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Assessment of Pre-rise Herbicides for Weed Administration and Rice Yield in Direct-Cultivated Rice in Cambodian Swamp Environments

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Abstract

Unfortunate weed administration in direct-cultivated rice (DSR) at the harvest foundation stage has prompted the need to investigate different pre-rise herbicides to diminish weed biomass and increment DSR yield in Cambodian swamp environments. During the early wet seasons, this study examined weed and yield responses to pre-emergence herbicides (pendimethalin, pretilachlor, butachlor, oxadiazon, and no application as the control) in farmers' rice fields. Pendimethalin was the most effective at controlling the population of mostly grassy weeds, and all pre-emergence herbicides reduced weed flora. When compared to the untreated control, pendimethalin significantly reduced the dry biomass of weeds by 36.2%. Weed dry biomass was fundamentally diminished by 46%with butachlor contrasted and the untreated plot. When compared to butachlor, pendimethalin caused a 44.8 percent decrease in SPAD (leaf greenness) and a 39.3 percent decrease in tiller numbers seven days after herbicide application (DAPH), but the plants recovered from pendimethalin toxicity at 14 DAPH. In comparison to the untreated control, the oxadiazon herbicide significantly increased grain yield by 61% (4.6 t ha 1), but oxadiazon produced grain yields that were comparable to pendimethalin's. In, there was no tremendous impact of pre-development herbicides on yield however butachlor created the most elevated rice yield followed by pendimethalin and oxadiazon. Rice growers can use butachlor to control weeds in dry soil and possibly pendimethalin to control weeds in good soil moisture conditions, as our study demonstrated that pre-emergent herbicides perform differently under varying soil-water conditions. This data is essential and protected in creating fitting methodologies to oversee weeds and upgrade DSR efficiency in swamp environments.

Keywords: Pre-development herbicides; Weed thickness; Biomass of weeds; Symptomatic phytotoxicity; Produced grain

Introduction

In the lowland rice production system that enables rice growers to plant crops twice a year, direct-seeded rice (DSR) is an alternative technology with numerous advantages, including a reduction in labor costs, reduced water consumption, and early maturity [1]. In spite of these advantages, weeds stay a significant requirement related with direct-cultivated rice creation, causing misfortunes of up to 80% of grain yield in Southeast Asia. In lowland areas, grasses like Echinochloa spp. are the primary weed groups that affect DSR productivity. what's more, Leptochloa chinensis (Linn.); broadleaf species Melochia corchorifolia and Ludwigia octovalvis; to sedges like Cyperus spp. and Fimbristylis militia Under limited irrigation water and nutrient (50 kg N ha1) conditions, DSR is currently grown in Cambodia without the use of pre-emergence herbicides. Over-reliance on post-emergence herbicides led to an increase in the number of weed species and the contamination of rice seeds with weed seeds. For instance, a survey of weeds conducted in rice-growing regions in Cambodia found that 70 percent of rice farmers relied on a single weed control strategy, such as applying post-emergence bispyribac herbicide multiple times at a rate of 50 g a.i. ha. instead of the recommended 20–30 g a.i. ha. Due to the risks of weed developing herbicide resistance and the ongoing evidence of high weed competitiveness and composition, this reliance on a single chemical is currently ineffective and unsustainable as a weed management strategy. Specifically, there are worldwide reports of inescapable obstruction of Echinochloa spp one of the greatest threats to dry-seeded rice is the lack of alternative herbicides for managing weed species with multiple resistance to herbicides like bispyribac and propanil.

Farmers in DSR use high seeding rates (>180 kg ha1) from low-vigor, low-quality seeds saved at harvest to suppress weeds despite concerns about poor weed management [2]. In contrast, in a rice production system, sowing at low seed rates may improve uniformity in plant stand, source-sink capacity, and grain yield. Grain yield increased when rice was sown at a seed rate of 20 to 40 kg ha-1, but decreased when seeded at 80 kg ha-1 in weed-free conditions. However, because weeds and rice seedlings emerge simultaneously, a low seeding rate may not increase the competitive ability of rice seedlings to suppress early weed growth in smallholder rice fields.

The incorporation of pre-emergence herbicides into the integrated weed management strategy ought to provide an initial advantage in the reduction of weed population, promotion of crop competitiveness, and economic benefits offered by direct-seeded rice, given the ineffectiveness of the rice growers' current weed management practices that rely solely on post-emergence herbicides. The suppression of weeds by pre-emergence herbicides like pendimethalin, oxadiazon, butachlor, and pretilachlor has been the subject of extensive research. In particular, pendimethalin, a member of the dinitroaniline family, prevents the enlargement of cells and chromosome movement during mitosis in germination seeds and young weed shoots by inhibiting the synthesis of microtubulin, which is necessary for the formation of microfibrils in cell walls. Oxadiazon controls weeds by repressing a fundamental plant development protein, protoporphyrinogen oxidase (proton) for

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plant formative capabilities and breaking down tissues. Pretilachlor and other chloroacetanilide herbicides, like butachlor, slow down the enzymes that make chlorophyll and fatty acids [3]. Pre-development herbicides were found to give compelling weed control and increment yield in DSR contrasted and the untreated plots nonetheless, this data on the viability of pre-rise on weed in DSR creation frameworks is unpublished. Our new review detailed a 22% increment in grain yield with 80 kg ha−1 cultivating rate utilizing pretilachlor in DSR revealed the oxadiazon controlled 100 percent of Echinochloa colona, Echinochloa crus-galli, and Leptochloa chinensis in DSR. Notwithstanding, various examinations have detailed phytotoxicity side effects in rice plants from oxadiazon and pendimethalin on a wide scale in smallholder fields as slight openness to developing rice seeds, roots or arising roots might in any case influence rice plant's digestion, morphology, and physiology. Pre-development herbicides act by repressing the arrangement of cell walls and chromosome development during mitosis if in touch with youthful roots and shoots.

