



ICAR-Directorate of Weed Research
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Prologue/Introduction

Weed problems in rice fields are a significant concern for farmers, as weeds compete with rice for nutrients, light, and space, leading to substantial yield losses of up to 30-50% if not effectively controlled. The extensive and repeated use of herbicides with similar modes of action may place strong selective pressure on weed populations, accelerating the evolution of resistance. Currently, there are 534 unique cases (species x site of action) of herbicide-resistant weeds globally, encompassing 273 species (156 dicots and 117 monocots). These herbicide-resistant weeds have been documented across 102 crops in 75 countries, affecting 21 of the 31 known herbicide sites of action and involving 168 different herbicides. Herbicide resistance has been confirmed in diverse agricultural systems worldwide, including cereals, soybean, cotton, and rice. The actual prevalence of herbicide-resistant weeds is likely underestimated, particularly in countries with limited research capabilities. In India, the use of herbicides for weed control is gradually increasing. The over-reliance on acetolactate synthase-inhibiting herbicide (bispyribac-sodium) for broad-spectrum weed control in the rice-rice cropping system has led to an increase in the population of bispyribac-sodium resistant (BR) *Cyperus difformis* L.

Methodology

The experiment was imposed in 2 sets on a completely randomized design with six replications. In the first set, 53 putative biotypes of *Cyperus difformis* (30 from Chhattisgarh and 23 from Kerala) were screened against bispyribac-sodium. There were six treatments comprised of bispyribac-sodium at 0, 12.5, 25, 50, 100 and 200 g/ha (0 to 8X of field rate, field rate is 25 g/ha).

In the second set, three resistant populations (CGDCD-11, CGDCD-12 and CGRCD-20) with a resistant index of 10-to >20 based on ED₅₀ of the first set of experiments with one susceptible biotype (CGDCD-1) were chosen for the study. Five herbicides (florpyrauxifen-benzyl 31.25 g/ha, bentazone 960 g/ha, chlorimuron+metsulfuron 4 g/ha, 2, 4-D amine salt 500 g/ha and bispyribac-sodium 25 g/ha) were evaluated at recommended dose along with untreated control. Treatments were imposed at 3-5 leaf stage of *Cyperus difformis*.

Results

A whole plant bioassay revealed that bispyribac-sodium is no longer effective against *Cyperus difformis*. Of the 53 putative BR biotypes collected from Chhattisgarh and Kerala, 17 survived the recommended label rate of 25 g/ha. The effective bispyribac-sodium rate needed to control 50% of the plants in most BR biotypes (ED₅₀) ranged from 19 to 96 g/ha, while it was 10 g/ha in a susceptible biotype. This indicates a resistance level of 2- to >20-fold in BR biotypes. An ALS enzyme activity assay suggests that an altered target site serves as a resistance mechanism to bispyribac-sodium. This study confirms the first case of evolved resistance to bispyribac-sodium in *Cyperus difformis* in India. However, the newly developed synthetic auxin florpyrauxifen-benzyl effectively controlled (100%) all BR biotypes at the field use rate of 31.25 g/ha. The next best herbicide was bentazone at 960 g/ha (>90%), while chlorimuron + metsulfuron at 4 g/ha and 2, 4-D amine salt at 500 g/ha also resulted in a substantial reduction in the growth of both susceptible and resistant populations.

Benefits

- a. Productivity gain: 12-50% in resistant developing area
- b. Saving of labour: Florpyrauxifen-benzyl 31.25 g/ha can save 35 man-days/ha with enhanced efficiency over farmers' practice (bispiribac-sodium 25 g/ha).
- c. Efficiency: Florpyrauxifen-benzyl 31.25 g/ha provided 100% control on resistant and susceptible population of *Cyperus difformis* and other weeds followed by bentazone 960 g/ha.
- d. Cost effectiveness including benefit cost ratio: Use of florpyrauxifen-benzyl saved Rs 8600/- over manual weeding and may reduce selection pressure and delays herbicide-resistant evolution.

Severity of *Cyperus difformis* in rice fields



Severity in rainy season



Severity in summer rice

Photos of different biotypes showing resistance at various dosages of bispyribac-sodium



Upscaling

This is newer information for the rice growers, policymakers and researchers. The researcher should be very careful about the development of herbicide resistance and their expansion. Immediate intervention is required to restrict its expansion to newer areas. Hence, herbicide rotation with integrated weed management must be used in management strategies.

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