

**REPORT TO THE AGRICULTURAL RESEARCH FOUNDATION  
FOR THE OREGON PROCESSED VEGETABLE COMMISSION  
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**Project Title:** Evaluation of Fungicides for the Control of Gray and White Mold in Snap Beans

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**Background and Justification:** Cancellation of the registration of an effective bean mold fungicide, Ronilan, is slated to occur at the end of growing season in 2005. Finding equivalent alternatives by 2006 for use in snap bean is critical. The goal of the project is to continue evaluations of alternative fungicides for their effectiveness in controlling Gray Mold (*Botrytis cinerea*) and White Mold (*Sclerotinia sclerotiorum*) on snap bean using Ronilan as the industry standard.

Selected products used in the 2000-02 trials demonstrated effectiveness against both white and gray molds but efficacy was not always equal to that of Ronilan. In 2000, Boscalid (Endura) and Fluazinam (Omega) applications both resulted in good control of white mold and gray mold on bean pods but whole plant ratings were more severe than that found with Ronilan. In 2001, white mold and gray mold levels on bean pods from plots treated with Boscalid, Fluazinam, and Cyprodinil + Fludioxonil (Switch) all were statistically comparable to the Ronilan treatment but these alternative fungicides all had a greater incidence of white mold on pods than that found with Ronilan. The 2002 studies had very little disease, probably due to the drier conditions in the Willamette Valley. Two field studies conducted during 2004 showed that Endura combined with certain surfactants controlled white mold and percentage of pods infected were similar to that found in Ronilan treatments while very little gray mold was found in either trial.

Registered fungicides for control of bean mold include Endura, Topsin, and Rovral. Thiophanate-methyl (Topsin) controls white mold well but has little effect on gray mold because many gray mold strains are resistant to these fungicides. Rovral (iprodione) controls gray mold but past research had shown it to be weaker in controlling white mold. Of concern is the efficacy of Topsin and Rovral under the more narrow row spacing and higher plant density found in current snap bean fields than that found during the production in the 1980's, when much of the research on these older fungicides in snap bean was last conducted in the Willamette Valley.

Fungicides not registered on snap bean but that hold promise include Switch and some numbered products in the IR-4 program. Expanded evaluation of Endura on the effectiveness of this alternative fungicide is needed as well as further study of the non-registered alternative fungicides is necessary to expedite registrations. Rovral and Topsin will be included for examination of their efficacy and will be also examined in a rotation program with Endura for resistance management as well as pre-harvest interval limitations of early and late snap bean plantings. Spray timing will also be examined to evaluate pre-bloom applications with Endura, which is locally systemic but lacking in the kick-back activity associated with Ronilan applications, as well as single applications of selected fungicide mixtures.

**Objective:** The purpose of this research was to evaluate fungicide performance and compare registered alternative fungicides and non-registered materials to the industry standard, Ronilan.

**Procedures:** Four field trials were established in the Willamette Valley using the snap bean variety 91G. Two trials were conducted in commercial fields (Dickman's Farm and Kraemer's Farm) and the other two trials were located at the OSU Horticultural Research Farm in Corvallis. Only two sites developed sufficient disease to warrant bean ratings and only these two studies will be depicted in this report. One site was located on the OSU Vegetable Farm in a Chehalis silt loam soil and the other site was on a commercial farm in Marion County in a Dayton silt loam soil. Plots were 5' by 20' and were arranged in a randomized complete block design with four replications. The OSU field was planted on 14 Jun using a 30-in row spacing (190,000 seeds/A) and 433 lb of 12-19-10 fertilizer was banded at planting followed by 30 lb N/A as urea banded at the second to third trifoliolate leaf stage. Dual Magnum (0.98 lbs ai/A) and Cobra (0.156 lb ai/A) were used for weed control, followed by cultivation at the second trifoliolate leaf stage and hand weeding. The on-farm site was planted 21 Jun using a 20-in row spacing (206,000 seeds/A) and a preplant broadcast of 14 lb/A urea and 98 lb/A muriate of potash was applied. Then a planter sidedress of 30 gal/A of 10-34-0 fertilizer and 6 gal/A of thiosul, and a broadcast of 150 lb/A ammonium sulfate was applied 4 weeks after planting. Eptek 7EC (3.5 pt/A) and Trust (0.5 pt/A) were broadcast and incorporated with a tiller 4 days before planting, and Basagran (2 pt/A) and Poast (2 pt/A) were broadcast 24 days after planting for weed control. Both fields were sprinkler-irrigated weekly with 1" to 1.5" of water. Fungicide treatments were applied with a CO<sub>2</sub> backpack sprayer calibrated to deliver 22 gal of water/A at 38-40 psi using three 8002 flat fan nozzles. Pre-bloom (popcorn) applications were made on 18 Jul and 26 Jul while 10% bloom applications were made on 22 Jul and 1 Aug and 100% bloom application were made on 29 Jul and 8 Aug at the OSU and on-farm sites, respectively. Phytotoxicity ratings were made 7 days after application. On 16 Aug and 22 Aug, the number of pods, presence of white or gray mold on pods  $\geq$  2 inches in length, and number of stems with white or gray mold were determined for 30 individual plants selected arbitrarily from each plot at the OSU and on-farm site, respectively. Means were calculated on the % pods or stem number affected per plant. Treatments were compared with Tukey's W statistic ( $P=0.05$ ).

