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Control of Mycogone with fungicides

Commercial in confidence

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AUTHENTICATION

I declare that the work reported was done under my supervision according to the procedures described herein and this report represents a true and accurate record of the results obtained.

.....

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SUMMARY

In a replicated and randomised experiment eight fungicide treatments were compared for the control of Mycogone perniciosa. All the fungicides, Benlate, Bavistin DF, Bavistin FL, Sporgon, Bravo 500 and Hymush, have label recommendations for the control of this pathogen. The fungicides were applied exactly as recommended and with Sporgon and Bravo 500 two treatments of each were included to cover different recommendations.

The uninoculated control treatment remained disease free throughout the experiment yielding approximately 50% more than the inoculated control. Significant disease control as weight of diseased mushrooms was given by Bavistin DF, Bavistin FL, Bravo, Sporgon and Hymush. Only Benlate failed to control the disease.

From these results it appears that there are adequate alternative products should Benlate become unavailable. Reasons for the poor performance of Benlate are discussed.

INTRODUCTION

Although fungal pathogens of the mushroom crop (Agaricus bisporus) are generally well controlled, serious outbreaks do occur from time to time. Verticillium fungicola is currently the most serious pathogen but Mycogone perniciosa and Cladobotryum dendroides also occur (Fletcher et al. 1989). The benzimidazole fungicides were widely used on mushrooms following the introduction of benomyl (Benlate) in 1970 (Snel & Fletcher, 1971). Strains of Verticillium fungicola resistant to these fungicides became widespread within three years (Fletcher et al. 1976) but only recently have there been any reports of resistance in Cladobotryum dendroides or Mycogone perniciosa. However failure of Benlate to control M. perniciosa was reported earlier but attributed to biological degradation of the fungicide and not resistance (Fletcher et al. 1979).

Recently Benlate has been used by some growers to control weed mould problems in particular those caused by Trichoderma harzianum and is still extensively used for the control of Cladobotryum and Mycogone.

In 1992 Du Pont decided to withdraw Benlate for the use on mushrooms and many other horticultural crops. Mushroom growers in the UK will no longer be able to use Benlate unless there is a successful application for an off-label approval. However there are various other fungicides on the market with label recommendations for

use in mushroom crops including closely related fungicides such as carbendazim (Bavistin) and thiabendazole (Hymush). In addition there are a number of unrelated products.

With the withdrawal of Benlate it is clearly important for growers to know which product or products will give an equivalent or better disease control.

To test the fungicides, the pathogen Mycogone perniciosa was chosen. All of the fungicides used have label recommendations for the control of this pathogen. Where the label has alternative recommendations, these were included.

MATERIALS AND METHODS

Experimental Method

Phase II compost from HRI Littlehampton was spawned with Darmycel 609 (0.5%) and incubated at 25°C in 20 kg polythene sacks. When fully colonised the compost was weighed into 2 kg lots and placed in 25 cm pots. Six days later the pots were cased with a sphagnum peat and ground limestone mixture (16 kg limestone/200 litres of peat). Following 6 days of casing run at 25°C the air temperature was reduced to 16°C. The number and weight of diseased and healthy mushrooms was recorded at every harvest. Whole mushrooms were removed and were not trimmed, so the weights included both caps and stalks.

Inoculation was done by mixing into the casing aleuriospores of an isolate of M. perniciosa (IMI 351729) known to be benzimidazole sensitive. The spore concentration used was 10^6 spores/ml and 1 litre of this suspension was applied to the casing of 11 treatments (110 pots). The number of spores applied per pot was therefore approximately 9×10^6.

Fungicides were applied exactly as specified on the label. The applications were made using a Polyspray No.3 sprayer with one litre of fungicide applied to each treatment. Control plots received the same amount of water at the time of fungicide application and where the treatment involved multiple applications, water was applied to the other treatments.

The pots were set out in a randomised block layout (Appendix 1). Each treatment was replicated ten times.

Experimental Diary

August 19th - Compost received

August 20th - Compost spawned 609

September 3rd - Compost divided into 2 kg lots and put in pots

September 9th - Casing inoculated and applied

September 15th - Air temperature reduced to 16°C

September 28th - First harvest

October 7, 9, 10, 13, 16, 20, 21, 22, 27, 28 and 30th - Subsequent harvests

For spray dates see Treatments.

Treatments

1. Uninoculated untreated
2. Inoculated untreated
3. Inoculated - treated at first watering (Sept 10th) with Benlate 0.8 g/litre
4. Inoculated - treated at first watering (Sept 10th) with Bavistin DF 1.25 g/litre
5. Inoculated - treated at first watering (Sept 10th) with Bavistin FL 1.25 ml/litre
6. Inoculated - treated one week after casing (Sept 15th) with Bravo 500 1 ml/litre
7. Inoculated - treated one week after casing (Sept 15th) and two weeks later (Sept 29th) with Bravo 500
8. Inoculated - treated one week after casing (Sept 15th) and after 1st (Oct 5th) and 3rd flushes (Oct 26th) with Sporgon 0.33 g/litre
9. Inoculated - treated one week after casing (Sept 15th) and after 2nd and 3rd flushes (Oct 18th) with Sporgon 0.66 g/litre
10. Inoculated - treated immediately after casing (Sept 10th) with Hymush at 1.15 g/litre and after 1st (Oct 8th) and subsequent flushes (Oct 18 & 26th) at 0.57 g/litre

Footnote: Benlate 50% w/w benomyl, Bavistin DF 50% w/w carbendazim, Hymush 60% w/w thiabendazole, Sporgon 50% w/w prochloraz manganese and Bravo 500, 500 g/l of chlorothalonil.

