Amendments

Biological and chemical treatments for control of Sclerotinia disease of bean and kale crops

PO1/01

Final Report due 15th March 2002

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SECTION 1 BEAN TRIAL

1. Introduction

The objective of this research was to test the efficacy of fungicides, biologicals and a plant defence elicitor for control of Sclerotinia disease of bean.

2. Materials and Methods

The trial was set up at a field site (17 x 17m, Wakanui silt loam) at Lincoln University which was naturally infested with *Sclerotinia sclerotiorum* (inoculum level approximately 1 sclerotium/g soil). Prior to setting up the trial, basal fertiliser (Nitrophoska blue TE N:P:K:Mg, 12:15:14:4) was applied to the field site (60g/m^2) and the site irrigated thoroughly.

2.1. Treatments

There were 12 treatments included in the experiment (Table 1).

Table 1: List of fungicide and biological treatments evaluated for Sclerotinia control in a bean trial, Jan-April 2001

Treatment/product	Active ingredient
1. Untreated control	-
2. Water control	-
3. Bion (plant elicitor)	50% w/w acibenzolar-S-methyl
4. *Coniothyrium minitans* A69	-
5. BAS 51600F	exp product – 67g/kg pyroclostrobin
6. Sumisclex 25	250g/kg procymidone
7. Amistar SC	250g/l azoxystrobin
8. Compass	2l Rovral + 1.25l Topsin
9. Bavistin DF	500g/kg carbendazim
10. Rovral Flo	250g/l iprodione
11. Stroby WG	500g/kg kresoxim-methyl
12. Shirlan	500g/l fluazinam

2.2 Trial design

The experiment was designed as a completely randomised block design. Each block was separated by a 0.5m guard path. There were 72 plots, each plot was 1x1m and there were six replicate plots per treatment. Bean seeds (cultivar Labrador) were sown at 50mm depth. Each plot had five rows with five plants per row at a spacing of 0.2 x 0.2m to give approx 25 plants per plot. Plants were irrigated through an

overhead sprinkler system. A standard herbicide spray programme was implemented to control weeds.
All products were applied according to label recommendation. Fungicides were applied at 64 and 75 days after transplanting (early and late flowering, respectively) with the exception of Bavistin which was applied immediately after transplanting and at 64 days after transplanting. The plant activator Bion was applied at 21, 64 and 75 days after transplanting. *C. minitans* A69 formulated in a maizemeal-perlite solid substrate was applied to the soil 28 days prior to planting (0.8 L m^{-2}) followed by the same application at planting plus additional top-up sprays ($1x10^7$ spores mL^{-1}) at 64 and 75 days after transplanting.
The field trial was set up on 15th January 2001 and harvested on 10th May 2001.

2.3 Assessment and analysis

Emergence counts were made on 2nd February 2001. Number of infected pods per plant and yield (weight of healthy pods) per plot were recorded at harvest. The trial was analysed as a completely randomised design with unequal replication (due to poor weed control in some plots) using Genstat 5 statistical software. Infected pod numbers were converted to a percentage (proportion of total pod number per plant). Percentage values were transformed to angular values to minimise differences and give symmetric and normal data. Infection and yield data were analysed using ANOVA and least significant differences (LSD) calculated to indicate the probability of significant differences between treatments.

3. Results

The results of the bean trial are presented in Table 2. Weed control was not satisfactory across the trial. Hand weeding was performed on four separate occasions but this was still not sufficient to prevent significant loss of bean plants in some plots. These plots were eliminated from further assessment resulting in unequal replication of treatments. There was low disease observed in the bean crop over the course of the trial due to the very dry weather conditions which prevailed (irrigation was not sufficient to create conducive conditions). A few small apothecia were observed in some plots 7-10 days prior to harvest. Some heavy rainfall close to harvest initiated a small amount of pod infection. The assessment procedure was modified to take into account the low disease levels. Rather than determine percentage plant infection, the number of infected pods per plant were determined. No attempt was made to determine severity of infection since all infection was considered to be mild and, therefore, no additional information on treatment effects would have been obtained.

