EFFECT OF BENOMYL ON BLACK ROOT ROT OF TOBACCO CAUSED BY THIELAVIOPSIS BASICOLA[1]

S.K. Gayed[2]

Abstract

Benomyl at concentrations of 1-2 ppm was fungistatic to Thielaviopsis basicola (Berk. and Br.) Ferr. in culture, whereas 5 ppm was fungicidal. Dipping roots of 4-week-old tobacco (Nicotiana tabacum L.) seedlings in a suspension containing 15 ppm benomyl protected them against black root rot infection under controlled conditions in a growth chamber, but such treatment failed to protect older seedlings when transplanted into heavily infested soil in the field. Benomyl mixed with infested soil in pots at concentrations of 1,3, and 10 ppm significantly reduced black root rot infection. In a heavily infested field, row treatment at the rate of 6.25 kg benomyl/ha considerably checked the disease. The effectiveness of benomyl on black root rot may be due to the contact effect of the fungicide on T. basicola as well as to the systemic effect.

Introduction

Black root rot of tobacco caused bv the soil borne fungus Thielaviopsis basicola (Berk. and Br.) Ferr. is the most serious disease of flue-cured tobacco in Canada. It attacks the root system forming black lesions of disintegrated tissue. Maturity of infected plants is delayed and, as they are stunted, their yield is poor.

The new systemic fungicide Benlate (Du Pont of Canada Ltd., Toronto, Ont.), previously known as Fungicide 1991, is a 50% wettable powder of benomyl (1-[butylcarbamoyl]-2-benzimidazole carbamic acid, methyl ester). It has been effective in controlling several fungal diseases, e.g. damping off (2), verticillium wilt (3), powdery mildews (4), and fruit rots (6). The present paper reports the effect of benomyl on the growth of T. basicola in culture and on the black root rot disease under controlled conditions and in the field.

Materials and methods

In all experiments concentrations of benomyl are expressed as amounts of active ingredient.

For testing the effect of benomyl on the growth of Harrow and Ky 1238-1 strains of T. basicola, the chemical was mixed with potato dextrose agar (PDA) at rates between 0.01 and 100 ppm and poured into petri dishes. Four dishes were prepared for each concentration, inoculated with standardized mycelial discs of either Harrow or Ky 1238-1 strain, and incubated for 2 weeks at 25C. Linear growth was measured daily. Mycelial discs which did not grow in the presence of benomyl were transferred to PDA to find out whether the treatment was fungicidal or fungistatic.

To evaluate the effect of benomyl on black root rot, experiments were carried out in a growth chamber and in the field.

GROWTH CHAMBER EXPERIMENTS

The fungicide was applied as a root dip or as a soil amendment:

Root dip - Roots of 4-week-old tobacco seedlings were dipped in water or in a 5 ppm suspension of benomyl for 24 hr. The water or suspension was continuously stirred by a magnetic stirrer. The seedlings were then planted in pots in steam-sterilized sandy soil which was subsequently infested with T. basicola endoconidia at a rate of 10,000 endoconidia per gram soil;

Soil treatment - inoculated sandy soil was mixed with benomyl at the rate of 0,1,3, or 10 ppm by weight and distributed in pots. After 3 days seedlings were transplanted to the pots.

In growth chamber experiments, the Harrow strain of T. basicola was used as inoculum. Each treatment consisted of twelve pots with two seedlings of tobacco (Nicotiana tabacum L.), variety Hicks Broadleaf. The pot randomized in a growth chamber adjusted to 17-19C, a relative humidity of about 68%, and light intensity of about 3,000 ft-c for 16 hr/day. After 5 weeks, the seedlings were carefully uprooted and the roots cleaned and rated for disease lesions, using a scale of 0-5, with 0 representing no lesions and 5,

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[1] Contribution No. 49, Research Station, Canada Department of Agriculture, Delhi, Ontario.

[2] Plant Pathologist.

complete coverage of the root by lesions. The fresh and dry weights of the seedlings were obtained, and the results were statistically analysed.

FIELD TRIALS

An experiment was carried out in 1968 in a heavily infested field grown with tobacco for the last 13 years. The experiment consisted of single-row plots 10.5 m long with 105 cm between the rows and 45 cm between plants. Three treatments and two checks were arranged in a randomized block design replicated four times. Benomyl was applied as follows:

Root dip = roots of tobacco seedlings at the transplanting stage were dipped for 24 hr either in stirred water of in a suspension containing 5 ppm benomyl.

