Testing the compatibility of mesh crop covers with desiccant sprays in seed potato production

Report written for PotatoesNZ and Foundation for Arable Research (FAR)

June 2018. Report number 06-2018

Dr Charles N Merfield

The BHU Future Farming Centre

Permanent Agriculture and Horticulture Science and Extension

www.bhu.org.nz/future-farming-centre

Live, like you'll die tomorrow;
Farm, like you'll live for ever.

Disclaimer

This report has been prepared by The BHU Future Farming Centre, which is part of The Biological Husbandry Unit Organics Trust. While every effort has been made to ensure that the information herein is accurate, The Biological Husbandry Unit Organics Trust takes no responsibility for any errors, omissions in, or for the correctness of, the information contained in this paper. The Biological Husbandry Unit Organics Trust does not accept liability for error or fact or opinion, which may be present, nor for the consequences of any decisions based on this information.

Copyright and licensing

Citation Guide

Merfield, C. N. (2018). Testing the compatibility of mesh crop covers with desiccant sprays in seed potato production. Report number 06-2018. The BHU Future Farming Centre, Lincoln, New Zealand. 10.

Table of contents

List of figures

List of tables

1. Summary

- A field trial was conducted to test the compatibility of mesh crop covers with desiccant sprays used in seed potato production.
- A randomised trial using 9 x 9 m mesh sheets with 0.3 mm holes, with a control of standard field practices, with six replicates, in a commercial field of seed potatoes was undertaken.
- Mesh noticeably inhibited desiccation, clearly indicating that mesh should be removed before desiccation.
- Yield was reduced by 9% under the mesh, which is contrary to previous trials where mesh increased yield, and no obvious cause is evident so it is unclear if this is a real effect or a statistical fluke.
- There was no impact on plant numbers or tuber size grade out, which is contrary to previous research where tuber size has increased, but, for seed production, this lack of difference is positive as tubers stayed in the optimum size range.
- The trial has shown that mesh can be used for seed potato production, however, growers should be undertaking their own yield comparisons.
- Crop access for rouging and seed certification inspection, under mesh need to be resolved, but, the solutions are not considered difficult.
- The more important issues of mesh being able to reduce virus and *Candidatus* Liberibacter solanacearum transmission still need further research, which if successful could significantly improve the quality of seed potatoes, both in New Zealand and globally.

2. Introduction

Previous research by the Future Farming Centre has show that 'mesh crop covers' are exceptionally effective at controlling tomato potato psyllid (TPP, *Bactericera cockerelli*), and as they are a form of protected cropping, they also significantly increase yield and profit of table potatoes (Merfield, 2012, 2013; Merfield *et al.*, 2015a; Merfield *et al.*, 2015b; Merfield, 2017). They also offer considerable potential for seed potato production, and, it is already being used by some growers (Andy Innes, pers. comm.). One issue for seed production requiring clarification, is the ability to spray desiccants through mesh, as these are required to terminate the crop when the tubers reach the required size. A trial was therefore conducted by the Foundation for Arable Research (FAR) and the Future Farming Centre to investigate this issue.

3. Methods

The trial was established in a commercial seed potato crop grown by Tim Pike, at -43.686810, 171.78422, w3w.co/aspiration.inseparable.circular on Urral Road, between Lauriston and Barrhill, Canterbury, New Zealand. Soil is Lismore f, a silty, pallic firm brown soil (smap.landcareresearch.co.nz).

The crop, cultivar Agria, was planted in 1.8 m beds with three rows per bed, on 30 Nov 2017. Mesh was installed immediately after planting. Treatments were a control, consisting of the standard treatment for the rest of the crop, and 0.3 mm hole size mesh, in 9 × 9 m squares (as used in (Merfield, 2017), see for details), in a randomised layout with six replicates. The mesh squares were laid across three beds, and dug in around their entire periphery. This left enough slack in the sheets for the potato haulm to grow (Figure 1).

Figure 1. Photo of trial at establishment, on 30/11/2017

Residual herbicides were then applied, both to the open field and through the mesh. Irrigation was by centre pivot, with the wheels being clear of all trial plots.

The crop grew well, with a noticeable increase in height of the crop under mesh (Figures 2 & 3).

Figure 2. Photo of the trial on 23/01/2018, 54 days after planting.