There was no significant difference ($P>0.05$) in infection or yield parameters between the untreated control and the water control. Plots treated with Shirlan had significantly higher percentage pod infection ($P<0.05$) than the untreated and water controls and the Bion, *C. minitans* and Sumisclex treatments. All other treatments were not significantly different to the control treatments. There was no significant difference in yield between any treatment.

Table 2: Effect of fungicide and biological treatments on Sclerotinia infection and yield of beans,

Treatment	Replication	Percentage infected pods[1]	Yield (g/plot)
1. Untreated control	6	24 (28)	710
2. Water control	6	23 (28)	681
3. Bion	6	21 (26)	669
4. *C. minitans* A69	6	17 (24)	998
5. BAS 51600F	6	25 (29)	702
6. Sumisclex 25	6	17 (24)	971
7. Amistar SC	6	26 (30)	674
8. Compass	6	26 (30)	815
9. Bavistin DF	5	28 (32)	1004
10. Rovral Flo	4	24 (30)	870
11. Stroby	4	30 (33)	920
12. Shirlan	4	43 (40)*	683
LSD(5%) min.rep		9.2 (12.2)	408.9
min.max		8.4 (11.1)	373.3
max.rep		7.5 (10.0)	333.9

[1] values in parentheses are angular transformed
* significantly different ($P<0.05$) to the control treatments

4. Discussion

Unfortunately, even with regular irrigation of the trial site, conditions were not sufficiently conducive for Sclerotinia infection to give high enough disease expression to enable meaningful comparisons of the efficacy of the different treatments to be made. Whilst percentage infection data ranged from 15-43%, this was an overestimate of the amount of disease occurring in the crop since all of the infected pods were only mildly affected (sometimes only one small lesion). However, the data does yield some trends in treatment effects. Although not statistically significant, the *C. minitans* A69 and Sumisclex treatments resulted in the lowest levels of pod infection and gave high yields. Shirlan was the least effective of all of the fungicide applications giving significantly greater pod infection than the controls and resulting in the lowest yield at harvest.

SECTION 2 KALE TRIAL

1. Introduction

The objective of this research was to test the efficacy of fungicides, biologicals and a plant defence elicitor for control of Sclerotinia disease of kale.

2. Materials and Methods

The trial was set up on a commercial growers property (Mr Yan Lepoutre) at Pendarvis, South Canterbury in a site naturally infested with *Sclerotinia sclerotiorum* (inoculum level approximately 0.4 sclerotium/g soil). Prior to setting up the trial, basal fertiliser (Nitrophoska blue TE N:P:K:Mg, 12:15:14:4) was applied to the field site ($60g/m^2$) and the site irrigated thoroughly. The kale cultivar chosen was Wrightson variety number 200025687.

2.1. Treatments

There were 12 treatments included in the experiment (Table 3).

Table 3: List of fungicide and biological treatments evaluated for Sclerotinia control in a kale trial, March 2001-March 2002

Treatment/product	Active ingredient
1. Bion (plant elicitor)	50% w/w acibenzolar-S-methyl
2. *Coniothyrium minitans* A69	-
3. BAS 51600F	exp product – 67g/kg pyroclostrobin
4. Sumisclex 25	250g/kg procymidone
5. Amistar WG	50g/l azoxystrobin
6. Compass	2l Rovral + 1.25l Topsin
7. Bavistin DF	500g/kg carbendazim
8. Rovral Flo	250g/l iprodione
9. Stroby WG	500g/kg kresoxim-methyl
10. Shirlan	500g/l fluazinam
11. Untreated control	-
12. Water control	-