Soil treatment - 7.22 g of the wettable powder (equivalent to 6.25 kg/ha) was suspended in 1 liter of water and was uniformly sprayed in a 20-cm band along the row. A rototiller was used to incorporate the chemical in the soil to a depth of 10 cm. The treatment was made on June 3, eight days before planting;

Treatment of the planting water - 150 cc/plant of a suspension containing 15 ppm benomyl was used as planting water.

Shoot length was measured on July 15. On August 21, plants number 4,7,10,13, and 16 in each row were dug out carefully. Their roots were cleaned and black root lesions were rated. Fresh and dry weight of shoots were obtained.

Results and discussion

Low concentrations of benomyl in PDA medium were highly toxic to Harrow and Ky 1238-1 strains of T. basicola in culture. Increasing the concentration of benomyl in the medium between 0.1 and 1.0 ppm gradually decreased the growth rate of the fungus. Concentrations between 1 and 2 ppm were fungistatic, whereas 5 ppm was fungicidal.

In the soil inoculation experiment, dipping roots of 4-week-old tobacco seedlings in a 5 ppm suspension of benomyl for 24 hr induced protection against black root rot under controlled conditions in the growth chamber (Table 1). Such treatment failed, however, to protect 7- to 8-week-old transplanted tobacco seedlings against infection in the field (Table 3). This may have been due to the difference in age of the treated seedlings or to the prevailing environmental conditions, including temperature, inoculum potential of the pathogen, and soil water content. It has been established that these factors affect the incidence and severity of the black root rot disease of tobacco (5).

Treatment of infested soil with benomyl at concentrations of 1,3, and 10 ppm checked black root rot infection in pots and increased growth of tobacco seedlings, as compared with seedlings grown in infested, untreated soil (Table 2).

Under heavy field infestation, benomyl rototilled into the row at a rate of 6.25 kg/ha considerably reduced black root rot infection. Such effect was clear in July and became more pronounced in August (Table 3). At harvest, roots and shoots of plants in the treated rows were much further developed than the check plants, which were stunted and had root lesions ratings significantly higher than the treated plants (Fig. 1). Effectiveness in the field may be due to a contact effect of the fungicide on T. basicola in the soil, as well as to systemic action. Since the manufacturers of benomyl suspect the stability of the compound (1), a decomposition product (3) may also be a factor in black root rot control.

Table 1. Effect of dipping roots of tobacco seedling in benomyl suspension for 24 hr on black root rot infection under controlled conditions in a growth chamber

Treatment	Seedling fresh weight (g)	Seedling dry weight (g)	*Root* lesion rating*
Benomyl, 5 ppm	5.08 ± 0.41**	0.39 ± 0.03**	1.45 ± 0.19**
Water (check)	1.62 ± 0.11	0.19 ± 0.01	3.38 ± 0.17

* 0 = no visible lesions, 5 = lesions covering the root surface

** Significant compared with the check (P = 0.01)

Table 2. Effect of soil treatment with benomyl on severity of black root rot under controlled conditions in a growth chamber

Concentration of benomyl (ppm)	Seedling fresh weight (g)	Seedling dry weight (g)	Root lesion rating*
1	4.97 ± 0.67**	0.52 ± 0.065**	0.17 ± 0.047**
3	4.40 ± 0.48**	0.45 ± 0.045**	0.05 ± 0.021**
10	5.18 ± 0.55**	0.51 ± 0.052**	0.02 ± 0.01**
Check	2.59 ± 0.23	0.28 ± 0.026	2.63 ± 0.23

* 0 = no visible lesions, 5 = lesions covering the root surface

** Significant compared with the check (P = 0.01)

Table 3. Effect of different treatments with benomyl on the severity of black root rot of tobacco in a highly infested field, 1968

Treatment	Shoot length (cm)		Shoot fresh wt (g)	Shoot dry wt (g)	Root lesion rating*
	July 15	August 21			
Seedling roots dipped in 5 ppm benomyl for 24 hr	12.8	54.7	224	29.0	3.8
Seedling roots dipped in water for 24 hr	12.5	52.8	166	26.1	3.8
Benomyl rototilled into the row at 6.25 kg/ha	16.2	102.0	559	77.5	1.2
Benomyl in planting water, 15 ppm; 150 cc/plant	13.5	62.8	228	30.0	3.6
Check	12.9	55.6	169	25.5	3.6
L.S.D. 0.05	1.89	13.16	98.97	12.76	0.40
0.01	2.66	18.47	136.92	17.91	0.56
Coefficient of variation	9%	13%	24%	22%	8%

