Impact of Management Strategies for Rice Water Weevil on Populations of Non-Target Invertebrates in California Rice

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ABSTRACT - Registered and experimental insecticides were evaluated for their efficacy against rice water weevil as well as their effects on populations of non-target invertebrate organisms in rice fields. Both preplant applications and post-flood treatments were utilized and compared. The effect on non-target invertebrates has become more significant with the increased importance of mosquito-vectored West Nile Virus in California. Many of these non-target invertebrates are potential predators of mosquito immatures in the rice system and may help to keep mosquito populations in check. Small plos studies were used and multiple sampling methods were employed to assess invertebrate populations at weekly intervals following application.

KEY WORDS - integrated pest management; insects; insecticides.

I. INTRODUCTION

The Rice Water Weevil (RWW) (*Lissorhoptrus oryzophilus*) and armyworms (western yellow-striped armyworm [*Spodoptera praefica*] and Atrue@ armyworm [*Pseudaletia unipuncta*] are the most important insect pests of rice in California. RWW has been present in California for 45+ years and has been a consistent threat over the rice production area for the last 30 years [1]. Armyworms, although not new insects to the rice area, seem to be adapting to the rice agroecosystem and becoming a more significant pest in recent years. RWW damage is inflicted by the larvae feeding on the rice plant roots, similar to that seen in other parts of the world. Armyworms damage rice by 1.) defoliation and 2.) feeding on developing panicles and kernels. Management of RWW in California relies on chemical and cultural controls [2]. Biological control of this pest is lacking and, although populations and damage vary among rice varieties, there are no cultivars with true host plant resistance to RWW. Cultural controls are important for management of RWW in California. Removal of levee vegetation (approximately 2 weeks before and after field flooding) in the spring helps reduce RWW densities in the adjacent rice basins. Two additional cultural methods, dry seeding rice and delayed seeding dates, assist in reducing RWW densities, but are not accepted techniques by growers. Winter-flooding of rice field stubble, used primarily to aid in straw decomposition, reduces levels of RWW larvae by ~50% the following production season. Armyworm larvae can be heavily parasitized and this can provide effective control; in addition, increased weed populations appear to be linked to higher armyworm larval populations. Although cultural controls are a key part of rice IPM programs, insecticides are critical for managing high populations of RWW and armyworms. Pyrethroid insecticides (three different active ingredients) and diflubenzuron are registered for use on rice in California. Programs have been designed to effectively use these insecticides but two key issues have surfaced in recent years, 1.) utilization within a Best Management Practices approach for minimizing populations of mosquitoes and 2.) environmental concerns with the use of pyrethroid insecticides. West Nile Virus is a flavivirus commonly found in Africa, West Asia, and the Middle East [3]. It is closely related to St. Louis encephalitis virus which is also found in the United States. The virus can infect humans, birds, mosquitoes, horses and some other mammals. It was first found in the eastern U.S. in 1999 and gradually moved westward reaching the rice production area of California in 2004 [4] and some human fatalities have resulted. This has placed an added importance on mosquito populations potentially arising from rice fields. Pyrethroid insecticides comprise about 95% of the insecticide use in rice IPM in California. While these products have a high degree of toxicity in aquatic systems, they have been carefully and efficiently used by rice growers for the last 6 years. Recent studies have suggested that pyrethroid insecticides can move off-site, while tightly bound to organic matter, and potentially accumulate in aquatic systems [5] [6]. Sediment movement from rice fields is non-existent but these ideas have prompted a regulatory review of these insecticides within California. Therefore, alternative products are needed to ensure the future availability of control options.

II. MATERIAL AND METHODS

Studies were conducted from 2003 to 2006 at the Rice Experiment Station near Biggs, CA. Efficacy of registered and experimental insecticides was evaluated in plots comprised of aluminum rings (0.9 sq. m.) placed in the flooded fields with 'M-202' rice. Treatments were applied per use directions and were replicated four times. RWW adults were collected from nearby infested, untreated fields and placed in each ring to guarantee a consistent population. Larval populations were sampled at 5 and 7 weeks after seeding using 16.5 cu. cm. cores (five samples per plot per date). RWW immatures were recovered using a washing-flotation technique. Grain yields were measured at maturity. Separate plots were used to assess the impact of treatments on populations of non-target invertebrates. Treatments were applied to individually leveed