2.2 Trial design

The experiment was designed as a completely randomised block design. Each block was separated by a 1m guard path. There were 72 plots, each plot was 4m long and 1.5m wide and there were six replicate plots per treatment. Kale seed (Wrightson var

no 200025687) was sown at 45mm depth. Each plot had four rows with a plant spacing of 69mm to give approx 232 plants per plot. Plants were irrigated through an overhead sprinkler system. A standard herbicide spray programme was applied by South Pacific Seeds on our behalf to control weeds.
All products were applied according to label recommendation. Fungicides were applied at two times during the growing season, at 20% and 80% flowering. The plant activator Bion was applied at two monthly intervals with the first application made in May 2001. *C. minitans* A69 formulated in a maizemeal-perlite solid substrate was applied to the soil 42 days prior to planting (0.8 L m^{-2}) followed by the same application at planting.
The field trial was set up on 1st March 2001 and was due to be harvested in March 2002. The entire trial area was sprayed with Kocide + Mancozeb + Insecticide during autumn for control of insects, downy mildew and ringspot.

2.3 Assessment and analysis

Emergence counts were made 10 weeks after planting. Number of infected plants per plot were recorded at 2-3 weekly intervals over the disease risk period (spring – summer). Replication was reduced down to four plots per treatment due to poor weed control at the eastern edge of the trial site. No yield data was taken since severe lodging of the crop (due to excessive vegetative growth and strong winds occurring in February 2002) prevented the crop from being harvested. Infection data were analysed using ANOVA and least significant differences (LSD) calculated to indicate the probability of significant differences between treatments.

3. Results

The results of the kale trial are presented in Table 4 and Figure 1. Weed control early in the season was not satisfactory in some plots and these were eliminated from further assessment resulting in reduced replication of treatments (from six down to four). Hand weeding was done on five separate occasions to safeguard the remaining plots.
Disease was first evident in the control plots during November 2001. Disease levels increased slowly during November – January rising to 17% at the final assessment in February. There was no significant difference ($P>0.05$) in infection between the untreated control and the water control. The water control was more indicative of the disease pressure operating within the field trial and so treatment comparisons have been made preferentially with this control treatment.
At trial completion (47 weeks after planting), all treatments with the exception of the fungicide Stroby (treatment 9) and the plant defence elicitor Bion (treatment 1) gave a significant reduction in disease ($P<0.05$) compared to the water control. Although there was no statistically significant difference between these treatments, best control was achieved with the Rovral and Bavistin treatments which reduced disease by 70.4 and 63.4%, respectively. A general trend observed over the trial period was that the Rovral, Bavistin and Sumisclex treatments resulted in less severe infection (ie smaller stem lesions produced).

Table 4: Effect of fungicide and biological treatments on Sclerotinia infection of kale.

	Mean Percentage Diseased Plants (weeks after planting)							
Treatment	39		41		44		47	
1. Bion	1.62	a[1]	4.22	ab	4.41	abcde	12.81	abcd
2. *C. minitans*	1.25	abc	3.41	bc	4.81	abcd	8.78	bcde
3. BASF	0.31	bc	2.39	bc	3.20	bcdef	9.61	bcde
4. Sumisclex	0.31	bc	1.03	c	2.32	cdef	7.93	cde
5. Amistar	0.01	c	1.01	c	0.98	f	7.78	cde
6. Compass	1.02	abc	3.25	bc	3.45	abcdef	9.68	bcde
7. Bavistin	0.35	abc	1.42	c	1.81	def	6.23	de
8. Rovral	0.53	abc	2.12	bc	2.28	cdef	4.98	e
9. Stroby	0.50	abc	2.22	bc	6.20	ab	14.43	ab
10. Shirlan	0.36	abc	3.27	bc	3.89	abcdef	8.89	bcde
11. Untreated	0.35	abc	4.38	ab	5.14	abc	11.77	abcde
12. Water	1.57	ab	6.24	a	6.41	a	17.04	a
LSD	1.29		2.55		3.00		6.15	

[1] Within columns, means followed by the same letter are not significantly different ($P< 0.05$).

