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Effect of fungicide and biological control treatments on germination, survival and growth of beech seedlings

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ABSTRACT

Pre-germinated beechnuts which were soaked in a weak solution of fungicides germinated faster than beechnuts dusted with the fungicides. Of the four materials tested only Novozir MN 80 and Apron 35 SD (dry application) had a detrimental effect on emergence or growth of seedlings. Biological treatment of the seedling growing medium with *Trichoderma* or *Bacillus subtilis* did not affect beechnut germination, but seedling growth increased.

INTRODUCTION

Beech (*Fagus sylvatica* L.) is the main forest tree species in Slovakia (Konôpka, 1990). New methods for long-term storage of beechnuts and breaking of their dormancy under controlled conditions (Suszka, 1979; Muller *et al.*, 1990) allow nurseries to produce beech seedlings even in years when beechnut crops are poor. The following techniques are used in Slovak nurseries for storage and presowing treatment of beechnuts. The collected nuts are dried to 10 % of their water content and then stored at -7°C for 1 to 5 years. In early spring before sowing the nuts are subjected cold stratification (without medium) at 1 to 6°C so that their water content is 31%. Before sowing the seeds are treated with fungicides to protect the seedlings against seed and soil fungi (Simancík, 1986). Mancozeb fungicide preparations are recommended for control of *Phytophthora cactorum* (Lév. et Cohn.) Schroet. one of the most important pathogens of beech seedlings (Jancarík, 1989). However, since fungicides may threaten the enviroment or nursery workers it was decided to test some biological control

Table 1. Fungicides and biological control products tested.

Trade name and manufacturer	Active ingredient	Powder dosage in grams per kg seeds	Water solution, concentration	Dosage
FUNGICIDES				
APRON 35 SD Ciba-Geigy Basil Switzerland	35 % metalaxyl	2	0.25 %	-
RIDOMIL MZ 72 WP Ciba-Geigy Basil, Switzerland	8 % metalaxyl 64 % mancozeb	2	0.25 %	-
ALIETTE Rhône-Poulenc Agrochimie Lyon, France	80 % fosetyl-Al	2	0.25 %	-
NOVOZIR MN 80 Duslo s.p. Sala, Slovakia	80 % mancozeb	2	0.30 %	-
BIOLOGICAL CONTROLS				
SUPRESIVIT Cooperative farm Blatnice, Czech Republic	*Trichoderma harzianum* Rifai	-	-	1 g / m^2
T VELDEMAN Rijkstation voor Plantenziekten Merelbeke, Belgium	*Trichoderma harzianum* Rifai	-	-	10 g / m^2
IBEFUNGIN Cooperative farm Strachotín, Czech Republic	*Bacillus subtilis* Cohn emend. Prazmowski	-	-	0.8 ml / m^2

1/ Biocontrols were added to the growing medium immediately after seed sowing as a water suspension in dosages, recommended by the manufacturer.

agents against diseases of beech germinants. Such agents have been used for control of various soil-borne fungi on seedlings and plants of trees (Bojarczuk *et al.*, 1991; Duda and Sierota, 1987; Turchetti, 1982). Thus, the purpose of this study was to test new fungicides and biological controls as alternative treatments for germinating beechnuts . The experiment was made in a greenhouse using four fungicides which were applied by dusting or soaking the beechnuts in weak solutions of the fungicides, and three biological preparations. Besides determining the effect of these materials on germination rate of the beechnuts, their effect on growth of beech seedlings was also determined.

MATERIALS AND METHODS

The beechnuts were soaked in water to increase their water content to 31% and stratified (without medium) at 3° C for 13 weeks. One hundred, healthy nuts with a visible radicle were selected, part of these were treated with a fungicide, a second portion of the nuts was left untreated and used in the biopreparation treatment (applied to the growing medium) and a third portion (untreated) was used for the control. Four fungicides (Apron SD 35, Ridomil MZ 72, Aliette, Novozir MN 80) recommended for *Phytophthora* control were used for seed treatment. Seeds were either dusted with the materials or soaked for 20 minutes in a weak fungicide solution. The fungicides tested, their dosages and concentrations are listed in the table 1.

Seeds were sown in plastic containers (110 mm high, 460 x 150 mm) containing a growing medium of 2 parts peat and 1 part sandy-loam, nursery soil. The substrate was either sterilized by steaming or left unsterilized in which case it contained natural populations of *Fusarium oxysporum* Schlecht. emend Snyder et Hansen and *Rhizoctonia solani* Kühn propagules.

Fifty seeds were placed in each container for each treatment (including the control) which was done in four containers with sterilized medium and four containers with a non-sterilized medium. The containers were placed in a greenhouse and watered three times a week.

The germinants and surviving seedlings were counted 1, 2, 3 and 20 weeks after sowing. On the last date 10 seedling from each container were collected to determine the the root and shoot lengths, dry weight, and root-collar diameter of each seedling. The data were subjected to analysis of variance and the individual means were compared using the Tukey test for multiple comparisons.