* 0 = no visible lesions, 5 = lesions covering root surface,

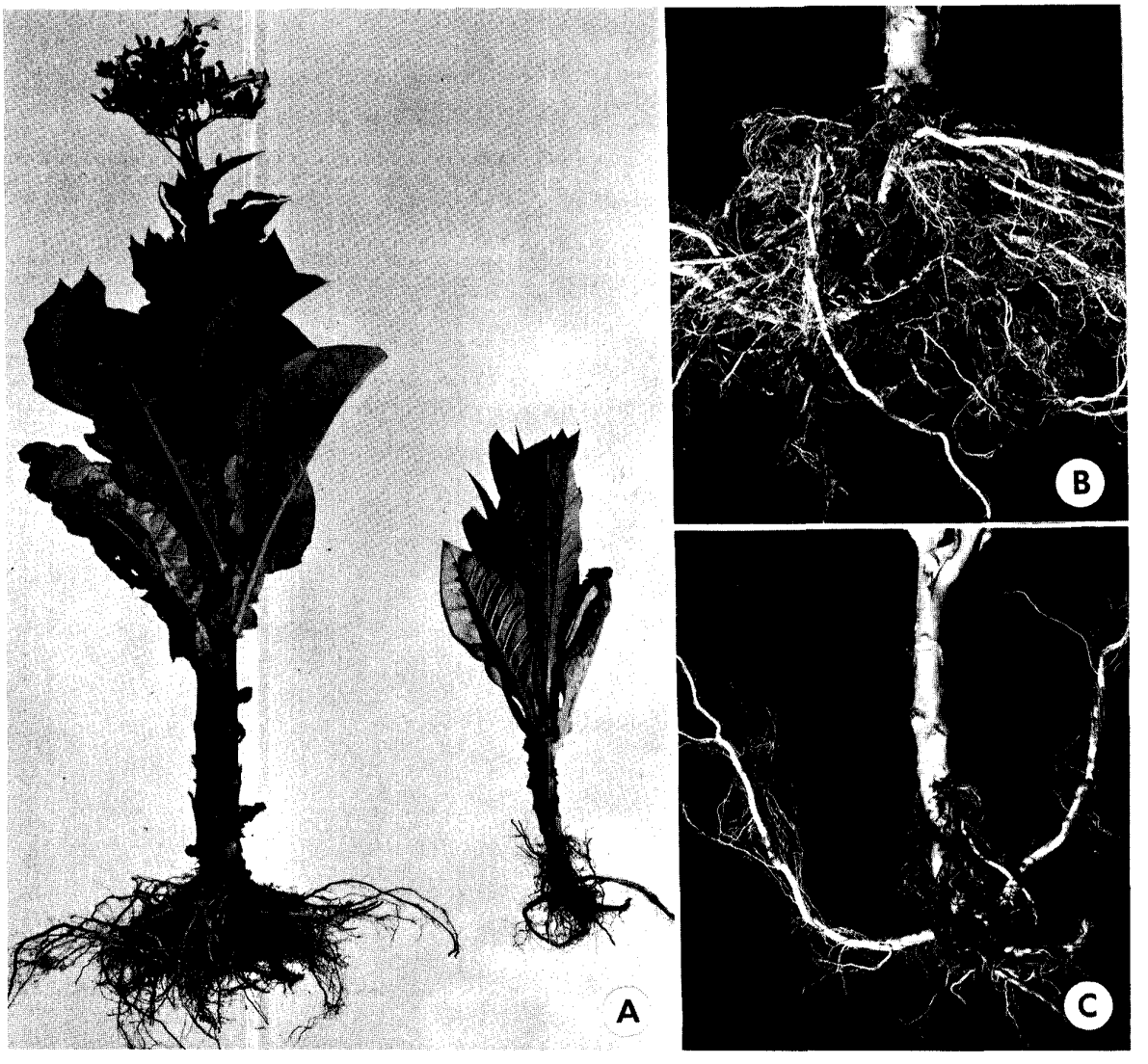

Figure 1. Relative development of tobacco plants grown in a field heavily infested with *Thielaviopsis basicola*. A) (left) plant treated with benomyl rototilled into the row at the rate of 6.25 kg/ha; (right) untreated check; B) root from treated soil; C) root from untreated soil.

Benomyl applied in the planting water at a concentration of 15 ppm had no appreciable effect on the disease in the field. Trials on the effect of benomyl on the physical and chemical properties of tobacco leaf are in progress.

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