**Results:** At the OSU site (Table 1), affected stems were infrequent but percentage of pods  $\geq$  2-in. in length affected by white mold were significantly lower in the highest rates of Endura, Topsin, or Rovral, compared to the nontreated plants where affected pod number (7.2%) was well above the processor rejection threshold of 3%. Control of white mold on pods was not significantly better than nontreated plots when Endura, Topsin, or Rovral were applied at lower rates, either alone, in tank mixes or rotation. Serenade did not offer significantly better mold

control on pods compared to the nontreated plants. Poor control was found in the Ronilan plots, where pod incidence was greater than 3%. Among the non-registered materials, V10135 at the higher rate resulted in good white mold control on bean pods. The lower rate of V10135, Switch at both rates, and JAU 6476 did not significantly decrease bean pod white mold relative to the nontreated plots.

At the commercial farm site (Table 2), percentage of pods  $\geq$  2-in. in length and stem number affected by white mold was lower in all of the fungicide treatments compared to the nontreated plants, where affected pod number (10.85%) was well above the processor rejection threshold of 3%. Endura, Topsin, or Rovral at the highest rates provided good white mold control when used alone, as mixes, or in rotations. Single applications of the higher rates of Topsin + Rovral appear to be nearly as efficacious as two applications at the commercial site but further study is warranted.

Rovral + Topsin + Microthiol Disperss provided good white mold control at both sites. Gray mold disease levels were low in both locations, less than 0.5% of pods  $\geq$  2-in. in length or one stem per plant were affected at either site. Thus, any treatment differences are not considered relevant. No significant difference in the number of healthy pods  $\geq$  2-in. in length or healthy and diseased pod numbers were found among treatments at either location. No phytotoxic effects were observed for any of the treatments.

**Conclusions:** Sclerotia of white mold germinate and produce a small fruiting structure which releases millions of spores into the air. Under moist conditions, spores may infect senescent tissue such as blossoms. After colonizing blossoms or senescing leaves, the white mold fungus can invade any healthy plant part it contacts. So, to protect developing bean pods, pods must be protected from contact with infected blossoms. Oregon growers must manage more closely for bean mold because the currently registered materials lack the kick-back activity associated with Ronilan, thus timing of applications is important.

Our studies show that a tank-mix of Rovral with Topsin controlled white mold and control of both white and gray mold is expected. The full rate of each material in the combination will give good control. Mixtures with as little as a half-rate of Rovral combined with a half-rate of Topsin may be adequate under moderate disease pressure but further research is warranted. A tank-mix of Endura with Topsin or application of Endura after Topsin + Rovral should also control both white and gray mold. The full rate of each material in the combination will give good control of white mold. Mixtures with as little as a half-rate of Endura combined with Topsin should be adequate under moderate disease pressure. Microthiol Disperss is labeled for use on snap bean to control leaf spot and powdery mildew. Our studies showed that two applications of Microthiol Disperss with Topsin + Rovral resulted in good control of white mold. However, if temperatures exceed 90 F within 3 days after application of Microthiol Disperss, crop injury may occur. These results from our 2005 field studies are encouraging for snap bean mold management in the absence of Ronilan.

