	Keyplex® 0.237L 0.5 pint/acre	Keyplex® 0.476L, 1 pint/acre	Keyplex® 0.946L (2 pint/acre)
$P = 0.05$	2307 a	1630 ab	1498 b	1479 b
$P = 0.10$	2307 a	1630 b	1498 b	1479 b

Table 2. Economic comparison of different treatment rates based on increase in saleable fronds.^a

Rate	Increase in no. of uninfected fronds (%)	Increased no. of bunches/acre/cut	Price/bunch	No. of cuts/year/acre	Annual total gain in revenue/acre	Cost of Keyplex® for 52 weeks	Revenue minus cost of material
1/2 pint	29%	322	\$1.20	3	\$1,159.20	\$81.12	\$1,078.08
1 pint	33%	370	\$1.20	3	\$1,333.08	\$162.76	\$1,170.32
2 pint	43%	478	\$1.20	3	\$1,719.48	\$325.00	\$1,394.48

^aThe results of this trial may vary due to the environmental conditions, seasonality, market price and thus may be variable between ferneries.

Table 3. Analysis of leatherleaf fern frond damage in the 2013 chemirrigation study. Two treatments with and without Keyplex® were statistically compared using ANOVA (t-test) at the 95% confidence level ($P = 0.05$). Treatments at each date with different letters are significantly different ($P = 0.05$).

Date	10 Apr. (Pretreatment)	9 July	6 Aug.	22 Aug.	4 Sept.	2 Oct.	28 Oct.
Untreated control	1.0 a	2.0 b	2.6 b	2.1 b	1.3 b	3.0 b	0.9 b
Keyplex®	0.5 a	0.88 a	1.3 a	0.8 a	0.2 a	0.8 a	0.2 a

% of Anthracnose Infected Fronds for Different Rates of Keyplex® Compared to Control

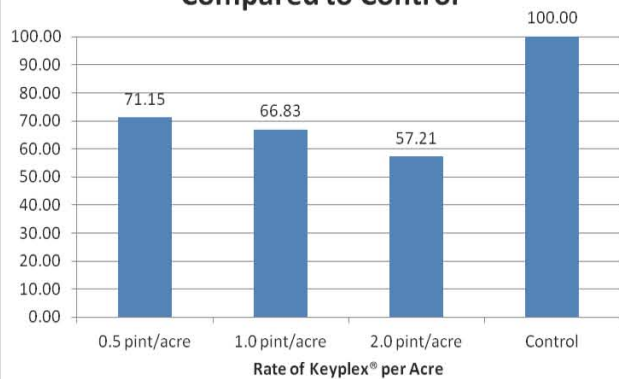


Fig. 3. Percentage of anthracnose-infected fronds for different rates of Keyplex® compared to control.

Results and Discussion

In the 2011 trial there were differences (90% confidence) found for all rates 1/2 pint, 1 pint, and 2 pint per acre rates. Only the 0.476L and 0.946L (1 pint/acre and 2 pint/acre) rates were statistically significant compared to the control (95% confidence level) in Table 1.

None of the treatment rates caused any phytotoxicity to the plants. The treatments did decrease the number of anthracnose infected leatherleaf fern fronds (Fig. 3). The age of increase in

the number of uninfected fronds due to treatment (more salable fronds) increased with rate per acre with 2 pints/acre showing the greatest gains in salable fronds. The economic gain from increased salable fronds ranged from \$1,078 to \$1,394 dollars per acre (Table 2).

In the 2013 chem-irrigation study the application of Keyplex on leatherleaf fern fronds resulted in significantly less damage at the 95% confidence interval ($P = 0.05$) (Table 3) when compared to the control. Additionally, no difference was detected in pre-treatment zero day readings on 10 April. This indicates that each area had similar disease incidence when trial was initiated and any differences can be attributed to treatment effects.

Two years of trials indicate that Keyplex® in leatherleaf fern production aided fungicide applications to limit the incidence of anthracnose infection on fronds, which increased saleable stock and increased growers profit per acre.

Literature Cited

- Mayer, R.T. 1998. Exploiting Plants Protective Proteins. Agricultural Research Magazine. USDA-ARS. p.8-10. <<http://www.ars.usda.gov/is/ar/archive/may98/prot0598.htm>>.
- Stamps, R.H. 2012. Irrigation and nutrient management practices for commercial leatherleaf fern production in Florida. Bul. 300. Environ. Hort. Dept., Fla. Coop. Extension Serv., Univ. of Fla., IFAS First published: 1995. Revised July 2006. Reviewed Nov. 2012. 26 pp. <<http://edis.ifas.ufl.edu/ep027>>.
- Strandberg, J.O, R.H. Stamps, and D.J. Norman. 1997. Fern anthracnose: A guide for disease management. Bul. 900. Univ. Fla. Agr. Expt.Sta., IFAS. 37 pp. <https://mrec.ifas.ufl.edu/jos/Bulletin%20900-PDF/TITLE_1.pdf>.