Technical Report

Evaluation of Fungicide Seed Treatment Combinations for the Control of Onion Smut Under Glasshouse Conditions in Pukekohe, New Zealand, 2025

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Summary

Onion smut, caused by *Urocystis cepulae*, is a soil-borne disease that infects onions during germination and early seedling growth. Infection occurs at the cotyledon stage and becomes systemic, often resulting in distortion, reduced vigour or plant death. Where soil inoculum levels are high, establishment losses can be substantial. Because infection is restricted to the early stages of development, protection at sowing through seed-applied fungicides is a key component of management.

A glasshouse trial was undertaken to evaluate a range of fungicide seed treatment combinations for suppression of onion smut in the cultivar PLK. In addition to disease incidence, emergence and germination response were assessed to determine whether treatments influenced seedling establishment.

Methods

The trial was conducted in a glasshouse at Plant and Food Research, Pukekohe, New Zealand, during September–November 2025. Seed was sown on 24 September 2025 into cell trays under controlled glasshouse conditions.

The trial was established as a randomised complete block design (RCBD) with seven treatments and four replicates. Each plot consisted of a single tray section containing 24 individually sown cells (24 seeds per plot). Trays were arranged by replicate within the glasshouse to allow for any positional effects.

The growing medium was pre-inoculated with onion smut prior to sowing to provide consistent disease pressure across all treatments.

Seedlings were irrigated daily to maintain consistent moisture conditions conducive to both germination and smut infection.

Seven seed treatment combinations were evaluated (Table 1), comprising an untreated control and combinations of penflufen, fluopyram, fluxapyroxad, fludioxonil, metalaxyl-M and captan. Application rates are expressed as g/a.i per kg seed.

Table 1: Fungicide Seed Treatment Details

Treatment	Active Ingredients (g a.i/kg seed)
1	N/A
2	Penflufen (2.5g a.i), metalaxyl-M (8g a.i), captan (3g a.i)
3	Fluopyram (9.75g a.i), metalaxyl-M (8g a.i), captan (3g a.i
4	Fluopyram (9.75g a.i), penflufen (2.5g a.i), metalaxyl-M (8g a.i), captan (2.5g a.i)
5	Fluxapyroxad (10g a.i), metalaxyl-M (8g a.i), captan (2.5g a.i)
6	Fludioxonil (0.5g a.i), metalaxyl-M (8g a.i), captan (2.5g a.i)
7	Metalaxyl-M (8g a.i), captan (2.5g a.i)

Assessments

Emergence was recorded daily from first seedling emergence for 15 consecutive days. A germination index was calculated using weighted daily emergence counts to account for both rate and total emergence. n. The germination index (GI) is calculated as:

$$GI = (10 \times n1) + (9 \times n2) + \cdots (1 \times n10)$$

Smut incidence was assessed as the number of visibly infected plants per 24-plant plot. Assessments were conducted on 16, 17, 20 and 23 October, and subsequently on 6 and 12 November 2025 to capture both early and progressive infection.

Statistical analysis

Data were analysed using ANOVA in ARM. Treatment means were separated using Tukey's HSD test at the 5% significance level. Replicate effects were assessed and model assumptions examined. Coefficients of variation (CV) and standard deviations are presented for each assessment timing.

Results

Smut incidence

Treatment effects were significant at all assessment dates (P < 0.001), demonstrating clear and consistent separation among seed treatments under the conditions of this glasshouse study. Replicate effects were not significant (P > 0.05), indicating good uniformity across the layout.

The untreated control sustained a high level of infection throughout the assessment period. Between 16 and 23 October, mean incidence ranged from 13.8 to 16.8 infected plants per 24-plant plot, representing infection in more than 50% of emerged seedlings. Incidence recorded in November (12.8 and 12.3 plants per plot) was marginally lower than peak October levels. This decline is attributable to the loss of severely infected seedlings over time; plants expressing advanced smut symptoms had senesced or collapsed and were no longer present for scoring, rather than reflecting a reduction in disease pressure.

A similar trend was observed in several partially effective treatments, where incidence increased through October before stabilising or declining slightly in November as a result of plant mortality. Incidence at later timings therefore reflects surviving infected plants and should be interpreted alongside earlier assessments.

Treatments containing penflufen and fluxapyroxad provided the most consistent suppression. Treatment 2 prevented detectable infection through 23 October and maintained negligible incidence thereafter (0.3 plants per plot in November). Treatment 4 maintained zero infection at all assessment dates. Both treatments were clearly separated from the untreated control at each timing. Treatment 5 also maintained low infection pressure throughout the trial, with incidence not exceeding 1.0 plant per plot.