4. Discussion

The kale cultivar chosen, combined with the unusual growing conditions experienced during early spring, resulted in excessive stem elongation and top growth of the plants. Whilst this did not appear to suppress disease development during the summer months, it did result in lodging of the crop after strong winds in mid/late February which made it impractical to harvest the crop and obtain yield data. Results showed that the dicarboximide (Rovral, Sumisclex) and benzimidazole (Bavistin) groups of fungicides were effective against Sclerotinia at this site. There was no strong evidence to suggest that any of the other fungicide groups were better able to control the disease. The one exception to this would be Amistar which performed well across the first three assessments but dropped off in efficacy at the final assessment. This fungicide would be worthwhile evaluating further. The biocontrol agent *C. minitans* A69 gave equal control to the fungicides. Given the fact that it was applied prior to and at planting time compared to the spray applications of fungicides during flowering, it is clear that there are two quite separate mechanisms of disease control operating (most likely sclerotial parasitism by the biocontrol agent versus plant protectant activity by the fungicides).

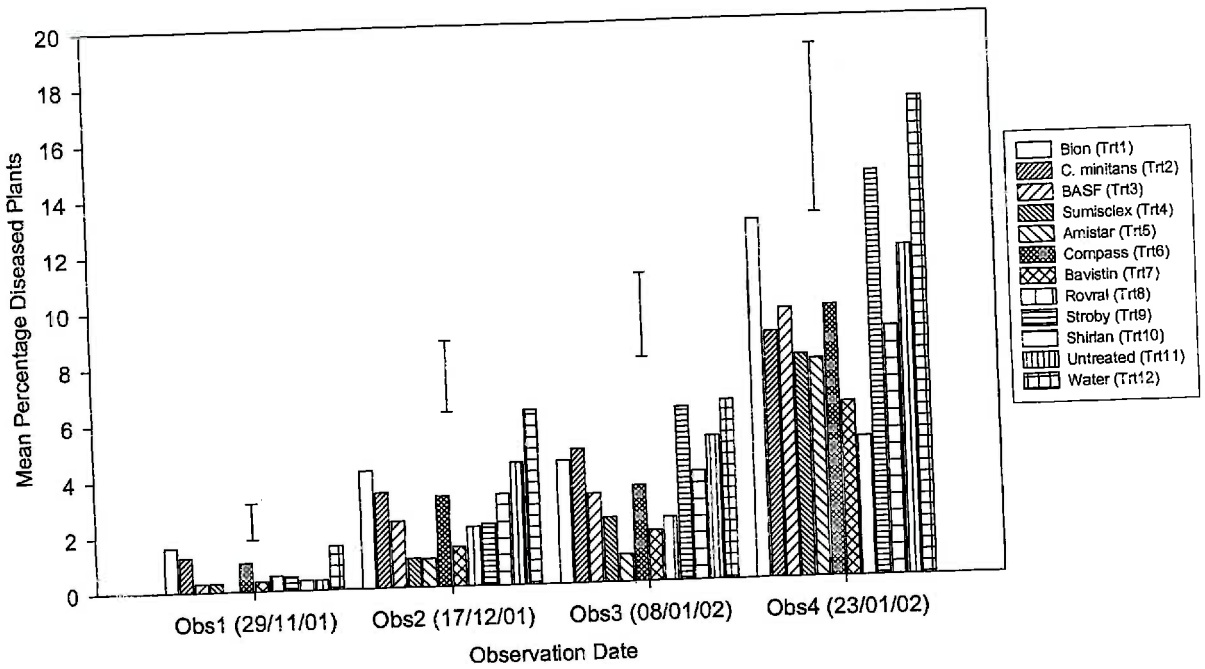

Figure 1. Effect of fungicide and biological treatments on *Sclerotinia* infection of kale, Pendarvis.

SUMMARY CONCLUSIONS

The dicarboximide fungicides were the most effective against *Sclerotinia* in both field trials. The biocontrol agent *Coniothyrium minitans* A69 also gave promising results in both trials. To gain benefit from the different mechanisms of disease control which have been identified, an integrated approach to disease management would seem sensible with the biocontrol fungus applied at planting followed by one or two foliar applications of fungicide during the flowering period.