

Control of gangrene and *Fusarium* dry rot on potato tubers with thiabendazole

Thiabendazol til bekæmpelse af Phoma- og Fusarium-råd hos kartofler

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Summary

Thiabendazole (TBZ) and some other fungicides have been screened for effectivity against gangrene (*Phoma exigua* Desm. var. *foveata* Foister (Boerema)) and *Fusarium* dry rot (*Fusarium coeruleum* (Lib.) Sacc.) in vitro. TBZ was very effective in inhibiting the growth of both fungi. In media containing 5 ppm TBZ, colonies grow less than control, but at 10 ppm TBZ in vitro no visible colonies developed.

Treatment of artificially inoculated tubers, with TBZ as a mist had a good preventive effect on infection of both gangrene and *Fusarium* dry rot. The best effect of TBZ against gangrene occurred when the tubers were treated during the first 14 days after artificial inoculation, while *F. coeruleum* was only strongly inhibited when the tubers were treated during the first 7 days of inoculation.

Key words: Potato, thiabendazole, gangrene (*Phoma exigua* var. *foveata*), *Fusarium* dry rot (*Fusarium coeruleum*).

Sammendrag

Thiabendazols virkning overfor *Phoma exigua* var. *foveata* og *Fusarium coeruleum* har in vitro været afprøvet i forskellige koncentrationer og sammenlignet med virkningen af seks andre midler ved en koncentration på 200 ppm. Thiabendazol var blandt de mest effektive midler ved denne koncentration. I substrater indeholdende 10 ppm thiabendazol var der ingen synlig vækst, og i substrater indeholdende 5 ppm thiabendazol var væksten stærkt hæmmet.

In vivo har virkningen af thiabendazol været afprøvet i koncentrationer på ½, 1 og 2 pct., ved 4, 8 og 12° og ved behandling med thiabendazol straks efter såring men dagen før inokulering, (+ 1 døgn), straks efter såring og inokulering (0 døgn) og 3, 7, 14 og 21 døgn efter inokulering samt tillige 10 og 28 døgn efter inokuleringen ved undersøgelserne af virkningen overfor *Phoma*. Inokuleringen blev foretaget ved befugtning med 2 ml sporeopløsning pr. kg kartofler.

Målt med procent angrebne sår havde thiabendazol i alle de anvendte koncentrationer (½, 1 og 2 pct.) en betydelig virkning. Virkningen af ½ procent opløsningen var dog lidt mindre end af 1 og 2 procent opløsningen. Virkningen overfor *Phoma* var stor ved behandling indtil 10 døgn efter inokuleringen, overfor *Fusarium* kun ved behandling indtil 3 til 7 døgn efter inokuleringen.

Ved behandlingen 21 døgn eller senere efter inokuleringen blev der ikke opnået nogen virkning mod *Phoma* og ved behandling 14–21 døgn efter inokuleringen ingen virkning mod *Fusarium*.

Overfor *Phoma* var den virkning, behandlingstidspunktet havde, kun lidt afhængig af temperaturen, mens dets virkning overfor *Fusarium* i nogen grad afhang af temperaturen. Hos kartofler, der var lagret ved 12°, begyndte procent *Fusarium* angrebne sår at stige stærkt ved behandling senere end 3 døgn

efter inokuleringen, og ved behandling senere end 14 døgn efter inokulering blev virkningen lille. Hos kartofler, der blev lagret ved 4°, begyndte procent angrebne knolde først at stige ved behandling senere end 7 døgn efter inokuleringen og virkningen var aftagende indtil 21 døgn efter inokuleringen.

Nøgleord: Kartofler, thiabendazol, Phomaråd (*Phoma exigua* var. *foveata*), Fusariumråd (*Fusarium coeruleum*).

Introduction

Disinfection of seed potatoes during storage may be undertaken to minimize subsequent gangrene, dry rot and other storage diseases.

Boyd (1960) using the varieties Doon Star and King Edward found that dry rot, gangrene and also skin spot were controlled satisfactorily by ethoxy- or methoxyethyl mercurichloride, when treatment took place immediately after lifting. Satisfactory control was not achieved by treatment of tubers taken from storage six weeks later.

