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# Significance of seed-borne *Ascochyta* on pea and test of management strategies

**Large amounts of Danish pea seeds are rejected each year due to high levels of Ascochyta infections. Selection of less susceptible pea varieties may reduce seed infections, while intercropping with barley only gives a small reduction. Increasing seeding rates has no effect. Short pea varieties generally seem to be more susceptible to seed infection by Ascochyta than taller varieties.**

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Figure 1.

Levels of *Ascochyta* spp. on Danish pea seeds have been increasing during the last decade, and large amounts of seeds have to be rejected each year because they exceed the threshold level.

Three different fungi within the *Ascochyta* spp. complex cause disease on peas: *Mycosphaerella pinodes*, *Ascochyta pisi* and *Phoma medicaginis* var. *pinodella*.

Symptoms are lesions and necrosis on pods, stems and leaves (see Figure 1 above). All three fungi can be seed-borne.

*M. pinodes* causes pea blight and is the only species being spread epidemically via air-borne spores. It was the dominating species in Denmark in the 1980'ies. Lately, however, *A. pisi*, which primarily causes leaf and pod spot has become the dominating species. *P. medicaginis* var. *pinodella* causes primarily foot rot and occurs only to a limited extent on seeds in Denmark. The cause of the shift in species composition is not clear (see Box 1).

## Significance of seed-borne infection

Countrywide trials in conventional peas carried out by the Danish Agricultural Advisory Service have shown that seed-borne *Ascochyta* causes 0.059 hkg/ha yield reduction for each percent seed infection.

Thus, sowing seeds with 20% *Ascochyta* is expected to give a yield reduction of 1.18 hkg/ha (Planteavlsorientering nr. 09-696). In similar organic trials, no significant relationship between seed infection levels and yield was found (Table 1). This can probably be explained by the fact that factors other than *Ascochyta* have a higher influence on yield in organic peas. Under humid conditions the disease can develop and spread quickly. Therefore, there is no correlation between infection levels in the seed sown and in the harvested seed.

The Danish threshold level for *Ascochyta* spp. in pea seeds is 5% infected seeds (10% when growing whole-crop peas). Because of very high seed rejection levels during recent years, seed producers and organic farmers' associations agreed each year from 2003 to 2005 to raise the threshold level for organic pea seed to 20%.

Nevertheless, 20% of organic pea seed lots had to be rejected in 2003, and 66% in 2004 (data from the Danish Plant Directorate). Thus, growing peas for seed production is very risky in Denmark.

## Limited effect of intercropping of pea and barley

In order to investigate whether intercropping of pea and barley could reduce the level of seed infection in the harvested pea seed, peas were sown in mixture with barley in various proportions: 100% peas, 75/25% pea/barley and 50/50% pea/barley (percentage of normal seeding rate). Trials were carried out in farmers' fields in 2002 and 2003, each year with a short and a tall pea variety.

As shown in Table 2, infection levels in the harvested pea seed when grown in monoculture reached 31 to 70%, dependent of the year and the variety. Infection levels were somewhat reduced through intercropping and in the variety Sponsor this reduction was significant. Also, infection levels were lower in the tall than in the short variety. However, even in the 50/50% mixture, seed infection levels reached 29 to 66%, which is far beyond the threshold level.

In trials by Kinane and Lyngkjær (DARCOFenews, March 2005), seed infection levels were reduced further by increasing the proportion of barley seed up to 75%. However, it is not considered realistic to grow pea seeds routinely in mixtures with such high proportions of barley seed.

## No effect of increased seeding rates

The effect of increased seeding rates was tested. This was based on the assumption that a higher plant density would give a more upright plant stand and thereby reduce seed infection. Trials were carried out in farmers' fields. In 2003, two seeding rates – 80 and 120 seeds/m2 – were tested in 4 trials. In 2004, three seeding rates – 60, 80 and 120 seeds/m2 – were tested in three trials. Results in Table 3 show that it was not possible to reduce seed infections in this way.

### Testing resistance

Resistance of pea varieties was studied in two different field trial systems:

1) Artificial inoculation was carried out with each pathogen species separately, assuming that a variety might exhibit differential resistance towards the three pathogens.

Trials were carried out under organic conditions at Research Centre Flakkebjerg. Plants of 11 varieties were inoculated after emergence with fungal inoculum produced on barley grain and/or by spraying with a spore suspension after flowering. Harvested seeds were subjected to seed health testing. *A. pisi* and *M. pinodes* were detected in relatively high numbers, whereas *P. medicaginis* only was recovered in very low levels. In 2003 the three species could successfully be kept separately. In 2004, however, background levels of *A. pisi* were so high that it was the dominating species on all seeds tested.

