Influence of water conservation practices on the status of rice pests in southern Australia

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Introduction

In order to minimise water usage, agronomic approaches to rice production in southern Australia are changing. An increase in repeat cropping (growing rice on the same field for a second or subsequent consecutive season), a trend towards drill sowing in areas where this is feasible, delayed permanent water (DPW) in drill-sown crops, and mid-season dry-down (MSDD) are all being used to increase rice yields in terms of tonnes per megalitre. Whilst these approaches may be effective, they create challenges for pest management that are only now starting to be understood.

Methods

The published literature, along with studies currently in progress, were reviewed to provide a synthesis of how changes in agronomic practices are likely to affect the status of the three most significant invertebrate pests affecting rice production in southern Australia – the water snail *Isidorella newcombi*, chironomid midge larvae (bloodworms), and the common armyworm, *Leucania (Mythimna) convecta*. These are all polyphagous native species that have adapted to rice as a food source.

Results and Discussion

Isidorella newcombi

Isidorella newcombi represents one of the most intractable pest problems for NSW rice growers, particularly in aerial-sown crops. For many years control was achieved either through the use of crop rotations or the application of copper sulphate pentahydrate. The performance of copper sulphate is strongly influenced by water chemistry, with higher application rates required in response to higher levels of dissolved organic carbon in the water column (Stevens *et al* 2014). Due to the short persistence of ionic copper in the water column it has little effect on snail eggs, often necessitating repeat applications.

Isidorella is a pest primarily due to its capacity to enter dormancy in the soil (Stevens 2002). When 'new' ground is flooded for rice production *Isidorella* colonises the fields quite slowly, with substantial populations only developing later in the season when alternative food sources are readily available. When the crop is drained many snails die, however a proportion enter dormancy in the top layer of the soil and if a repeat crop is planted in the following spring around 45% of the dormant snails will still be alive and will emerge at flooding. Feeding and reproduction begin almost immediately, leading to high levels of seedling damage. If crop rotations are in use, however, these dormant snails cannot survive the period between two non-consecutive rice crops. The increased use of repeat cropping to conserve water (through utilising residual water in the soil profile) has led to a substantial increase in the area affected by snails each season, placing greater pressure on chemical control. Snails are generally a lesser problem in drill-sown crops, and the trend back to drill sowing has probably mitigated the overall impact of increased repeat cropping to some extent. Niclosamide is currently being evaluated as an alternative to copper sulphate for snail control.

Chironomid midge larvae

The larvae of *Chironomus tepperi* dominate a complex of chironomid species that colonise rice fields shortly after flooding. Some of these species attack the seed and roots of rice plants in the weeks following aerial sowing (Stevens *et al* 2006). The adult midges are opportunistic colonisers of water bodies and colonisation appears unaffected by field history.

Chironomid larvae require constantly flooded conditions, so in drill-sown crops populations do not develop until after permanent water is applied, by which time the plants have developed strong secondary roots and are largely unaffected by any feeding damage that does occur. Control is currently achieved using two low dose applications of insecticides, with chlorpyrifos and alphacypermethrin being the most commonly used. Fipronil is registered as a seed treatment, and work is currently underway to develop it as an alternative spray treatment for use in aerial-sown rice crops. Alphacypermethrin is effective in most situations (Helliwell & Stevens 2000), however evidence is accumulating to suggest efficacy declines when it is applied later in the establishment period. This may be linked to increases in dissolved organic carbon concentrations.

As chironomid larvae are establishment pests, agronomic practices later in the season (e.g. MSDD) will have no impact on their pest status.

Leucania convecta

Common armyworms were sporadic pests until five or six years ago, but are now much more frequently encountered in rice, regardless of the agronomic practices being used. The reasons for this remain unclear. Armyworms are late season pests that attack the foliage and also clip spikelets from the maturing panicles. Studies on *L. convecta* in other cropping systems indicate infestations arise from moths moving from western rangelands into cropping areas. Preliminary data suggests that rice is largely a 'dead-end' crop for *L. convecta* because of two factors – high rates of parasitism which prevent most larvae producing viable adults (although this also occurs in other crops), and a shortage of pupation sites. *L. convecta* normally pupates in the soil but cannot do so in a flooded rice crop, although viable pupae are occasionally found lodged in the leaf sheaths.

Repeat cropping is unlikely to influence armyworm colonisation of Australian rice crops, however anecdotal evidence suggests populations are higher in drill-sown crops and especially where DPW and/or MSDD have been used. Any agronomic practice that leads to plant water stress could potentially make rice more attractive to ovipositing female moths by altering the profile of volatile compounds released by the crop, however this needs to be tested experimentally. Additional factors that may be involved include the use of broad-spectrum insecticides for armyworm control, which may make crops more vulnerable to reinfestation because of their impact on predators and parasitoids, and variations in microclimate within DPW and MSDD crops that may also adversely affect the survival of beneficial species. Better population monitoring techniques, improved economic thresholds and development of more selective compounds for armyworm control will all contribute to improving armyworm management.

Conclusions

Changing agronomic practices are likely to increase the extent of snail damage in aerial-sown crops (due to more repeat cropping) and this is likely to only be partly offset overall by increased drill sowing. The impact of chironomid larvae will decline as the proportion of drill-sown crops increases. The most significant change in pest status arising from changing agronomic practices is likely to involve increased damage from armyworms. The underlying factors behind this change should be investigated and improved monitoring and management practices need to be developed.

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