Treatments 3 (fluopyram + metalaxyl-M + captan) and 6 (fludioxonil + metalaxyl-M + captan) provided significant suppression compared to the untreated control. Infection levels in treatment 3 were low at the initial assessments but increased during October and were significantly higher than treatments 2 and 4 at the conclusion of the experiment.

Treatment 7 showed reduced infection relative to the untreated control but did not prevent progressive disease development. Incidence increased from 3.8 plants per plot on 16 October to 8.3 plants by 12 November,and had disease incidence comparable to the untreated control at the conclusion of the experiment.
Coefficients of variation ranged from 33% to 57%, increasing at later assessment timings as treatment differences became more pronounced.

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Germination index

Treatment effects were also detected for germination index (P = 0.0006).

The untreated control recorded the highest germination index (40,952), reflecting rapid and uniform emergence. All treated seed lots recorded lower indices, although treatment 5 was not statistically different from the untreated control. Treatment 7 had the lowest germination index, although it is not clear why this was the case, with metalaxyl-M and captan being common amongst all treated lots.

Overall, although treatment effects on emergence were statistically significant, the differences were small when compared with the clear separation observed in smut control.

Table 2: Effect of Fungicide Seed Treatment on Onion Smut Incidence and Germination Index

Treatments		Smut incidence Oct-16-2025	Smut incidence Oct-17-2025	Smut incidence Oct-20-2025	Smut incidence Oct-23-2025	Smut incidence Nov-6-2025	Smut incidence Nov-12-2025	Germ Index Oct-13-2025
1	Untreated	13.8 a	15.0 a	16.8 a	16.8 a	12.8 a	12.3 a	40952.3 a
2	Penflufen, metalaxyl-M, captan	0.0 c	0.0 c	0.0 c	0.0 c	0.3 d	0.3 d	19311.0 b
3	Fluopyram, metalaxyl-M, captan	0.8 c	1.8 c	2.5 c	2.5 c	6.0 bc	6.8 abc	11805.0 b
4	Fluopyram, penflufen, metalaxyl-M, captan	0.0 c	0.0 c	0.0 c	0.0 c	0.0 d	0.0 d	17178.8 b
5	Fluxapyroxad, metalaxyl-M, captan	0.3 c	0.3 c	0.5 c	0.5 c	0.8 d	1.0 cd	25875.8 ab
6	Fludioxonil, metalaxyl-M, captan	0.0 c	0.0 c	0.3 c	0.5 c	1.8 cd	4.8 bcd	12378.3 b
7	Metalaxyl, captan	3.8 b	5.0 b	6.0 b	6.3 b	9.0 ab	8.3 ab	8587.0 b
	Tukey's HSD P=.05	2.08	2.78	3.03	3.67	5.20	6.36	19736.01
	Standard Deviation	0.89	1.19	1.30	1.57	2.23	2.72	8446.40
	CV	33.71	37.87	34.96	41.47	51.07	57.3	43.45
	Replicate F	0.300	0.000	0.226	0.560	0.663	1.727	2.801
	Replicate Prob(F)	0.8250	1.0000	0.8771	0.6480	0.5852	0.1972	0.0695
	Treatment F	130.080	86.580	89.555	61.155	20.240	11.642	6.871
	Treatment Prob(F)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0006

Discussion

Under the glasshouse conditions of this trial, clear and consistent differences were observed between seed treatments in their ability to suppress onion smut.

Treatments containing penflufen and fluxapyroxad provided the most consistent and sustained suppression across all assessment timings. The absence of infection in Treatment 4 throughout the trial period indicates a high level of protection during the critical infection window following emergence.

Fluopyram and fludioxonil based combinations showed high levels of suppression early in the experiment, although incidence increased at later assessments. Treatment 7 reduced infection relative to the untreated control but did not provide equivalent suppression to other treatments.

All fungicide treatments were associated with lower germination index values relative to the untreated control.

Conclusion

Significant differences in onion smut incidence were detected between seed treatment combinations at all assessment timings.

Seed treatments containing penflufen, and fluxapyroxad provided the highest and most consistent level of suppression under glasshouse conditions. Fluopyram and fludioxonil treatments exhibited good initial control, however infection appeared to be increasing at the conclusion of the experiment.

Germination index differed between treatments, with all treated seed recording lower values than the untreated control, although not all reductions were statistically significant.

These results confirm the importance of active ingredient selection in seed treatment for effective management of onion smut during early seedling establishment under high disease pressure conditions.