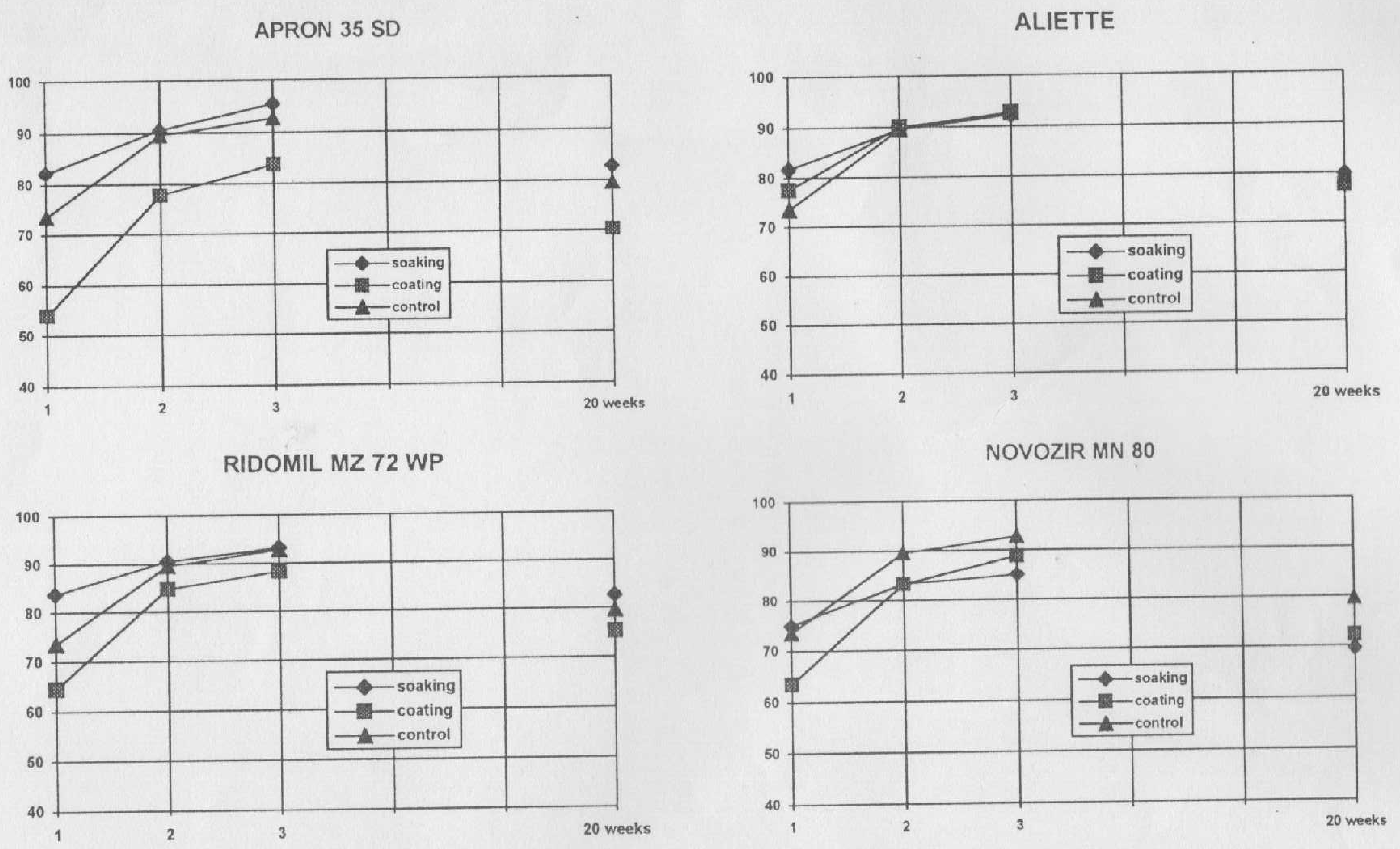

Fig. 1. Comparison of the germination rate of the seeds soaked into fungicide solution and coated with the powdery preparation

RESULTS AND DISCUSSION

The beechnuts treated by soaking in fungicide solution germinated faster than dusted beechnuts (Fig. 1). In the case of Apron and Ridomil these differences were significant (Table 2). The higher germination rate of seeds soaked in the fungicide solutions may be the result of soaking the seeds in water. Application of dry fungicide can damage radicles. Thus, soaking beechnuts in low concentrations of fungicides should be the best method for applying fungicides to pregerminated beechnuts, followed by dusting with dry fungicides.

Dusting beechnuts with Apron fungicide was the only treatment that significantly decreased germination. The lowest number of surviving seedlings at the end of the trial occured in the dry application of Apron and soaking of seeds in Novozir solution (statistical significant for both the sterilized and unsterilized substrate). Germination after biological treatment was about the same as in the control with none of the differences among means being significant (Table 3).

Sowing beechnuts in soil with *Fusarium* and *Rhizoctonia* had no influence on germination or seedling survival; however seedlings were significantly smaller in the non-sterlized substrate. The statistical analyses showed that there were no significant differences in root and shoot dry weights among the various treatments (Table 4).