2) Varieties were tested under natural infection in trials carried out by the Advisory Service in organic farmers' fields. Eleven varieties were tested.

### Resistance of varieties

Despite variation between trials, varieties Pinochio, Jackpot, Brutus, Attika, Faust and Nitouche tended to have lower seed infection levels, while seeds of Sponsor, Bastille, Javlo and Algarve had higher infection levels (Figure 2, Figure 3, Figure 4, Figure 5). No differential resistance towards the three pathogen species was detected. In artificial inoculation trials, seed infection levels reached 15 to 35%, in one trial even 75%.

Even under natural conditions, high seed infection levels occurred (Figure 5 and Figure 6), ranging from 6 to 37% in 2003. In 2004 they ranged from 45 to 65%, with only small differences between varieties.

### Short varieties are more susceptible than tall varieties

It has been hypothesized that short varieties may be more susceptible to seed infection than taller ones, and the same tendency was seen in the current trials. In two out of three trials a significant negative correlation between crop height and seed infection was found (Figure 7, Figure 8, Figure 9).

### Conclusion

Seed-borne *Ascochyta* has become widespread in Denmark during the last 10 years. Large numbers of seed lots are rejected each year because the threshold for *Ascochyta* spp. has been exceeded – even though the threshold was raised from 5% to 20% in organic pea seed.

Selection of less susceptible varieties can reduce seed infections, while growing peas in mixture with barley can only give a small reduction. The risk of exceeding the threshold level is still very high.

**Box 1. Shift in species composition of Ascochyta**

It is not clear what has caused the shift in the species composition of *Ascochyta* spp., which has occurred in nature. While *M. pinodes* used to prevail, *A. pisi* is now the dominating species. Several causes are possible. Within the last 10-15 years the genetic composition of varieties has shifted towards semi leafless varieties. Within the same period the use of fungicide treatments on conventional pea seeds, which used to control seed-borne *A. pisi*, has stopped because the fungicide Thiram has been banned.

**Table 1.** Effect of seed-borne *Ascochyta* spp. on the yield of peas. Results from countrywide organic field trials by the Danish Agricultural Advisory Service, grouped according to the infection levels in the seed sown and the height of the pea variety.

| Trials grouped according to infection levels of the seed sown and height of variety | Yield and yield increase hkg/ha |
|---|---|
| **2002-2004**, 9 trials, variety tall at harvest | |
| 2 – 5% Ascochyta on seed | 38.0 |
| 6 – 19% Ascochyta on seed | -1.9 |
| LSD | n.s. |
| **2002-2004**, 9 trials, variety short at harvest | |
| 2 – 7% Ascochyta on seed | 35.3 |
| 8 – 15% Ascochyta on seed | -0.1 |
| LSD | n.s. |
| **2002 and 2004**, 6 trials, variety tall at harvest | |
| 2 – 5% Ascochyta on seed | 35.0 |
| 6 – 19% Ascochyta on seed | -1.4 |
| 22 – 37% Ascochyta on seed | -0.8 |
| LSD | n.s. |
| **2002-2003**, 7 trials, variety short at harvest | |
| 2 – 7% Ascochyta on seed | 38.1 |
| 8 – 15% Ascochyta on seed | 0.4 |
| 33 – 46 % Ascochyta on seed | -2.2 |
| LSD | n.s. |

**Table 2.** Effect of intercropping of pea and barley on seed infection of peas with *Ascochyta* spp. Each year a short (Athos) and a tall pea variety (Sponsor, Attika) was tested. A mixture of three barley varieties was used. Each figure represents data from 4 trials in 4 replicates.

| Percent pea/barley mixture* | % *Ascochyta* spp. in seed | | | |
|---|---|---|---|---|
| | 2002 | | 2003 | |
| | Athos | Sponsor | Athos | Attika |
| 100/0 | 70.4 | 62.3 | 48.4 | 31.5 |
| 75/25 | 69.3 | 57.0 | 45.4 | 31.8 |
| 50/50 | 66.2 | 54.4 | 43.6 | 29.7 |
| LSD | n.s. | 5.5 | n.s. | n.s. |

* Seeding rate in a pea monocrop was 80 germinable seeds/$m^2$, in barley it would be 350 seeds/$m^2$.