Figure 3. Increased height of haulm under mesh, 54 days after planting.

Due to the haulm being so advanced near desiccation, a decision was made to spit the mesh plots into two, by rolling the mesh back halfway, to create a new treatment of 'mesh removed' prior to desiccation, which meant that there was a direct comparison between desiccation of the control, with potatoes grown under mesh, but, then not having the mesh acting as a barrier for the desiccant. The three final treatments are therefore:

- No mesh - same treatment as the rest of the field
- Mesh removed - mesh removed just before desiccation on 13 February
- Mesh left - mesh left on the plots until harvest.

The desiccant Reglone, at 2 L/ha in 250 L/ha water, at 2.5-3 Bar, was applied on three occasions: 13 Feb, 23 Feb and 12 March 2018. The percentage of dead haulm was then recorded on seven occasions, 16 Feb, 23 Feb, 27 Feb, 2 Mar, 5 March, 9 March, 13 March 2018.

The trial was harvested on 5 June 2018, with a 3m length, in two 1.8 m beds, dug up per plot, giving a total harvested area of 10.8 m^2 per plot. The number of plants and stems were measured over the whole 10.8 m^2 plot and then converted to a m^2 measure. The total tuber yield from each plot was recorded, and then a fifty tuber sub-sample was taken from each plot, by, collecting every fifth tuber shaken out of the collection sacks, and grading them into five grades: <28 cm, 28-40 cm, 40-55 cm, 55-60 cm and >60 cm, using a Victorian Certified Seed Potato Growers Committee seed potato sizing template, with square grading holes, with a tuber being classed as below the given template size if it could pass through the grading hole, in any orientation, without removing any skin.

Results were analysed by ANOVA and Chi-Square Test for the tuber grades.

4. Results and discussion

4.1. Plants and stems per square meter

There was no difference in the number of plants per m^2 or stems per m^2, Table 1.

Table 1. Average number of plants and stems per square meter.

	Mesh left	Mesh removed	No Mesh	p value	LSD
Plants m^2	6.23	5.88	6.11	0.368	0.525
Stems m^2	25.55	24.53	24.62	0.780	3.388

A lack of difference in plants and stems was expected as these are principally driven by the number of tubers planted and the physiological age of the tubers which determines the number of eyes that sprout. It does however provide a useful check that the plant populations among the treatments are the same.

4.2. Desiccation

There was a clear difference in the proportion of dead plants as a result of the desiccation treatments (Figure 4).

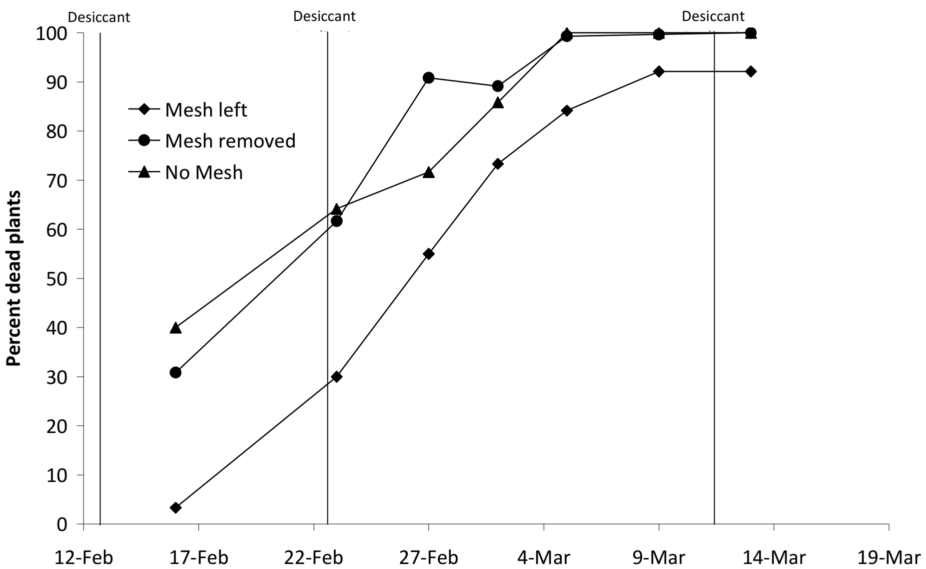

Figure 4. Percentage dead plants and desiccant application dates.

