Controlling invasive wild rice with ACCase-inhibiting herbicides

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Abstract

Wild rice (*Oryza rufipogon* Griff.) a close relative of cultivated rice, *O. sativa* L., is a noxious weed in rice fields of central Thailand. After a few years of infestation, the wild rice seed bank builds up rapidly. Invasion in some fields was so severe that the crop was abandoned. To slow down this process, ACCase-inhibiting herbicides (quizalofop-p-tefuryl, fenoxaprop-p-ethyl and profoxydim) were tested under glasshouse and field conditions. In the glasshouse experiment, quizalofop-p-tefuryl at a rate of 50 g a.i./ha effectively induced sterility, i.e. empty seeds, when applied at either flowering or booting stages. Fertile wild rice seeds were reduced by 50% compared to untreated plants. In the field experiment, yield loss could be prevented by herbicide treatments. Quizalofop-p-tefuryl at the rate of 50 g a.i./ha gave higher grain yield than the other treatments. ACCase inhibiting herbicide not only prevented yield loss but it may also help in slowing down the seed bank build up in the field.

Media summary

Yield loss by wild rice infestation could be prevented by ACCase-inhibiting herbicides.

Key Words

ACCase-inhibiting herbicides, seed bank, wild rice (*Oryza rufipogon* Griff.)

Introduction

Wild rice (*Oryza rufipogon* Griff.) a close relative of cultivated rice, *O. sativa* L., is widely distributed throughout Thailand (Chitrakorn, 1995). However, it had not been recognized as an aggressive weed in rice fields until recently. In 2001, we discovered severe and extensive infestation of wild rice in rice fields of central Thailand. It not only reduces yield but also lowers the grain quality of rice because of an admixture of grains with red pericarp. Invasion in some fields was so severe that the crop was abandoned.

Wild rice has always been difficult to control in cultivated rice because of genetic similarity between the two species. As a result, its control with traditional rice herbicides i.e. butachlor/propanil and fenoxaprop-p-ethyl has been unsuccessful (Maneechote et al. 2002). Hand removal of wild rice seedlings in the field at the early stages is costly and also impractical because it is very difficult to distinguish wild rice from cultivated rice until heading.

Once wild rice has invaded a rice field, its seed bank in the soil builds up rapidly in a few seasons. Noldin (2000) estimated that only two seeds of red rice/kg planted in a rice field free of red rice could produce 100 kg/ha red rice within three seasons. Although panicle topping is quite effective to reduce the seed bank of wild rice, it is time-consuming with high labour cost.

Chemical application to reduce seed set without injury to the crop could be more viable economically. Medd *et al*. (1992) reported that some ACCase-inhibiting herbicides such as fenoxaprop-p-ethyl, flamprop-methyl and tralkoxydim could be used during stem elongation and booting stage of wild oats (*Avena fatua* L.) to reduce seed production. ACCase-inhibiting herbicides are represented by two classes of herbicides, the aryloxyphenoxypropionates and cyclohexanediones. Although these herbicides are

structurally different, they both inhibit the acetyl-CoA carboxyalse (ACCase) enzyme in grass species (Gronwald, 1991). In Thailand, ACCase-inhibiting herbicides, such as fenoxaprop-p-ethyl, profoxydim and quizalofop-p-tefuryl, are registered as a “grass killer” in rice. An objective of this study was to investigate whether ACCase-inhibiting herbicides could prevent yield loss and halt the build up of the wild rice seed bank.

Methods

Glasshouse experiment

Five seedlings of a wild rice population from Kanchanaburi province, Thailand, WKG-SN, were grown in 30 cm-plastic pots filled with a clayey soil. Plants were watered daily and kept in the glasshouse during June-August 2002 at the Weed Science Group, Plant Protection Research and Development Office, Department of Agriculture, Bangkok, Thailand. When plants were at the booting and flowering stages, an ACCase-inhibiting herbicide quizalofop-p-tefuryl at 25 and 50 g a.i./ha was sprayed with a knapsack sprayer equipped with T-jet nozzle. Spray volume was delivered at 300L/ha. Pots were arranged in randomised complete blocks (RCB) with four replicates. One day after herbicide application, panicles were covered with glassine bags. Five panicles of each plant were harvested. For each panicle, sterile and fertile seeds were counted, and data presented as the percentage of seed sterility.

Field experiment

The experiment was conducted in a farmer’s field in Kanchanaburi province in the dry season during March-June 2003. Pre-germinated seeds of a high yielding variety Chainat 1 were sown by wet-seeding at the rate of 18 kg/ha. Plot size was 6 x 6 m^2. Six treatments were arranged in RCB with four replicates. Three ACCase-inhibiting herbicides, fenoxaprop-p-ethyl at the rate of 150 g a.i./ha, profoxydim at 187.5 g a.i./ha, quizalofop-p-tefuryl at 25 and 50 g a.i./ha were sprayed at flowering. The spray volume was delivered at 200 L/ha. Herbicide applications were compared with a panicle topping with sickle, and an untreated check. An area of 2 x 2 m^2 was harvested. Grain yield, plant height and number of panicles/m^2 were measured.