**Table 3.** Effect of seeding rate on occurrence of *Ascochyta* spp. on pods and in the harvested seed.

| Seeding rate germinable seeds/m$^2$ | *Ascochyta* lesions on pods – % coverage GS 79 | % *Ascochyta* spp. in seeds | Yield and yield increase hkg/ha |
|---|---|---|---|
| **2004**, 3 trials | | | |
| 60 | 1 | 44.8 | 32.9 |
| 80 | 1 | 45.6 | 1.8 |
| 120 | 3 | 46.4 | 2.0 |
| LSD | | ns | ns |
| **2003**, 4 trials | | | |
| 80 | 4 | 26.5 | 33.3 |
| 120 | 4 | 24.5 | 2.1 |
| LSD | | ns | ns |

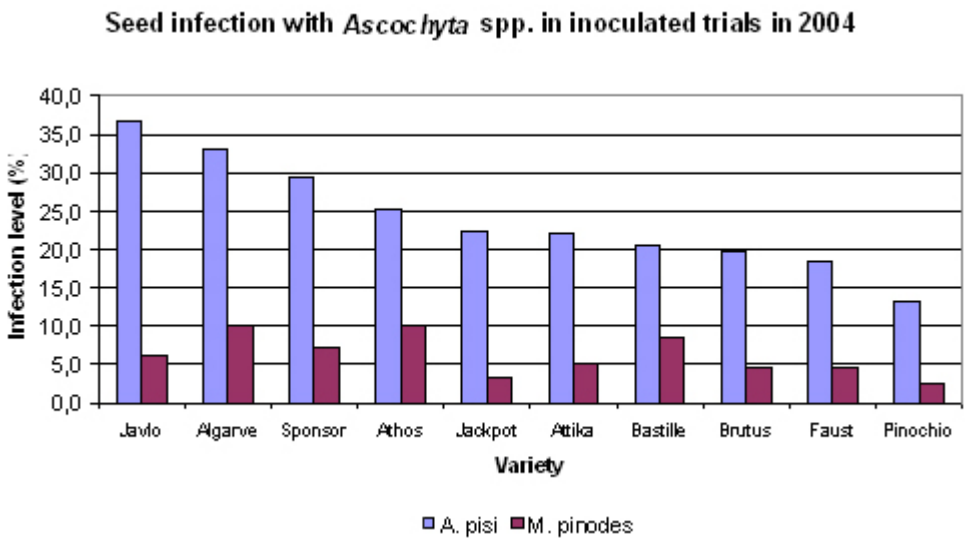


Figure 2. Seed infection in 10 pea varieties in field trials inoculated with *M. pinodes* at Research Centre Flakkebjerg 2004. A high background level of *A. pisi* is evident.

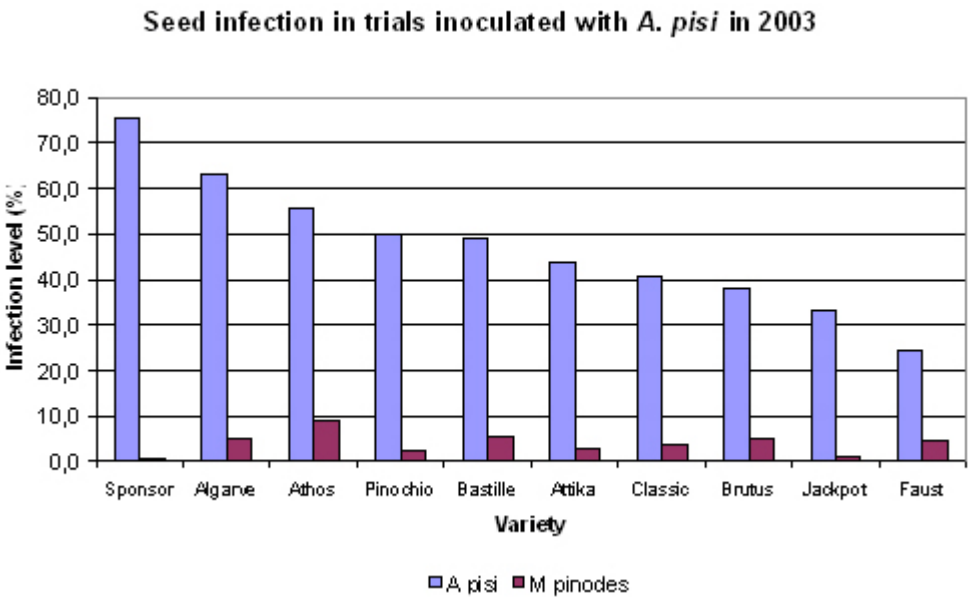


Figure 3. Seed infection in pea varieties in field trials inoculated with *A. pisi* at Flakkebjerg 2003. (M. pinodes was present as background infection).