The mesh left treatment had significantly less dead plants than the mesh removed and no mesh treatments, indicating that the mesh was blocking the desiccant (Figure 5).

Figure 5. Effect of desiccant on haulm in the mesh left treatment (left) and mesh removed treatment (right) on 23 Feb 2018.

The initially large difference between the mesh left and uncovered treatments reduced over time, but, was not completely eliminated with mesh covered plots still having some green plants at harvest while the uncovered treatments had reached 100% desiccation by the 4th March (Figure 5).

This demonstrates that it is best to remove the mesh before applying desiccants. As the mesh has to be removed at some point to allow for crop harvest, removing the mesh prior to desiccation is no more effort than removing it post desiccation. Removing mesh prior to desiccation would also avoid having desiccant residues on the mesh, which could be a health & safety issue. Further, unlike food crops where the plants are grown to maturity, and desiccants are used to avoid the need to continue to apply insecticides to prevent *Candidatus* Liberibacter solanacearum (CLso) infection, in seed crops, desiccation is undertaken prior to maturity to kill the plants to obtain optimum sized seed tubers, i.e., to stop the tubers getting too big. For food crops, mesh prevents TPP infestation of plants and therefore minimises / even eliminates CLso infection, so plants naturally senesce (CLso infection prevents plants senescing), and the presence of mesh continues to block TPP and CLso infection, thereby eliminating the need for desiccants. For seed crops, this does not apply, therefore use of desiccants is essential, but, once the plants are desiccated then there is no ability for TPP or other pests to attack the plants, therefore, mesh is no longer required once the haulm is dead so the risk of CLso and virus infection between mesh removal and haulm death are small. Also if non-chemical desiccation techniques, e.g., using flame or steam weeders, mesh would have to be removed prior to treatment.

It is also noted that the 0.3 mm mesh used in this trial is the smallest hole size field mesh available, and is half the 0.6 mm hole size required to achieve 100% TPP control. It is highly likely that larger hole size mesh would of let more spray through and achieved better desiccation rates. However, as noted above, the optimal tactic is to remove the mesh before desiccation, so in practice mesh hole size is irrelevant.

The unambiguous outcome of the research is therefore that mesh should be removed prior to desiccation.

4.3. Yield

The plot yields were converted into tonnes/ha. The no mesh treatment was just statistically significantly higher at p=0.044, with a yield of 28.11 t/ha compared to 25.69 t/ha for mesh left, and 25.51 t/ha for mesh removed (LSD=2.219). It would be expected that the two mesh treatments produced identical yields as yield would mostly have been accumulated by the desiccation date, when the original mesh plots were split in half. That the no-mesh treatment yielded 9% higher than the best mesh treatment is unexpected as in all previous mesh trials, mesh has out yielded the no mesh treatments, often by a considerable amount. In addition, the haulm on the mesh plots was clearly taller (Figure 3) which was taken to indicate that tuber biomass would also be larger. The key difference between this and previous trials, is that as this was a seed crop, the plants were desiccated and therefore forcibly stopped from growing before their natural senescence date.

Seed growers have reported that strong and vigorous top growth is often not matched / reflected in the yield. This may be because the plant puts its energy into producing foliage and less into the tubers. However a strong vigorous foliage can lead to a longer crop duration, which in the case of food crops would increase yield (Iain Kirkwood, pers. comm.).

It is therefore possible that the mesh covered plants, had they been grown to full term may have caught up and yielded more, but, there was no difference in the size grades (see section 4.4 below) which appears countrary to this hypothesis. Therefore, beyond the difference being a statistical fluke, no unambiguous cause is suggested and more research would be required to understand the effect.

