Deployment of heterogeneity in cereals for disease control and yield enhancement

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Introduction

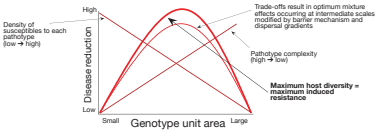
- Mixtures with multiple components reduce disease most
- Yield increases with component number even in absence of disease
- Mixtures provide yield stability

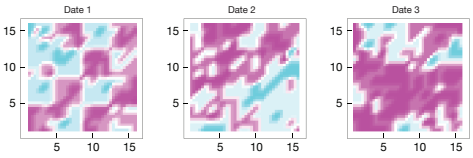
Questions

1. How should components be deployed spatially?
2. How much does each component contribute and: can good quality be obtained from mixtures?
3. Are mixtures suitable for all types of agronomy?

1. Spatial deployment

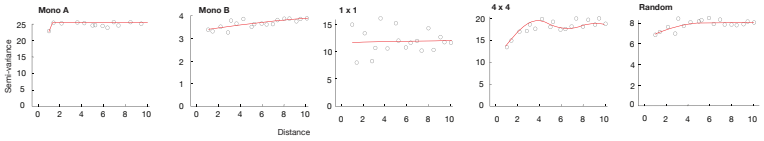
Grid-pattern sowing of barley shows optimum patch size for reducing disease of *Rhynchosporium secalis*:

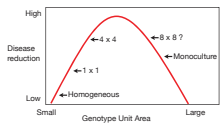




The variogram describes the spatial correlation of the observed Rhynchosporium scores by plotting the mean-squared difference (semi-variance) between observed scores as a function of the distance between plots.

The strength of the spatial structure present within the distribution of Rhynchosporium over the observed scale is quantified by the variogram sill.





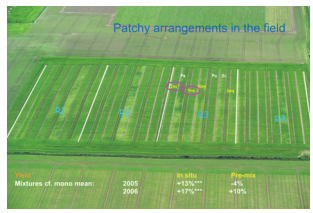
Comparison of the sill estimates showed a significant effect of scale (including monocultures) (trial 1-3: $F_{4,30} = 4.68$, $P = 0.0047$; trial 4: $F_{4,2} = 20.82$, $P = 0.0463$) with the 4x4 having a significantly greater sill than monoculture treatments.

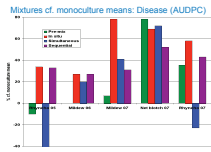
The flat variograms associated with the 1x1 scale deployments indicate that there is little or no spatial correlation across the observed separation distances when mixtures were deployed at this scale, however the alternation between high and low semi-variance values is consistent with patchiness at the scale of the 1 x 1 plots.

Spatial correlation in Rhynchyosporium scores was most evident at the 4 x 4 scale The oscillating variogram is consistent with a chequer board pattern in Rhynchosporium scores at the 4x4 scale.

These findings can be exploited at a farm drill scale:

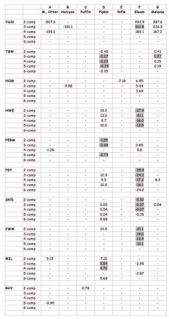
Treatments:
1. monoculture
2. *in situ* = very coarse patchy
3. simultaneous = stratified
4. sequential = in sequence





2. Component contribution to traits – especially quality

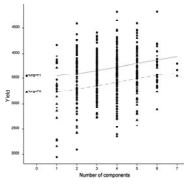
The percentage variance accounted for can be used in regression analysis can be used to determine the contribution of components to yield, disease resistance and quality traits:



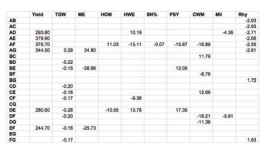
Mean effects of component cultivars for malting quality characteristics and yield in mixtures of winter barley with different component numbers.

Shaded data indicates F probability <0.001. Non-shaded data indicates F probability between 0.05 and 0.001.

Plot of yield against mixture component number, showing the fitted regression line with (solid line) and without fungicide.

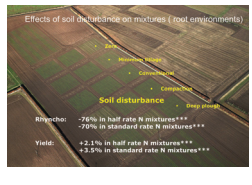


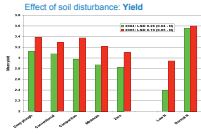
Cultivar mixtures showing significant interactions ($p < 0.001$) for yield, disease and quality components. The number shows the size and sign of the interaction effect (in addition to the mean of the monoculture effects).

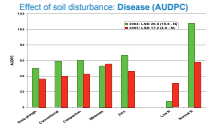


3. Agronomy interactions

Treatments:
1. zero tillage
2. minimum tillage
3. 15cm plough
4. 30cm plough
5. compaction







Conclusions

Cultivar mixtures are advantageous for many types of agronomy

Mixtures can be designed with different components to suit their purpose

Coarse patchy deployment of components is less costly and can give more benefits for disease control than homogeneous mixing

Acknowledgements:
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