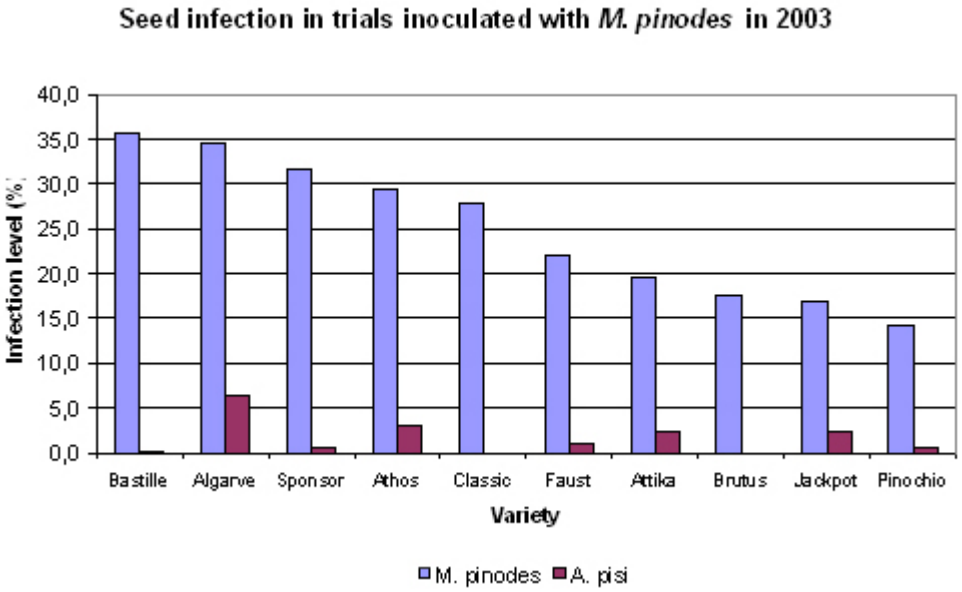


Figure 4. Seed infection in pea varieties in field trials inoculated with *M. pinodes* at Flakkebjerg. (*A. pisi* was present as background infection).

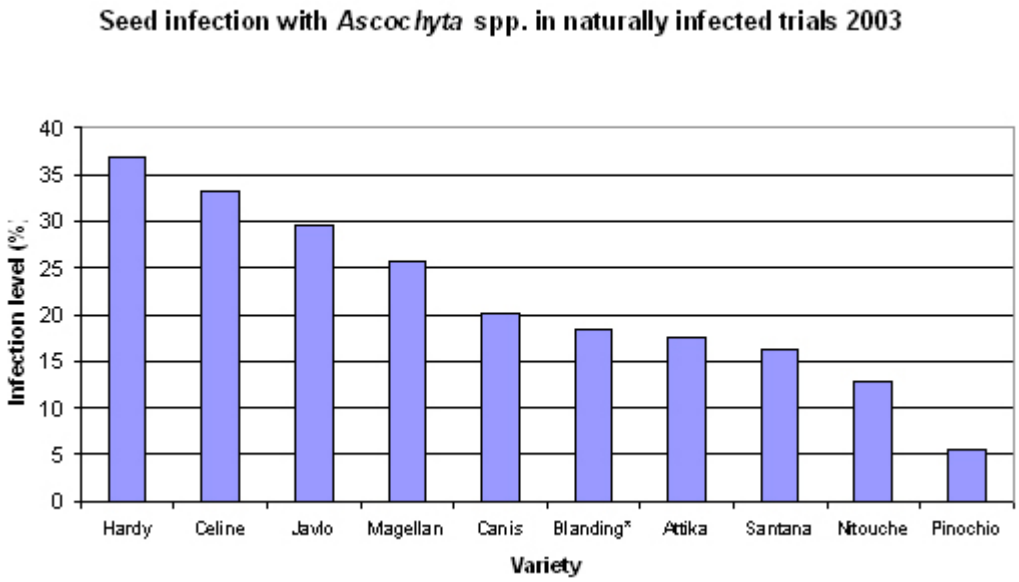


Figure 5. Seed infection levels in pea varieties in organic fields trials. Natural infection, mainly *A. pisi*. Average of 6 trials. *Blanding: Variety mixture of Attika, Sponsor, Jackpot, Pinochio.

