Neth. J. Pl. Path. 88 (1982) 79-85

Chemical control of Botrytis cinerea and Sclerotinia sclerotiorum on dwarf snap beans[1]

G. VULSTEKE[2] and P. MEEUS[3]

[2] Provinciaal Onderzoek- en Voorlichtingscentrum voor Land- en Tuinbouw, Roeselare (Rumbeke-Beitem), Belgium
[3] Station de Phytopharmacie, Gembloux, Belgium

Accepted 23 December 1981

Abstract

Two sprays of vinclozolin (0.5 kg a.i. ha^{-1}) or procymidone (0.5 kg a.i. ha^{-1}), the first at the beginning of flowering and the second two weeks later, gave the best control of *Botrytis cinerea* on dwarf snap beans *(Phaseolus vulgaris)*. Good results were also obtained with iprodione and with thiophanate-methyl. Vinclozolin and procymidone at the same program were the most active fungicides against *Sclerotinia sclerotiorum*. Treatments with the latter two fungicides resulted in increased yields of pods and had no influence on colour and quality of the pods. Residue levels were below the tolerances.

Additional keywords: vinclozolin, procymidone.

Introduction

Dwarf snap beans are an economically important crop in West-Flanders, Belgium. They are grown as a main crop or as a catch crop after early potatoes or other crops harvested early. *Botrytis cinerea* and *Sclerotinia sclerotiorum* are the most frequent fungal diseases of dwarf snap beans.

Trials carried out from 1971 to 1974 demonstrated clearly that the disease level could be reduced considerably by two sprays of fungicides. Systemic fungicides were more effective than those based on dichlofluanid and captafol (Meeus and Vulsteke, 1975). As reported by Baraer (1979) two treatments with vinclozolin gave very good results against *Botrytis* and *Sclerotinia* in comparison with benomyl. Benoist (1979) advised one application with vinclozolin at early flowering.

Baraer (1979) and Benoist (1979) did not mention the influence of the application of the fungicides on the residue level in the pods. The dose of the applied fungicides is not mentioned by Baraer (1979), whereas Benoist (1979) advised one treatment with vinclozolin at 0.75 kg a.i. ha^{-1} for dwarf snap beans. It was considered opportune to test the efficacy of different new fungicides against both diseases, as well as their influence on crop, on pod yield, on quality and particularly on the residue levels in the pods. In addition, the aim of our trials was to find an effective spraying scheme for the farmers.

[1] This research was subsidized by the 'Instituut tot Aanmoediging van het Wetenschappelijk Onderzoek in Nijverheid en Landbouw' (IWONL).

Table 1. Fungicides tested and rates applied.

Code name	Formulation	Trial year and rate (kg a.i. ha^{-1})			
		1975	1977	1978	1979
vinclozolin	w.p. – 50%	0.375	0.5	0.5	0.5
procymidone	w.p. – 50%	–	0.5	0.5	0.5
iprodione	w.p. – 50%	0.75	0.75	0.75	0.75
thiophanate-methyl	w.p. – 70%	0.7	0.7	0.7	0.7
thiophanate-methyl	w.p. – 70%	0.42	0.42	0.42	0.42
+ maneb	+ 60%	+1.8	+1.8	+1.8	+1.8
thiabendazole	w.p. – 12%	0.36	0.36	–	–
+ maneb	+64%	+1.92	+1.92		
tolylfluanid	w.p. – 50%	–	1.5	–	–

Tabel 1. Onderzochte fungiciden en gebruikte doses.

Materials

The trials were carried out on a loamy-sand soil under practical growing conditions. The field plots with a useful area of 10 m^2 were laid out with 4 repetitions according to the method of randomised blocs. Each plot consisted of 5 rows with a row spacing of 44 cm. Ten mature plants were harvested at random from the three centre rows in each plot. *B. cinerea* attack on the pods was evaluated according to the following scale: 5: healthy; 4: slight (tip of pod); 3: medium (1/2 of pod); 2: severe (3/4 of pod); 1: very severe damage (whole pod).

The number of plants attacked by *B. cinerea* or *S. sclerotiorum* was noted in percentage but no differences in intensity of the attack were observed.

The fungicides were applied with a knapsack sprayer at a constant pressure of 294 kPa applying 1000 l water/hectare. The spraying boom was equipped with conical Durotype nozzles with 1 mm split opening. In Table 1 the fungicides and the rates are mentioned.

The dates of the treatments were as follow: the first at stage 'early flowering', the second two weeks later at stage 'full flower' or at pod formation i.e. when almost all flowers were set.

The harvest was carried out by hand and the yields are expressed as a percentage of the untreated control.

Results and discussion

Disease incidence. During the trials disease development due to *B. cinerea* and *S. sclerotiorum* was generally modest with the exception of 1977 when a severe outbreak was noted. Only in 1976 there was no disease.

Efficacy of the fungicides. The trials have demonstrated that it is possible to control *B. cinerea* and *S. sclerotiorum* in dwarf snap beans with two fungicide sprays

Table 2. Influence of fungicides on pod attack caused by *B. cinerea* and on yield.