Logan (1974) mentioned that effective control of gangrene and dry rot usually was achieved, if seed potato tubers were treated with organo mercury solutions within 3 weeks of lifting. He added, that test with benomyl and thiabendazole (TBZ) also gave effective control of certain potato diseases with distinct advantage over mercury owing to very low toxicity. The very effective control of diseases obtained by dipping tubers in solution of TBZ encouraged investigations into the efficiency of this chemical when applied to the surface of tubers as an ultra low volume spray.

Copeland and Logan (1975) found that TBZ, benomyl and fuberidazole controlled gangrene as an 0,15 pct. a. i. organomercurial dip treatment. Leach (1975) found that TBZ, applied as a mist, had a high preventive effect against dry rot.

The present work was carried out to investigate the effect of TBZ on gangrene and dry rot, when used in vitro or in vivo at different dates, different concentrations and temperatures during the storage of potato tubers.

Materials and methods:

A. Action of fungicides in vitro

The growth of *Phoma exigua* var. *foveata* and *Fusarium coeruleum*, has been tested on agar plates containing the following fungicides at the rate of 200 ppm a.i.

1. Thiabendazole 40 per cent (TBZ) Tecto 40 L
2. Benomyl 50 per cent (Benlate)
3. Mancozeb 80 per cent (Dithane M 45)
4. Cuprihydroxychloride 85 per cent (O B 21)
5. Thiram 80 per cent (Pomarsol 80)
6. Maneb 60 per cent + carbendazim 15 per cent (Granosan)

The effect of different concentration (5 ppm to 500 ppm) of thiabendazole were tested on agar plates, too. The agar plates were prepared by 20 ml of Czapek-Dox agar media autoclaved at 120° for 15 minutes and cooled to 45°, 2 ml water or suspension of the fungicides were added immediately before the agar were poured on the plates. Alternatively agar and fungicide were autoclaved together at 105° for 10 minutes before plates were pouring. Fifteenday-old cultures were used for mycelial inocula, 7–8 mm disks from the edge of the colony were placed at the centre of agar plates. Cultures were incubated at 20°. The linear growth was measured at two directions at right angles and the means were calculated for each replicate. Five replicates were used for each particular treatment.

B. Action of thiabendazole in vivo:

Bintje tubers harvested in September were used, and the experiments were performed in January and March. Tubers were wounded by abrasion against sandpaper (1¼) at each ends, about ½ cm² of the periderm was lightly abraded in each wound. 25 tubers (about 1.5 kg) were used in each treatment. The inoculation was carried out immediately after wounding (except at the 1st date of treatment) with 2 ml spore suspension/kg tubers. The number of spores of *P. exigua* var. *foveata* and *Fusarium coeruleum*/ml was about 4 mill. and 10.000 respectively. Three concentrations of TBZ (½, 1 and 2 per cent a. i.) were used. The control was sprayed with water. The check

was only inoculated. The treatments were applied to the surface of the tubers as an ultra low volume spray with two ml/l kg tubers.

The treatments were carried out at different dates after inoculation i. e. just after wounding but the day before inoculation (± 1 day) just after wounding and inoculation (0 day), 3, 7, 14 and 21 days after wounding and inoculation. In addition 10 and 28 days after inoculation with gangrene. The tubers were inoculated at 4, 8 or 12°C at 95–100 per cent r.h. The infections were assessed after 6 weeks.

Results

A. Action of the fungicides *in vitro*:

The results shown in table 1 indicate that TBZ, Benlate and Granosan were very effective in inhibiting the growth of both *P. exigua var. foveata* and *Fusarium coeruleum*, followed by Dithane M 45 and Pomarsol. O B 21 at the rate of 200 ppm had no effect against any of the fungi

With regard to the effect of different concentrations of TBZ on the growth of both fungi, data obtained showed that in media containing 5 ppm TBZ, the lowest concentration used, colonies

Table 1. Effect of different fungicides (at the rate of 200 ppm a. i.) on the growth of *Phoma exigua var. foveata* and *Fusarium coeruleum*

| Fungicide | <i>Phoma sp.</i> | <i>Fusarium sp.</i> |
|------------------|------------------|---------------------|
| Tecto 40 L | *** | *** |
| Benlate 50% | *** | *** |
| Dithane M 45 80% | ** | *** |
| O B 21 85% | — | — |
| Pomarsol 80% | *** | * |
| Brassicol 60% | * | — |
| Granosan 75% | *** | *** |

*** = No fungal growth

** = Less than 20% of the control

* = Less than 50% of the control

— = No effect

grow little of the rate of controls. At 10 ppm TBZ no visible colonies developed.