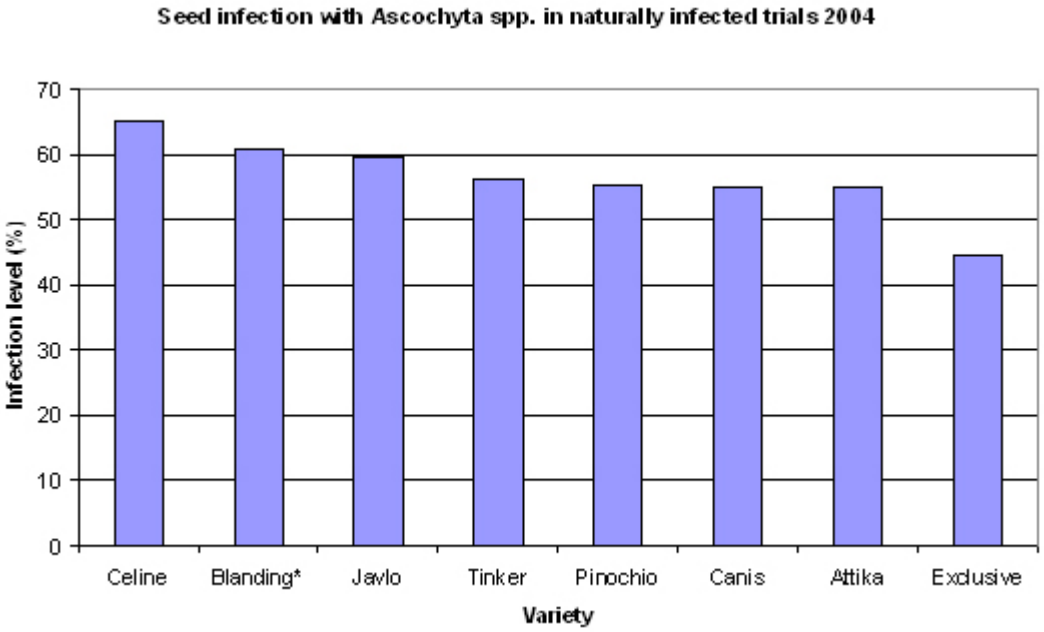


Figure 6. Seed infection levels in pea varieties in organic field trials. Natural infection, mainly *A. pisi*. Average of 2 trials. *Blanding: Variety mixture of Attika, Sponsor, Jackpot, Pinochio.

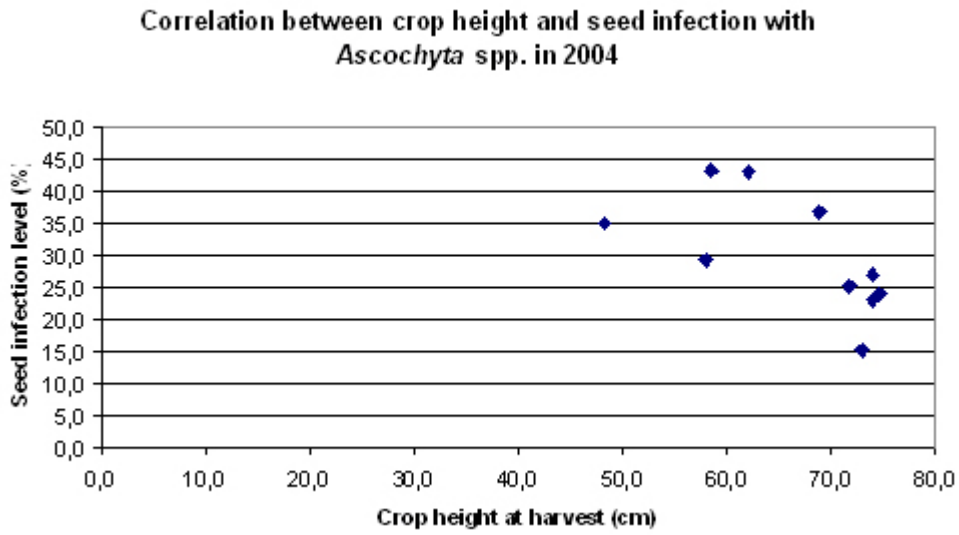


Figure 7. Correlation between crop height at harvest and *Ascochyta* spp. infection in the harvested seed. Each dot represents one variety. Data from an inoculation trial at Flakkebjerg in 2004 are shown. There was a significant negative correlation between crop height and seed infection.