Results

Glasshouse experiment

Quizalofop-p-tefuryl at 50 g a.i./ha applied at flowering and booting stages were very effective to reduce seed fertility of wild rice (Figure 1). In addition, the lower concentration (25 g a.i./ha) could be used when applied at the booting stage.

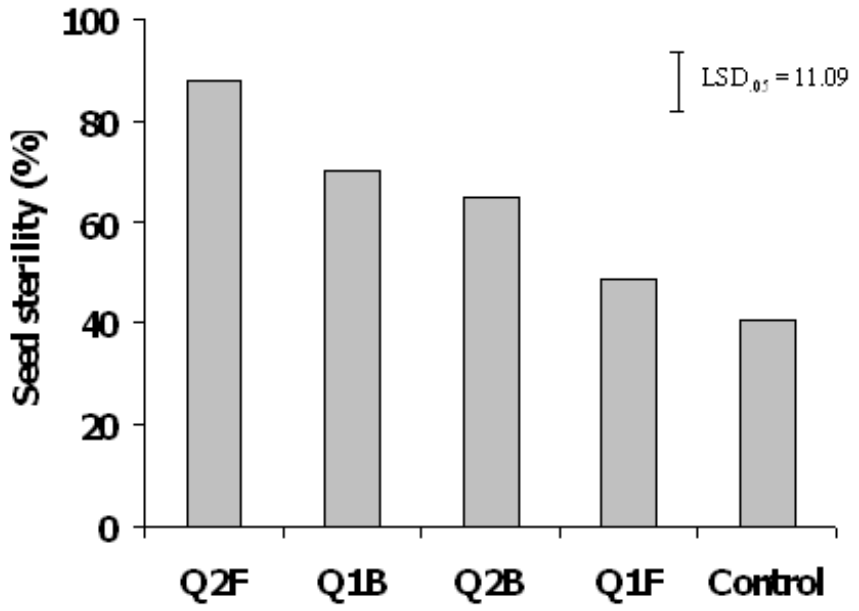

Figure 1. Effects of two concentrations of quizalofop-p-tefuryl (Q1 =25 and Q2 =50 g a.i./ha) on seed sterility of wild rice when applied at the booting stage (B) and flowering stage (F).

Field experiment

In this experiment, the field was infested with wild rice at over 50%, with 254-336 panicle/m^2 of crop rice and 353-467 panicle/m^2 of wild rice (Table 1). The wild and weedy habit of this wild rice population was shown by the earlier flowering, presentation of awn, high seed shattering (data not shown) and plant height about 30 cm above the crop (Table 1). Grain yield of cultivated rice was increased with herbicide application when compared to the untreated check and panicle topping of wild rice (Table 1). Quizalofop-p-tefuryl at the rate of 50 g a.i./ha gave a higher grain yield than the other treatments. In addition, data from the pot experiment indicated that seed fertility of wild rice could be reduced when treated with quizalofop-p-tefuryl at flowering stage. Medd et al. (1992) also found that seed fecundity of wild oats was reduced by ACCase-inhibiting herbicides. Therefore, this herbicide treatment may help in slowing down the seed bank build up in the field.

Table 1. Yield (g/m^2), plant height (cm) and number of panicles/m^2 of cultivated and wild rice in a farmer's field treated with herbicides or panicle topping at wild rice flowering stage compared to untreated check.

		Cultivated rice			Wild rice	
Treatments	Rate g a.i./ha	Grain yield (g/m^2)	Height (cm)	Panicle/m^2	Height (cm)	Panicle/m^2
1. fenoxaprop	150	223.6	61.8	336.2	93.4	435.9
2. quizalofop	25	216.1	65.6	314.2	95.3	362.2

3. quizalofop	50	266.3	63.4	336.4	90.9	353.2
4. profoxydim	187.5	217.3	62.3	254.0	86.6	467.2
5. panicle topping	-	185.8	65.5	295.6	91.3	366.6
6. untreated check	-	143.6	62.4	256.4	98.8	413.4
$LSD_{0.05}$		28.7	NS	NS	NS	NS

Although ACCase-inhibiting herbicides were effective in reducing seed production and seed bank accumulation, integrated management is the most important way to maintain good yield. As wild rice was established in the fields for a few consecutive years, the seed bank became enormous. Farmers could not get rid of all seeds in one or two years. Theoretically, a single wild rice plant can produce approximately 200 seeds. With 50% fertility 100 seeds drop on the ground and ready to germinate in the next season. If 50% are dormant or lost by some means, another 50 plants can produce 10,000 seeds. By the end of sixth season, farmers could have a very large number of wild rice seeds in the soil seed bank.

Once wild rice has invaded a rice field, long-term strategies are required. These include the use of clean seeds, hand pulling at the beginning, panicle topping with sickles, pre-planting herbicide application, minimum tillage with non-selective herbicides, and herbicides promoting seed sterility.

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