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rice plots (6 x 18 m) with 4 replications. Treatments were applied according to the accepted use pattern either pre-flood, post-flood at the 3-leaf stage, or mid-season (timing for armyworm control). Populations of aquatic invertebrates were assessed weekly from seeding (late May to early June) until the time of field draining (late August to September). Three sampling methods were used, 1.) floating barrier traps for the first 4 weeks after seeding [7], 2.) quadrant samples of 0.06 sq. m. where all invertebrate organisms were removed with an aquatic net (six sample per plot), and 3.) mosquito dip samples (25 samples per plot).

III. RESULTS AND DISCUSSION

Three experimental insecticide active ingredients, etofenprox, indoxacarb, and V-10170, all appear to have significant potential for RWW management in studies conducted from 2003 to 2006. Indoxacarb was active via a post-flood application whereas V-10170 had the most application timing flexibility showing good RWW control with a seed treatment, pre-flood (soil) application, and 3-leaf stage application. Results with a preflood application of etofenprox were erratic but the 3-leaf stage application efficacy was consistently excellent. In 2006, these products applied with various rates and application methods provided 95%+ RWW larval control and excellent protection of grain yield. Two additional active ingredients, DPX-E2Y45 and V10194, were evaluated against RWW only in 2006 and both showed good performance albeit somewhat less than the previously mentioned products. Efficacy of the standard registered treatments, lambda-cyhalothrin (Warrior®), zeta cypermethrin (Mustang®), and diflubenzuron (Dimilin®), applied at the 3-leaf stage was also good. In addition, preflood applications of lambda-cyhalothrin and zeta cypermethrin were evaluated and found effective against RWW. A biological material was also evaluated in field studies in 2005 and greenhouse tests in 2005-06. A granular formulation of Azadirachtin (Neemazal®) was ineffective with six tested rates/application methods; however, a liquid formulation of this material (Aza-Direct®) showed moderate activity against RWW. Greenhouse studies were used to investigate this biological material and rates higher than 0.017 kg AI/ha were effective, especially with the Aza-Direct product, with the post-flood timing being slightly more efficacious than the preflood treatment. The mode of action of Azadirachtin on RWW was investigated; the product affects different species of insects in different ways. RWW were sterilized by feeding on treated foliage; however, studies on repellency were inconclusive. Finally, studies evaluated the effects of insecticide treatments in rice on populations of invertebrate non-targets. In 2005, preflood applications of lambda-cyhalothrin had minimal effects on the number of aquatic insects and the number of other invertebrates from the quadrant samples. For the post-flood applications (made on 10 June), seven treatments were compared. For the first two weeks after application, there were some slight to moderate effects of the treatments on populations of aquatic insects (Fig. 1). Reductions were most severe with dinotefuron and zeta cypermethrin and intermediate with indoxacarb, etofenprox, and lambda-cyhalothrin.. Diflubenzuron and azadirachtin had no effects on aquatic insect populations. Although some of the reductions were in the 70% range, the populations quickly recovered and were not affected the rest of the season. Lambda-cyhalothrin was evaluated as a representative material that could be applied against armyworms in mid-season. In 2005, numbers of aquatic insects were reduced by ~70% by the Warrior application at 1 week after treatment but no effects were seen thereafter.

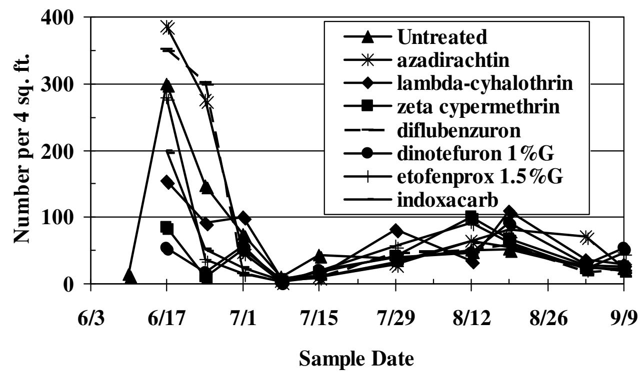

Fig. 1. Populations of aquatic insects from quadrant samples following application of indicated insecticides at the 3-leaf stage.

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