Fungicide	Percentage pods infected by *Botrytis*[1]					Yields (percentage of untreated control)				
	1975	1977	1978	1979	mean of 1977-1979	1975	1977	1978	1979	mean of 1977-1979
vinclozolin	5.8 a[2]	5.9 a	1.7 b	0.8 a	2.6 a	110.4 a	162.5 a	113.2 a	113.0 a	123.5 ab
procymidone	–	6.6 a	3.7 bc	2.1 a	3.7 a	–	158.8 ab	110.8 a	117.9 a	124.0 a
iprodione	12.4 b	11.8 ab	0.9 a	3.5 ab	4.0 a	105.5 ab	142.2 ab	108.3 a	102.9 a	113.2 bc
thiophanate-methyl	5.1 a	10.3 ab	1.9 b	4.0 ab	4.4 a	108.6 ab	133.9 bc	98.5 a	103.8 a	108.2 cd
thiophanate-methyl + maneb	4.6 b	13.5 b	5.0 bc	7.0 bc	8.2 b	105.9 ab	135.4 b	102.1 a	105.8 a	110.7 cd
thiabendazole + maneb	11.6 ab	24.6 c	–	–	–	103.0 ab	110.3 cd	–	–	–
tolylfluanid	–	24.2 c	–	–	–	–	100.0 d	–	–	–
untreated	9.7 ab	23.9 c	7.5 c	9.7 c	13.3 c	100.0 b (=18840)[3]	100.0 d (=8469)	100.0 a (=14688)	100.0 a (=17094)	100.0 d (=13417)
L.S.D. (P=0.05)	5.5	6.2	6.0	1.5	4.2	8.6	24.8	17.6	9.3	10.3

[1] Total number of pods attacked by *Botrytis*, obtained from 4 × 10 plants, expressed as percentage of total harvested pods.
[2] Duncan-test: objects without common character are significantly different (P = 0.05).
[3] Between brackets: yield expressed as kg ha^{-1}.

Tabel 2. Invloed van fungiciden op peulaantasting door B. cinerea en opbrengst.

Table 3. Influence of fungicides on percentage of plants infected by *B. cinerea* and *S. sclerotiorum*.

Fungicide	Percentage plants infected by *B. cinerea*					Percentage plants infected by *S. sclerotiorum*				
	1975	1977	1978	1979	Duncan-test mean of 1977-79	1975	1977	1978	1979	Duncan-test[1] mean of 1977-79
vinclozolin	7.5	2.5	10.0	7.5	a	5.0	5.0	5.0	0	a
procymidone	–	2.5	15.0	17.5	ab	–	5.0	17.5	2.5	ab
iprodione	10.0	5.0	10.0	27.5	ab	12.5	40.0	25.0	15.3	bc
thiophanate-methyl	12.5	5.0	15.0	20.0	a	7.5	45.0	17.5	5.0	ab
thiophanate-methyl + maneb	12.5	12.5	7.5	32.5	ab	10.0	32.5	27.5	10.3	b
thiabendazole + maneb	15.0	40.0	–	–	–	15.0	65.0	–	–	–
tolylfluanid	–	20.0	–	–	–	–	47.5	–	–	–
untreated	22.5	47.5	17.5	20.0	b	2.5	90.0	40.0	20.0	c
L.S.D. (P = 0.05)					0.58					0.56

[1] Objects without common character are significantly different (P = 0.05)

Tabel 3. Invloed van fungiciden op het percentage aangetaste planten door B. cinerea en S. sclerotiorum.

(Tables 2 and 3). Over the whole period vinclozolin and procymidone gave the best results against *B. cinerea* (Table 2). The results of Baraer (1979) and Benoist (1979) are in accordance. Also iprodione and thiophanate-methyl gave good results. There were no significant differences in efficacy against *B. cinerea* on the pods between these fungicides. Thiophanate-methyl + maneb gave very inferior results. Tolylfluanid and thiabendazole + maneb had, at the rates applied, and for the period of application, insufficient activity against *B. cinerea.* In general, no significant differences were noted in the number of plants infected by *B. cinerea* between the various fungicides (Table 3).

Best control of *S. sclerotiorum* was achieved with vinclozolin, followed by procymidone (Table 3). Thiophanate-methyl, too, gave a good control of *S. sclerotiorum.* Vinclozolin gave significantly better results than iprodione and thiophanate-methyl + maneb. Results in 1977 with thiabendazole + maneb and with tolylfluanid were poor and are in accordance with those of Baraer (1979).

It is very important to apply the fungicides at the beginning of flowering as the fungicides must be applied preventively because the period between flowering and pot set is very short. In this period when climatological conditions are favourable for infection many petals may remain attached to the small pods and may then stimulate infection of *B. cinerea.*

Yield. In the year of severe infection (1977) there was a positive correlation between pod yields and efficacy of the fungicides (Table 2). The highest pod yields were obtained following applications of vinclozolin and procymidone. Iprodione, thiophanate-methyl and thiophanate-methyl + maneb also gave higher pod yields, but, in general, the differences were nog significant in comparison with the untreated beans.