RESULTS

The numbers and weights of healthy and diseased mushrooms are shown in Tables 1 and 2.

Table 1. Weight and number of healthy mushrooms

Treatment	No.	Per cent uninoc.	Wt(g)	Per cent uninoc.
Uninoculated	241 e	100.0	6439 e	100.0
Inoculated - Untreated	128 a	53.1	3503 a	54.4
" - Benlate	147 abcd	61.0	4464 bc	69.3
" - Bavistin DF	189 d	78.4	5421 d	84.2
" - Bavistin FL	163 abcd	67.6	4781 cd	74.3
" - Bravo 500 x 1	136 abc	56.4	4015 abc	62.4
" - Bravo 500 x 2	137 abc	56.8	4203 abc	65.3
" - Sporgon x 3	133 ab	55.2	3816 ab	59.3
" - Sporgon x 2	159 abcd	66.0	4474 bc	69.5
" - Hymush x 4	174 bcd	72.2	4249 abc	66.0

Treatments with the same letter are not significantly different ($P = 0.05$) from each other using the Duncans Multiple Range test.

The uninoculated treatment remained free from disease throughout the experiment and consequently gave the highest yield of healthy mushrooms. On the basis of numbers of healthy mushrooms Bavistin DF and Hymush were significantly better than the inoculated control but when weight is considered, Benlate, Bavistin DF, Bavistin FL and Sporgon gave significant improvements (Table 1). With regard to diseased mushrooms only Sporgon and Bavistin FL gave significant reductions in numbers of diseased mushrooms, but Bavistin DF, Bavistin FL, Sporgon, Bravo and Hymush gave significant reductions in diseased weights (Table 2).

Table 2. Number and weight of Mycogone affected mushrooms

Treatment	No.	Per cent control	Wt(g)	Per cent control
Uninoculated	0 a		0 a	
Inoculated - untreated	101 de	0.0	2459 e	0
" - Benlate	78 bcd	22.8	1772 cde	28.0
" - Bavistin DF	65 bcd	35.6	904 b	63.2
" - Bavistin FL	52 bc	48.5	797 b	67.8
" - Bravo 500 x 1	67 bcd	33.7	1253 bcd	49.0
" - Bravo 500 x 2	61 bcd	39.6	1306 bcd	46.9
" - Sporgon x 3	46 bc	52.5	791 b	67.8
" - Sporgon x 2	49 bc	51.5	999 bc	59.4
" - Hymush x 4	88 cd	12.9	1463 bcd	40.5

Treatments with the same letter are not significantly different (P = 0.05) from each other using the Duncans Multiple Range test.

DISCUSSION

In this experiment disease levels were high severely testing all the fungicides. Perhaps the most surprising result is the poor performance of Benlate. Fungicide resistance can be discounted as the explanation, as the isolate used was tested and found to be sensitive. Growers have generally reported good results with Benlate for the control of Mycogone except where biological degradation occurs. With enhanced breakdown of the fungicide all of the active ingredient disappears before the first flush develops and in these circumstances no control is achieved.

The same casing was used in all treatments so degradation of Bavistin FL and Bavistin DF (carbendazim) might also have been expected to occur but good disease control was achieved with these fungicides.

Growers sometimes use benomyl outside the specified recommendations, making applications between flushes in addition to the one initial application recommended. Multiple applications of benomyl in this experiment may have given better results.

Of the other fungicides Bavistin DF and Hymush performed well. Sporgon and Bravo gave the lowest yields in particular where Sporgon was applied theree times.

Because Mycogone induces large nondescript distorted lumps of mushroom tissue which often fragment when removed, it is very difficult to get an accurate count of the numbers of diseased pieces. For this reason the weights of diseased tissue more accurately reflects the level of disease control. Best overall disease control was achieved with Bavistin (both DF and FL).

It is likely that of the two Bavistin formulations used in this work only Bavistin DF will be generally available to mushroom growers in the near future as the company (BASF) are anxious to market only one Bavistin product.

CONCLUSIONS

1. There are a number of fungicides on the market with label recommendations for use on mushrooms which have given a good control of Mycogone perniciosa.

2. None of the fungicides tested seriously reduced yield although Bravo and Sporgon appeared to have a slight effect.

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APPENDIX 1

PLAN OF EXPERIMENTAL LAYOUT IN THE MUSHROOM TUNNEL

2C 3C 8E 7K	1C 7G 11D 6B	8A 12B 1J 9B	1H 3H 11J 12K
4C 12G 11A (10) 5D	5C 12E (9) 10G 3F	4F 2J (8) 7B 10E	5B 6E (7) 7E 9D
1B 9K 10D 6A	2E 8H 4B 9J	3F 11H 6H 5F	4D 2F 8B 10H
	1G 7D 6D 3B	2A 9C 10A 4A	
	4G 8G (6) 5H 2K	3A 11K (5) 7A 12A	ENTRANCE
	10B 12D 11G 9A	8D 6G 5A 1K	
9H 6J 5G 1D	5J 2H 12F 9F	12H 9E 4K 3D	8C 4H 5K 1A
10C 7J (4) 11B 3G	1E 11E (3) 10J 6K	1F 11C (2) 8F 5E	9C 12J (1) 7C 10K
4E 8J 12C 2B	3K 4J 8K 7H	10F 2D 7F 6F	3J 11F 2G 6C

NB: This layout includes two experimental treatments not reported here.