Some of the biological treatments stimulated seedling growth, e.g., shoot and root length were better in the *Trichoderma* treatment (from Dr. Veldeman) and roots were longer in the Supresivit treatment, while root collar diameter increased in the Ibefungin treatment (Table 4). Biological treatment tended to provide a protective influence in the non-sterilized medium. Shoot and root lengths in the Novozir (dusting and soaking) treatments were significantly different from the best values in the chemical and biological treatments. However, this may have resulted from less competition in this treatment where there were fewer seedlings. In the treatments with 0.25% Ridomil and 2 g of Aliette the greater numbers of seedlings in the containers (Table 2) may have been partially responsible for the slightly smaller roots in these treatments.

Of the four fungicides tested, Apron 35 SD and Novozir MN 80 were phytotoxic. Mancozeb is one of the most frequently used fungicides in Slovak forest nurseries. The mancozeb preparations Novozir MN 80 and Dithane M 45 are (in higher dosages than used here) recommended for seed treatment (Svestka and Benes, 1989; Jancarík, 1989). Because germinating beechnuts are probably more affected by fungicide phytotoxic it is recommended that Novozir MN 80 not be used for treatment of pre-germinated beechnuts. The phytotoxic effects of Novozir MN 80 and Dithane M45 can differ, thus, it would be useful to

Table 2. Emergence and survival of the fungicide-treated beechnuts (in % of sown seeds).

Weeks after sowing 2/	Treatments 1/								
	Beechnuts soaked				Beechnuts dusted				
	Apron	Ridomil	Aliette	Novozir	Apron	Ridomil	Aliette	Novozir	Control
1									
S	92. 0*a*	89. 5*ab*	88.0*ab*	88.0*ab*	47.5*d*	62.0*cd*	74.0*abc*	69.0*bcd*	68.5*bcd*
N	72.5*a*	78.0*a*	75.5*a*	62.0*a*	60.5*a*	66.5*a*	81.0*a*	48.0*a*	78.5*a*
20									
S	86.0*a*	84.5*ab*	81.0*ab*	77.0*ab*	62.5*b*	70.0*ab*	77.50*ab*	68.0*ab*	76.5*ab*
N	79.5*ab*	81.0*a*	78.5*ab*	62.0*b*	78.0*ab*	80.5*a*	77.5*ab*	76.5*ab*	82.5*a*

1/. Values followed the same letter are not significantly different (P = 0.05).
2/. S and N = sterilized and non-sterilized seedling growing medium.

Table 3. Emergence and survival of biological control-treated beechnuts (in % of the sown seeds).

Weeks after sowing 2/	Treatments 1/			
	Supresivit	T.Veldeman	Ibefungin	Control
1				
S	74.5*a*	70.5*a*	73.5*a*	68.5*a*
N	75.5*a*	71.5*a*	68.5*a*	78.5*a*
20				
S	82.0*a*	81.0*a*	72.5*a*	76.5*a*
N	79.5*a*	69.5*a*	72.5*a*	82.5*a*

1/. Values followed by the same letters are not significantly different (p = 0.05); all treatments applied as a drench to the growing medium.
2/. S and N = sterilized and non-sterilized seedling growing medium.

Table 4. Growth of beech seedlings following treatment of beechnuts with fungicides and biological control products. 1/

	Beechnuts soaked				Beechnuts dusted				Medium drenched			
	Apron	Ridomil	Aliette	Novozir	Apron	Ridomil	Aliette	Novozir	Supresivit	Veldeman	Ibefugin	Control
Shoot length (cm)												
S	13.6a	14.6a	14.3a	12.7a	12.7a	13.9a	13.6a	12.6a	14.0a	14.4a	14.3a	13.9a
N	12.2a	12.7a	13.1a	12.4a	12.9a	12.3a	12.4a	11.6a	12.8a	13.0a	12.7a	12.9a
Root length (cm)												
S	23.4a	23.4a	22.4ab	19.1b	21.4ab	23.5a	19.3b	22.1ab	24.4a	24.7a	21.8ab	21.5ab
N	21.7a	17.5c	19.6abc	20.3abc	20.5ab	20.0abc	19.0abc	18.7bc	20.0abc	21.5ab	20.1abc	19.4abc
Root collar (cm)												
S	2.08a	2.16a	2.22a	2.09a	2.18a	2.19a	2.17a	2.11a	2.24a	2.22a	2.32a	2.16a
N	2.07a	2.09a	2.11a	2.20a	2.19a	2.15a	2.09a	2.08a	2.17a	2.19a	2.18a	2.06a
Shoot dry weight (g)												
S	203a	222a	225a	186a	195a	208a	217a	183a	215a	209a	193a	193a
N	165a	167a	175a	179a	166a	165a	149a	187a	168a	169a	171a	172a
Root dry weight (g)												
S	354a	381a	379a	360a	311a	354a	368a	316a	415a	352a	352a	365a
N	357a	348a	336a	414a	334a	340a	313a	323a	376a	413a	394a	338a

1/. Values followed by the same letter are not significantly different ($p = 0.05$). S and N = sterilized and non-sterilized seedling growing medium.