Effect on crop growth. On the whole two sprays favourably influenced the number of flower clusters and the number of harvestable pods per plant. Other plant characteristics were hardly affected. None of the fungicide or mixtures of fungicides had any phytotoxic effect or unfavourable influence on exterior quality, colour or maturity of the pods.

Residue levels in the pods. With the applied spray program at early flowering and two weeks later and the harvest at 1-3 weeks after the last spray, the residues were below the official tolerance levels (Table 4).

Conclusions

The trials have demonstrated that it is possible to control *B. cinerea* and *S. sclerotiorum* in dwarf snap beans with two fungicide sprays.

The new fungicides vinclozolin and procymidone gave the best results against both light and severe attacks by the two fungi. The dose of these fungicides was 0.5 kg a.i. ha^{-1}.

The spray program consisting of one spray at early flowering followed by a second spray two weeks later when pod set is almost complete and the pods are in full development, ensured sufficient protection against the two fungi.

Residue level were below the tolerances.

Table 4. Results of residue analyses.

Fungicide	Residue tolerance ($\mu g\ g^{-1}$ fresh material)	Residue levels ($\mu g\ g^{-1}$ fresh material)				
		1975 (1wk)[1]	1977 (3wk)	1978 (3wk)	1979 (2wk)	1979 (2wk after cooking)
vinclozolin	1	–	–	0.07	0.04	0.02
procymidone	–	–	0.13	0.15	0.07	0.04
iprodione	–	–	0.04	0.12	0.11	n.d.
thiophanate-methyl	2	n.d.[2]	n.d.	0.13	n.d.	n.d.
thiophanate-methyl	2	n.d.	n.d.	0.21	n.d.	n.d.
+ maneb	2	n.d.	n.d.	n.d.	n.d.	n.d.
thiabendazole	2	n.d.	n.d.	–	–	–
+ maneb		n.d.	n.d.	–	–	–
tolylfluanid	–	–	n.d.	–	–	–
untreated		n.d.	n.d.	n.d.	n.d.	n.d.

[1] Interval between last spray and harvest (wk = week).
[2] n.d. = not detectible. Limits of detection ($\mu g\ g^{1-}$ fresh material):

thiophanate-methyl (BCM):	0.2 $\mu g\ g^{-1}$	tolylfluanid :	0.02 $\mu g\ g^{-1}$
maneb :	0.3 $\mu g\ g^{-1}$	procymidone :	0.02 $\mu g\ g^{-1}$
iprodione :	0.02 $\mu g\ g^{-1}$	vinclozolin :	0.01 $\mu g\ g^{-1}$

Tabel 4. Resultaten van de residubepalingen.

Acknowledgements

The authors wish to acknowledge the 'Bureau voor Biometrie' at Gent (Director: Prof. Dr. A. Rotti; assistant: Ir. A. Calus) for the statistical analyses of the results; and the 'Laboratorium voor Fytofarmacie van de Rijksfakulteit der Landbouwwetenschappen R.U.G.' at Gent (Director: Prof. Ir. R. Kips; senior assistant: Dr. Ir. W. Dejonckheere) for the residue analyses. Many thanks are due to Ir. R. Nierinck for the translation of this paper.

Samenvatting

De chemische bestrijding van Botrytis cinerea and Sclerotinia sclerotiorum in stamslabonen

Twee bespuitingen met vinchlozolin (0,5 kg a.i. ha^{-1}) of procymidon (0,5 kg a.i. ha^{-1}), de eerste in het stadium 'begin bloei' en de tweede 14 dagen later tijdens de peulzetting, waren voldoende om *B. cinerea* in stamslabonen te bestrijden. Tevens werden goede resultaten verkregen met iprodion en thiofanaat-methyl. Vinchlozolin en procymidon gaven volgens hetzelfde schema toegepast ook de beste werking tegen *S. sclerotiorum*. Toepassingen van deze laatste twee fungiciden leverden een hogere peulopbrengst en hadden geen invloed op de kleur en de kwaliteit van de peulen. Het residugehalte in de peulen lag beneden de toelaatbare grens.

References

Baraer, J., 1979. Protection des cultures de légumes de conserve contre *Botrytis cinerea* et *Sclerotinia sclerotiorum*. Rev. Hort. No. 198: 52-54.

Benoist, M., 1979. La lutte contre les attaques du *Botrytis* et du *Sclerotinia* sur haricot et du *Botrytis* sur pois. Rev. Hort. No. 198: 55.

Meeus, P. & Vulsteke, G., 1975. Lutte fongicide contre la pourriture grise *(Botrytis cinerea* Pers.) dans les cultures de haricots. Med. Fac. Landbouww. Rijksuniv. Gent 40: 663-672.

Adresses

G. Vulsteke: Provinciaal Onderzoek- en Voorlichtingscentrum voor Land- en Tuinbouw, Ieperweg 87, 8810 Roeselare (Rumbeke-Beitem), Belgium.

P. Meeus: Station de Phytopharmacie, Rue du Bordia 11, 5800 Gembloux, Belgium.