**Table 1.** Mean disease incidence per plant from 2005 snap bean mold trial on OSU Veg. Farm

<b>Treatment &amp; rate/A</b>	<b>Timing</b>	<b>Healthy pod # *</b>	<b>Pod # (healthy &amp; diseased)*</b>	<b>% pods with white mold*</b>	<b>% pods &amp; pin beans with white mold*</b>	<b>Stem # with white mold*</b>	<b>% pods with gray mold*</b>
Ronilan EG (1 lb)	10% bloom, repeat 7 days later	11.03 a	11.44 a	3.61 ab	4.44 ab	0.43 ab	0.00 b
Endura (8 oz) + MSO 100 (2 qt/100 gal)	10% bloom, repeat 7 days later	11.33 a	11.41 a	0.67 b	0.83 b	0.18 ab	0.00 b
Endura (5.5 oz) + MSO 100	10% bloom, repeat 7 days later	10.86 a	11.08 a	1.82 ab	2.02 ab	0.26 ab	0.00 b
Endura (4 oz) + MSO 100	Prebloom (popcorn), trice repeat at 4 days intervals	9.74 a	9.82 a	0.57 b	0.76 b	0.00 b	0.00 b
Topsin 4.5FL (30 fl oz)	10% bloom, repeat 7 days later	9.33 a	9.42 a	1.12 ab	1.12 b	0.00 b	0.00 b
Rovral 4F (2 pt)	10% bloom, repeat 7 days later	10.57 a	10.68 a	1.20 ab	1.47 ab	0.07 ab	0.06 ab
Rovral 4F (2 pt) + Topsin 4.5FL (30 fl oz)	10% bloom, repeat 7 days later	11.71 a	11.82 a	0.80 b	0.80 b	0.03 ab	0.00 b
Rovral 4F (2 pt) + Topsin 4.5FL (40 fl oz)	10 % bloom	9.98 a	10.02 a	0.31 b	0.31 b	0.01 b	0.08 ab
Rovral 4F (1.3 pt) + Topsin 4.5FL (15 fl oz)	10% bloom, repeat 7 days later	10.10 a	10.30 a	1.79 ab	2.37 ab	0.31 ab	0.08 ab
Rovral 4F (1.3 pt) + Topsin 4.5FL (20 fl oz)	10 % bloom	9.39 a	9.68 a	2.92 ab	3.36 ab	0.36 ab	0.00 b
Rovral 4F (1.3 pt) + Microthiol Disperss (6 lb)	10% bloom, repeat 7 days later	11.08 a	11.39 a	3.11 ab	4.59 ab	0.12 ab	0.16 ab
Rovral 4F (1.3 pt) + Microthiol Disperss	10 % bloom	10.27 a	10.55 a	2.64 ab	3.21 ab	0.20 ab	0.00 b
Rovral 4F (1.3 pt) + Topsin 4.5FL (15 fl oz)	100 % bloom	11.35 a	11.73 a	2.93 ab	3.89 ab	0.48 ab	0.00 b
Rovral 4F (1.3 pt) + Topsin 4.5FL (20 fl oz)+ Microthiol Disperss	100 % bloom	11.13 a	11.20 a	0.52 b	0.52 b	0.10 ab	0.00 b
Endura (3 oz) + Topsin 4.5FL (40 fl oz)	10% bloom, repeat 7 days later	9.83 a	9.87 a	0.35 b	0.35 b	0.00 b	0.00 b
Rovral 4F (2 pt) + Topsin 4.5FL (40 fl oz) followed by Endura (8 oz) +MSO 100	10 % bloom, second application 7 days later	10.12 a	10.28 a	1.49 ab	2.12 ab	0.25 ab	0.00 b
Switch 62.5WG (11 oz)	10% bloom	9.51 a	9.83 a	2.97 ab	3.33 ab	0.13 ab	0.00 b
Switch 62.5WG (14 oz)	10% bloom	10.03 a	10.13 a	1.02 ab	1.02 b	0.03 ab	0.09 ab
V10135 20WDG (0.25 lb a.i.)	10% bloom	10.53 a	11.02 a	4.03 ab	4.50 ab	0.35 ab	0.09 ab
V10135 20WDG (0.50 lb a.i.)	10% bloom	10.13 a	10.23 a	0.85 b	1.17 b	0.10 ab	0.07 ab
JAU 6476	10% bloom	10.18 a	10.53 a	2.79 ab	3.08 ab	0.44 ab	0.34 ab
Serenade (1 lb/A) + ThermX70 (1 pt), followed by Serenade + Topsin 4.5FL (40 fl oz)	Pre-bloom (popcorn), second application at 10% bloom	8.87 a	9.10 a	2.33 ab	2.51 ab	0.30 ab	0.00 b
Nontreated		11.94 a	12.91 a	7.20 a	8.65 a	0.91 a	0.46 a

\* Means are based on the pod number, % pods, or stem number per plant. Column numbers followed by the same letter are not significantly different at  $P=0.05$  as determined by Tukey's multiple range test.