B. Action of TBZ *in vivo*

The effect of thiabendazole (TBZ) on the percentage of established infections by gangrene is illustrated in figures 1 and 2 and the effect on *Fusarium* dry rot in figures 3 and 4.

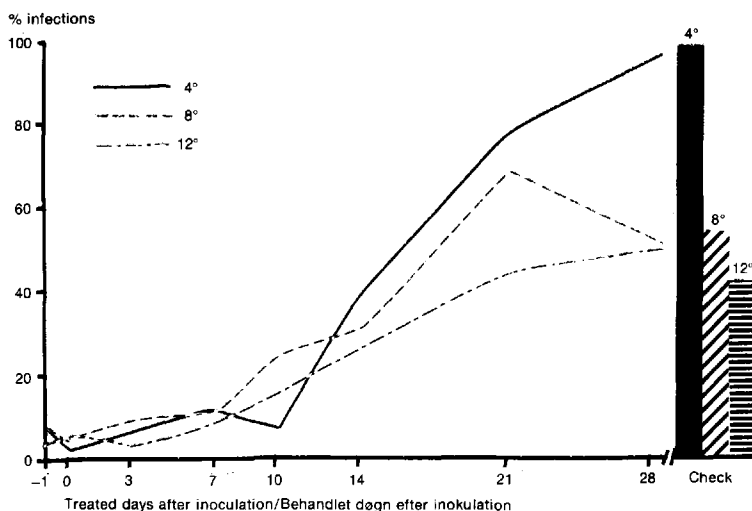


Figure 1. Infection with gangrene after treatment with TBZ until 28 days after inoculation and during storage at 4, 8 and 12°C

Infektion med Phoma-råd efter behandling med TBZ indtil 28 døgn efter inokulering og under lagring ved 4, 8 og 12°C

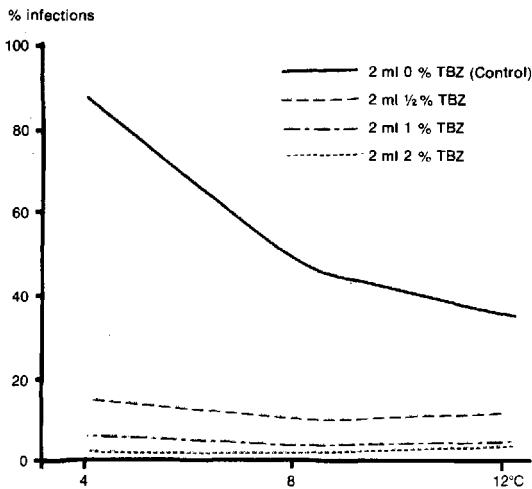


Figure 2. Infection with gangrene after treatment with different concentration of TBZ and storage at 4, 8 and 12°C (Average for treatment 1 day before to 7 days after inoculation)

Infektion med Phoma-råd efter behandling med forskellige TBZ-koncentrationer og lagring ved 4, 8 og 12°C (Gennemsnit for behandling 1 døgn før til 7 døgn efter inokulering)

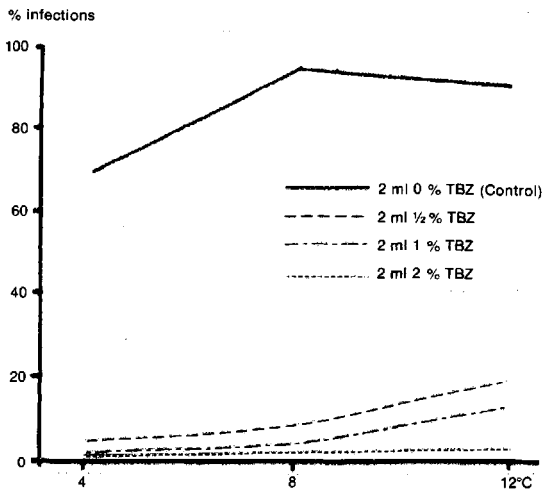


Figure 4. Infection with Fusarium dry rot after treatment with different concentration of TBZ and storage at 4, 8 and 12°C (Average for treatment 1 day before to 7 days after inoculation)