4.4. Size grades

There was no significant difference in the size grades of the tubers (Figure 6) analysed with a Chi-Square Test (Table 2)

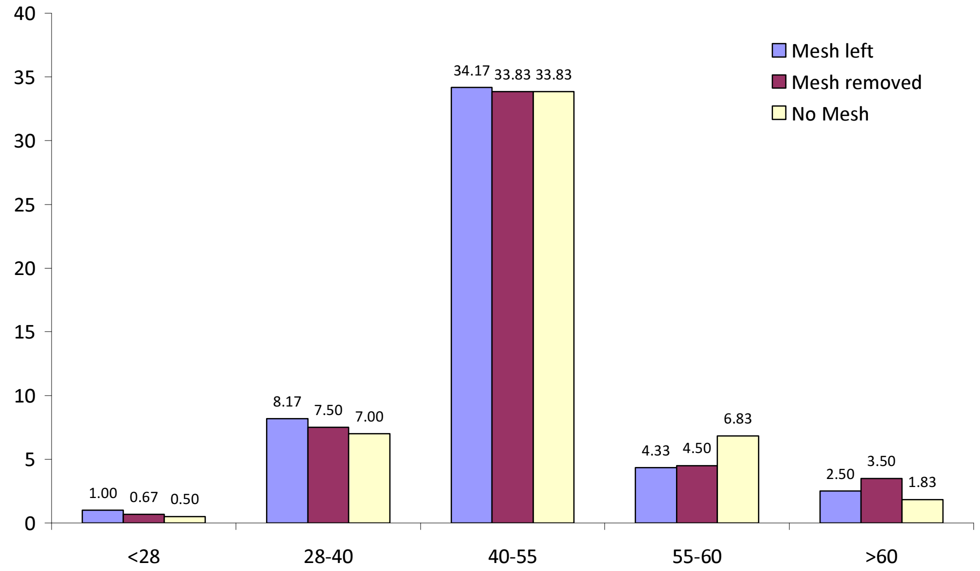

Figure 6. Average tuber size grades.

Table 2. Size grade Chi-Square Test.

	Chi-Square	DF	P-Value
Pearson	9.348	8	0.314
Likelihood Ratio	9.134	8	0.331

The lack of difference between the treatments is again at variance with all previous trials, where mesh has caused a significant increase in tuber size. As for yield, the lack of difference may be due to the crop being terminated while still growing. However, while larger sized tubers are of benefit for food crops, as they command higher prices, this is not true for see crops were the 40-55 cm size range is optimal. Therefore the lack of difference in tuber size between the treatments is in fact a positive result agronomically.

5. General discussion

The clear outcome of this trial is that spraying desiccants through mesh is not a good idea and that mesh should be removed before desiccant application. In comparison, the residual herbicides that were also sprayed through the mesh, provided good weed control in the mesh plots. It is possible that the higher water rates normally used with residual herbicides, and that the herbicides only need to wet the flat surface of the soil, compared with desiccants needing to penetrate the three dimensional mass of green leafy haulm, could explain the difference in efficacy.

Against expectations mesh did not increase yields. If this is a consistent effect in seed potato production then the causes need to be investigated. However, some seed producers have been using mesh for at least five years, and having done side by side comparisons, they have not reported such yield losses (Andy Innes, pers. comm.). Therefore, as the difference is only 9%, this could be a fluke result. Also 0.3 mm mesh was used in this trial, which is half the size of the 0.6 mm mesh that is psyllid proof. The 2016-17 trial of three mesh sizes found that the smaller the mesh size the larger the impact on the crop in terms of yield, temperature, relative humidity etc. (Merfield, 2017). Larger hole sizes may therefore reduce the increase in haulm growth, with a commensurate increase in tuber yield due to more photosynthates being put into the tubers during earlier stages of crops growth. Either way, growers need to be cognisant of this potential issue as they start to use mesh in seed crops and ensure they are taking their own yield measurements under and outside the mesh.

The lack of difference in the size grades is good news in that mesh has not made tubers larger. Though it has not increased the number of tubers in the optimal size band, but, as more than 50% of the tubers were in the optimal size of 40-55 cm, it would probably be difficult for mesh to increase this significantly.