**Table 2.** Mean disease incidence per plant from 2005 snap bean mold trial on Dickman's Farm

<b>Treatment &amp; rate/A</b>	<b>Timing</b>	<b>Healthy pod #*</b>	<b>Pod# (healthy &amp; diseased)*</b>	<b>% pods with white mold*</b>	<b>% pods &amp; pin beans with white mold*</b>	<b>Stem # with white mold*</b>	<b>% pods with gray mold*</b>
Ronilan EG (1 lb)	10% bloom, repeat 7 days later	15.68 a	15.69 a	0.07 b	0.12 b	0.01 b	0.00 a
Endura (8 oz) + MSO 100 (2 qt/100 gal)	10% bloom, repeat 7 days later	14.07 a	14.14 a	0.50 b	0.57 b	0.17 b	0.00 a
Endura (5.5 oz) + MSO 100	10% bloom, repeat 7 days later	18.49 a	18.79 a	1.56 b	1.76 b	0.55 b	0.03 a
Topsin 4.5FL (30 fl oz)	10% bloom, repeat 7 days later	17.11 a	17.40 a	1.86 b	1.86 b	0.53 b	0.17 a
Rovral 4F (2 pt)	10% bloom, repeat 7 days later	15.05 a	15.19 a	0.90 b	1.27 b	0.48 b	0.06 a
Rovral 4F (2 pt) + Topsin 4.5FL (30 fl oz)	10% bloom, repeat 7 days later	15.82 a	16.00 a	1.05 b	1.10 b	0.32 b	0.11 a
Rovral 4F (2 pt) + Topsin 4.5FL (40 fl oz)	10% bloom	13.83 a	14.00 a	1.18 b	1.49 b	0.55 b	0.18 a
Rovral 4F (1.3 pt) + Topsin 4.5FL (15 fl oz)	10% bloom, repeat 7 days later	16.26 a	16.60 a	1.96 b	2.32 b	0.48 b	0.22 a
Rovral 4F (1.3 pt) + Topsin 4.5FL (20 fl oz)	10% bloom	14.83 a	15.12 a	1.56 b	2.06 b	0.87 b	0.46 a
Rovral 4F (1.3 pt) + Microthiol Disperss (6 lb)	10% bloom, repeat 7 days later	17.13 a	17.20 a	0.33 b	0.41 b	0.17 b	0.09 a
Rovral 4F (1.3 pt) + Microthiol Disperss	10% bloom	15.33 a	15.64 a	1.58 b	2.09 b	0.51 b	0.09 a
Rovral 4F (1.3 pt) + Topsin 4.5FL (15 fl oz)	100% bloom	20.35 a	20.51 a	0.77 b	0.80 b	0.51 b	0.00 a
Rovral 4F (1.3 pt) + Topsin 4.5FL (20 fl oz)+ Microthiol Disperss	100% bloom	15.35 a	15.41 a	0.45 b	0.62 b	0.16 b	0.00 a
Endura (3 oz) + Topsin 4.5FL (40 fl oz)	10% bloom, repeat 7 days later	15.20 a	15.24 a	0.29 b	0.36 b	0.08 b	0.00 a
Rovral 4F (2 pt) + Topsin 4.5FL (40 fl oz) followed by Endura (8 oz) +MSO 100	10% bloom, second application 7 days later	16.50 a	16.58 a	0.45 b	0.56 b	0.09 b	0.06 a
Serenade (1 lb) + ThermX70 (1 pt), followed by Serenade + Topsin 4.5FL (40 fl oz)	Pre-bloom (popcorn), second application at 10% bloom	13.46 a	13.53 a	0.39 b	0.39 b	0.10 b	0.11 a
Nontreated		16.03 a	17.86 a	10.85 a	11.22 a	2.68 a	0.12 a

\* Means are based on the pod number, % pods, or stem number per plant. Column numbers followed by the same letter are not significantly different at  $P=0.05$  as determined by Tukey's multiple range test.