Recovery capacity.
A valuable trait for host-plant resistance?

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Summary We introduce a new idea, that recovery capacity is an important trait in cotton resistance to insect damage. We developed an index of recovery capacity that can be measured in short, simple and inexpensive glasshouse experiments. Using this index, we show that:

- A considerable variability exists among cotton genotypes in their capacity for recovery.
- A substantial proportion of variation among cotton genotypes in yield losses due to insects, including *Helicoverpa* and mirids, can be accounted for the variability in their recovery capacity.

How do plants deal with their enemies

Morphological and chemical defences are important traits in breeding for host-plant resistance. The okra leaf trait in CSIRO varieties is a good example of morphological defence. Bt toxins in transgenic plants demonstrate the value of chemical defences in cotton. Plant defences are, however, far from perfect. Even well defended plants will be damaged eventually. Bt cottons, for instance, are well protected against *Helicoverpa* and other lepidopteran pests but they are susceptible to mirids and other insects. The success of a variety in coping with variable insect pressure, we propose, will be affected by its capacity to recover after damage.

Recovery capacity and breeding for host plant resistance

To fully exploit recovery capacity as a strategy in host plant resistance we need, first, a means of measuring this trait. Second, we need to investigate the degree of variability for this trait among cotton genotypes. Finally, once some degree of variability has been demonstrated, we need to establish whether our measure of recovery capacity bears any meaningful relationship with yield of field crops subjected to insect damage.

Here we show that:

- A simple index of recovery capacity can be calculated in inexpensive glasshouse experiments.
- There is a large variability in the values of this index among a collection of cotton genotypes.
- This index is related to the yield losses caused by insects in independent field experiments.

An index of recovery capacity

Plants of 25 genotypes were grown in a glasshouse. Half of the plants were damaged by removing the growing tip and half were left as controls. An index of recovery (R) was calculated 18 days after the treatment (53 days after sowing):

R = leaf area damaged plant / leaf area control

The greater the value of R, the faster the capacity for recovery after the loss of the growing tip.

Variability among cotton genotypes

R ranged from 0.46 to 1.5. This three-fold range indicates that some genotypes had a very low capacity for recovery, and at the end of the experimental period they only achieved half the leaf area of the control while other genotypes were able to "overcompensate", producing 50% more leaf area than controls after damage.

Recovery capacity and yield

The yield of unprotected cotton crops was measured in a series of trials at Narrabri in 1993/94 and Biloela in 1993/94 and 1994/95. These trials included between 12 and 19 of the genotypes used for the recovery study and also included a fully protected treatment of each genotype as a control. Yields of varieties in the protected treatment ranged from 3.6 to 12 bales/ha. Yield reductions due to pests in the unprotected treatment ranged from almost complete loss (yield = 5% of control) to a slight yield increase (yield = 110% of control). *Helicoverpa* and mirids were the main pests in these experiments. Figure 1 shows that, in all experiments, yield losses due to pests were correlated with our measure of recovery ability, R.

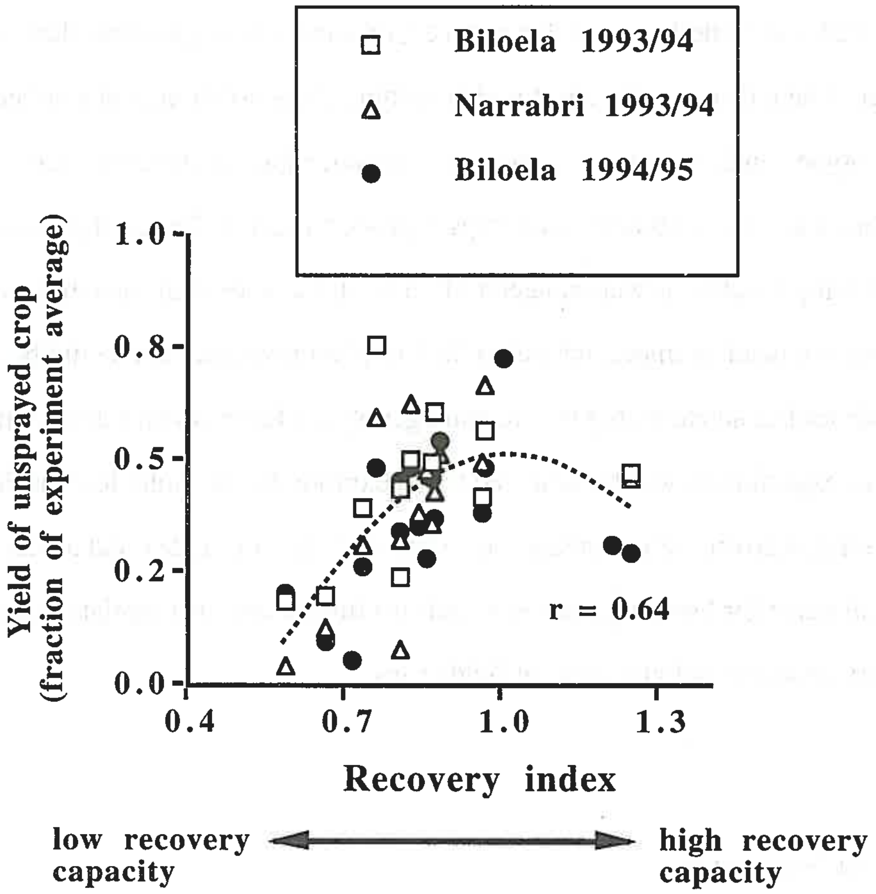

Fig. 1. Relationship between yield losses due to insects and an index of recovery capacity.

The association between our recovery index and yield of unprotected crops does not necessarily imply a causal relationship, of course. Fast recovery of leaf area after the loss of the apical bud may reflect, to some extent, a genotype's ability for rapid activation of secondary buds, a relevant trait for recovery after damage. A preliminary experiment to explore the basis of the relationship between yield of unprotected crops and R supports this hypothesis but more work is needed to establish the causes behind the correlation shown in Fig. 1.

Conclusion

We demonstrated that a quantitative index of recovery capacity can be measured in short, simple and inexpensive glasshouse experiments. Other indices can be developed that could be based, for instance, on square damage rather than on tip damage. The index of recovery R varied within a three-fold range in a collection of 25 genotypes, indicating the existence of a considerable intraspecific variability for this trait. Yield reductions of field crops exposed to various levels of pest damage and growing conditions were related to R. This association indicates that recovery capacity is indeed an important feature in host plant resistance and could be a valuable tool as an early step in screening genotypes for pest resistance. A new series of experiments will be designed to: (i) explore the physiological mechanisms involved in recovery after damage, (ii) refine our recovery index and assess its practical value for breeding purposes, and (iii) further test the correlation between recovery capacity and yield loss of field crops.

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