Infektion med Fusarium-råd efter behandling med forskellige TBZ-koncentrationer og lagring ved 4, 8 og 12°C (Gennemsnit for behandling 1 døgn før og 7 døgn efter inokulering)

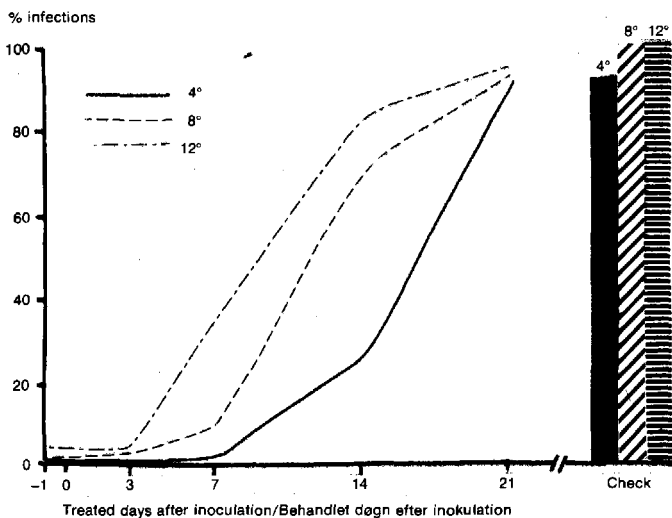


Figure 3. Infection with Fusarium dry rot after treatment with TBZ until 28 days after inoculation and during storage at 4, 8 and 12°C

Infektion med Fusarium-råd efter behandling med TBZ indtil 28 døgn efter inokulering og under lagring ved 4, 8 og 12°C

It is clear from the figures that TBZ had good effect on the incidence of the established infections. The highest effect against gangrene occurred, when the tubers were treated up to 10 days after inoculation. The best effect against *F. coeruleum* occurred after treatment within 7 days after inoculation, when the tubers were stored at 4 and 8°C, and within 3 days, when the tubers were stored at 12°C. After these periods the effect of TBZ decreased rapidly, and among the tubers inoculated with gangrene more fast during the storage at 4°C than at the higher temperatures. Among the tubers inoculated with *F. coeruleum* the opposite was the case, the effect decreased faster and earlier, too, during the storage at 12°C than at the lower temperatures.

Both diseases were highly inhibited by TBZ at all the three concentrations applied, although the effect increased a little with increasing concentration and most from ½ to 1 per cent.

Discussion

In the last few years a good effect against certain potato diseases has been observed, when thiabendazole was applied to the tubers either as dips or mist. In addition, this compound has a distinct advantage over mercury compounds in having a very low mammalian toxicity (Weinke *et al.* 1969 and Logan 1974).

In vitro tests indicated that TBZ, Benlate and Granosan greatly decreased the growth of both *Phoma exigua* var. *foveata* and *Fusarium coeruleum*. TBZ had a very good effect in media containing 5 ppm a. i. or more. This results were in agreement with Murdoch & Wood (1972). O B 21 and Brassicol were unlikely to be value in controlling any of the tested fungi.

Investigations were made to control or minimi-

ze the hazards of gangrene and dry rot diseases in vivo by TBZ applied to the surface of Bintje potato tubers as an ultra low volume spray. Data showed that the effect of this treatment depends strongly on the date of treatment. The greatest and most sure effect against gangrene and dry rot diseases was reached, if treatments were applied within the first 7 days after inoculation, whereas the effect of TBZ decreased rapidly after 10 to 14 days of artificial inoculation of the tubers with gangrene, and after 3 to 7 days of inoculation with *F. coeruleum*. These results are in accordance with the general statement in the literature that the fungicidal treatment against gangrene or dry rot ought to be performed soon after lifting. The results indicate that a treatment with TBZ should be performed not later than 10–15 days after a possible inoculation with gangrene, if an acceptable effect should be reached.

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