Overall these results show that mesh can be used for seed potato production. However, this trial did not aim to address the key concerns in seed production i.e., aphid and mechanically vectored viruses, TPP vectored CLso, rouging for off-type plants, and certification inspections. Mesh has the potential to effectively eliminate CLso from the seed crops by blocking TPP. Aphids are a complex issue as the new-born nymphs have been clearly shown to penetrate mesh (Merfield, 2017), but, as there is no maternal transmission of viruses they should not take viruses through the mesh, though this is only inferred not demonstrated. In press research has found no evidence of adults feeding through the mesh so that route of transmission appears unlikely. Insecticides are being used in conjunction with mesh for early generation seed crops to achieve exceptional aphid and other insect control. Biological control solutions are also entirely feasible, using commercially available aphid predators and parasitoids that are used in other protected cropping systems such as glasshouses. There are also insecticide impregnated meshes that have also been reported to significantly reduce, even eliminate aphid penetration of mesh (Martin *et al.*, 2013; Dáder *et al.*, 2015). Though, ideally a non-insecticide solution could be found, as using a single chemical in the mesh creates significant evolutionary pressure to select for resistance, and, in market perceptions of crops grown with pesticide impregnated mesh may not be as positive as completely spray free crops. An alternative suggested by Martin et al. (2013), is to use non-toxic repellents impregnated into the mesh to make any aphids that do land on the mesh to quickly take off again. This is considered to have a much lower risk of creating evolved resistance and as the repellent is not a pesticide, and it may have better market acceptance.

Mesh also dramatically reduces wind damage and requires the use of crop free alleyways for tractor access, it should therefore also be able to almost eliminate mechanical / sap vectored viruses. It does however impede crop access for inspection and roguing, however, overseas, both people and machinery operate under mesh, so, mesh does not preclude these activities though it will require a change in approach.

This means that mesh has the potential to create a step-change in the quality of seed potatoes, not only in New Zealand but globally, though, with the requirement for a significant change to crop production practices.

6. Acknowledgments

Potatoes New Zealand Inc. for funding the trial. Tim Pike for hosting the trial. The FAR team for field work and trial management. Iain Kirkwood, from Eurogrow Potatoes Ltd. for a range of advice and assistance. Crop Solutions for supply of mesh (reused from previous trial).

7. References

Dáder, B., Legarrea, S., Moreno, A., Plaza, M., Carmo-Sousa, M., Amor, F., Viñuela, E. & Fereres, A. (2015). Control of insect vectors and plant viruses in protected crops by novel pyrethroid-treated nets. *Pest Management Science, 71*(10), 1397-1406. https://onlinelibrary.wiley.com/doi/abs/10.1002/ps.3942

Martin, T., Palix, R., Kamal, A., Delétré, E., Bonafos, R., Simon, S. & Ngouajio, M. (2013). A repellent net as a new technology to protect cabbage crops. *Journal of Economic Entomology, 106*(4), 1699-1706. http://www.bioone.org/doi/abs/10.1603/EC13004

Merfield, C. N. (2012). *Initial results for tomato potato psyllid (TPP) management with mesh crop covers* (Report). Lincoln: The BHU Future Farming Centre. http://www.bhu.org.nz/future-farming-centre/ffc/information/crop-management/production/mesh-potatoes/initial-results-for-tomato-potato-psyllid-tpp-management-with-mesh-crop-covers-2012-ffc-merfield.pdf

Merfield, C. N. (2013). *Tomato potato psyllid (TPP) and blight management with mesh crop covers: second year's results and future research directions*. Lincoln: The BHU Future Farming Centre. http://www.bhu.org.nz/future-farming-centre/ffc/information/crop-management/production/mesh-potatoes/tomato-potato-psyllid-and-blight-management-with-mesh-crop-covers--second-years-results-and-future-research-directions-2013-ffc-merfield.pdf

Merfield, C. N. (2017). *Mesh crop covers for non-chemical potato pest & disease control: Final results from the 2016-17 field trial of mesh vs. agrichemicals* (Report). Lincoln, New Zealand: The BHU Future Farming Centre. http://www.bhu.org.nz/future-farming-centre/ffc/information/crop-management/production/mesh-potatoes/mesh-crop-covers-final-results-from-the-2016-17-potato-field-trial-of-mesh-vs-agrichemicals.pdf

Merfield, C. N., Geary, I. J., Hale, R. J. & Hodge, S. (2015a). Field evaluation of the effectiveness of mesh crop covers for the protection of potatoes from tomato potato psyllid. *New Zealand Journal of Crop and Horticultural Science, 43*(2), 123-133. http://dx.doi.org/10.1080/01140671.2015.1015576

Merfield, C. N., Hale, R. J. & Hodge, S. (2015b). Pore size criteria of mesh crop covers for the exclusion of tomato-potato psyllid (*Bactericera cockerelli*). *New Zealand Journal of Crop and Horticultural Science, 43*(1), 53-58. http://dx.doi.org/10.1080/01140671.2014.949800