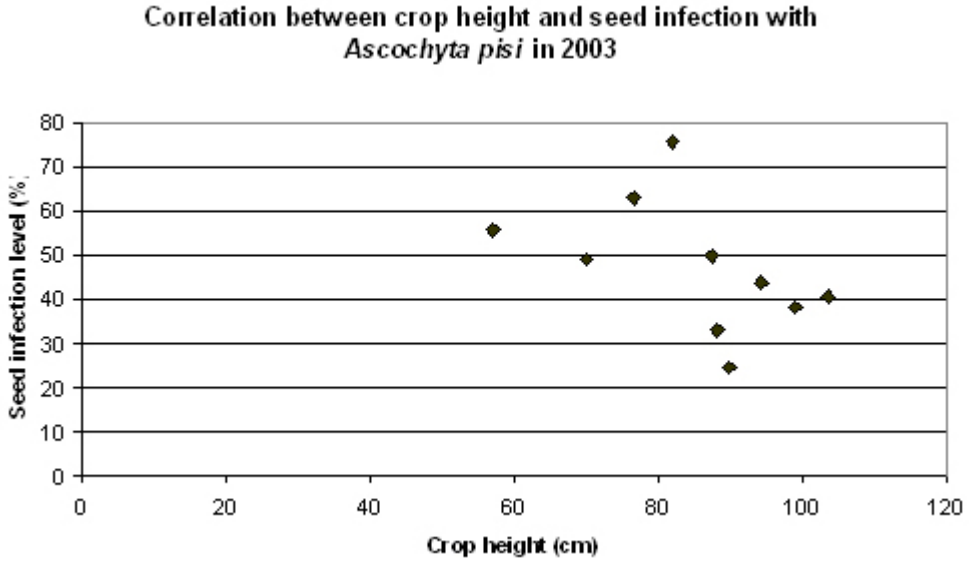


Figure 8. Correlation between crop height one month before harvest and *A. pisi* infection in the harvested seed. Each dot represents one variety. Data from an inoculation trial at Flakkebjerg in 2003 are shown. There was a significant negative correlation between crop height and seed infection.

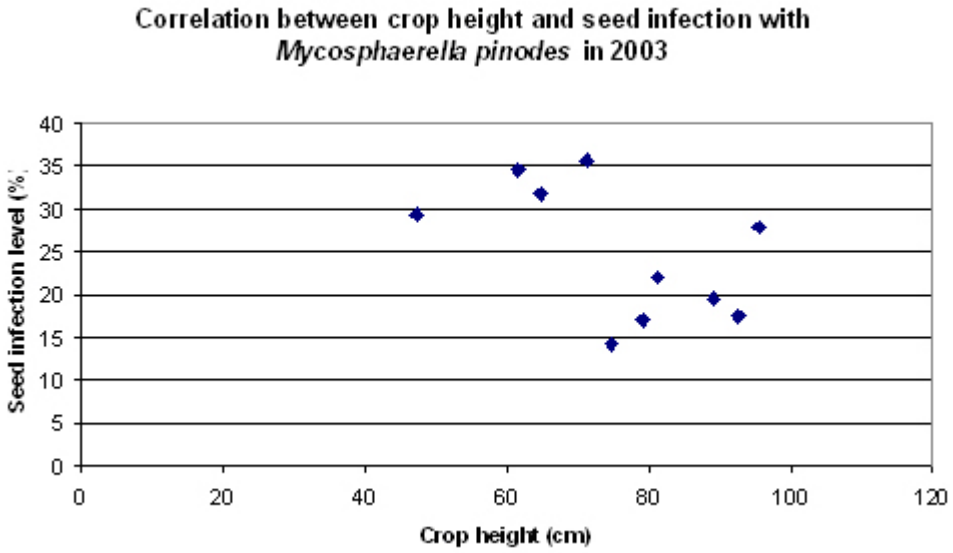


Figure 9. Correlation between crop height one month before harvest and *M. pinodes* infection in the harvested seed. Each dot represents one variety. Data from an inoculation trial at Flakkebjerg in 2003 are shown. There was no significant correlation between crop height and seed infection.