According to Chauhan and Johnson, after seven days in anaerobic conditions, an application of 1.5 kg a.i. ha. of oxadiazon reduced rice shoot biomass by 22–36% (2 kg a.i. ha.) and significantly reduced leaf greenness in rice plants. To accommodate these worries with the expected advantages of utilizing pre-rise herbicides, investigating pre-development herbicides and contrasting them and the ongoing rancher practice of no pre-development herbicides application is fundamental to work with better weed administration in ranchers' rice fields. Consequently, we hypothesized that under various weed management options of post-emergence herbicide application and seeding rates, the application of pre-emergence herbicides decreased weed biomass while increasing grain yield. The specific goal of this study was to find out how well different pre-emergence herbicides affected rice growth, yield, and weed biomass.

Materials and Techniques

The Don Bosco rice fields in Battambang Province, northwest Cambodia, served as the setting for two experiments that were carried out during the initial wet seasons [4]. The soil at the location is Toul Samroung (Vertisol), which is composed of light clayey to heavy clayey soil with a high water holding capacity and contains 40.15 percent clay, 44.57% silt, and 15.65 percent sand. In water and KCl, the average organic matter content is 3.35 percent, and the soil pH is 5.47 and 4.43, respectively. The soil has moderate exchangeable magnesium (Mg), sodium (Na), and low exchangeable potassium (K) levels of 2.1, 0.83, and 1.09 mol kg1, respectively, in its chemical properties. All out carbon (C), nitrogen (N), and phosphorus (P) levels are 1.95, 0.21, and 0.08%, separately.

During the rice growing seasons, the weather was different in both growing seasons. During the growing season, the average temperature was between 28 and 29 °C, and the total in-crop rainfall was 42.1 millimeters. The average temperature during the growing season was between 28 and 36 °C, and there was a total of 35.5 mm of rain on the crop. Each year, four replications were used in a split-plot design for the experiments. During the growing season, pre-emergence herbicides (butachlor, pendimethalin, oxadiazon, pretilachlor, and unsprayed as the untreated control) were used in the subplot. The main plot had two seeding rates of 40 and 80 kg ha1.

The farmers' experiment protocols were followed during the growing season, and the treatment slightly changed because the 80 kg ha-1 seeding rate is easier to implement and increased grain yield more than the previous year's 40 kg ha-1 seeding rate. Post-emergence herbicides (bispyibac-sodium and untreated as the control) were used in the main plot while pre-emergence herbicides remained in the subplot. The Kid planter was used to drill Sen Kra Oub seeds along the rows using the dry seeding method. Prior to planting, seeds were dealt with utilizing Cruiser Plus® (thiamethoxam) bug spray to advance seed power and safeguard against early-season bug assault. The Sen Kra Oub variety of rice has a maturity period of 106 days and is not sensitive to photoperiod. It typically grows in northwest Cambodia during the wet season and has a potential yield of 3.9–4.9 t ha1. A pressurized knapsack sprayer was used to apply pre-emergence herbicides three days after sowing (DAS), and it was calibrated to deliver 200 L ha-1 [5]. After the weeds had emerged, bispyibac-sodium, a post-emergence herbicide, was applied once at 1.0 a.i.g. L-1 at 15 DAS. In the growing seasons, the sowing dates were 20 June and 20 July, respectively.

Data from tillering and optical sensing

These were used to monitor rice seedling phytotoxicity from herbicides. To avoid bias, in this study, we did not rely solely on the visual observation of tiller number to indicate potential herbicide stress. Using a single-photon avalanche diode (SPAD) sensor, the degree of foliage greenness as a proxy for the relative chlorophyll content at leaf level was used to characterize pre-emergence toxicity in rice seedlings. Using a threshold value of 35, SPAD was used to monitor leaf stress at the leaf level [6]. At 7, 14, and 14 days after pre-emergence herbicide application (DAPH) in each plot, SPAD and tiller data were randomly taken from 12 fully developed flag leaves.

Statistical analysis

A two-way analysis of variance (ANOVA) in a split-plot design in a linear mixed model with a probability level of 0.05 was used to analyze each year's data separately in R Studio version 3.5.1. In the model, the main effects of the dependent and independent variables, which were pre-emergence herbicides and weed management options (seeding rates and post-emergence herbicides cropping seasons, respectively), were used as fixed effects, and the R Package (Version 1.4.8) used blocks as random effects. Treatment implies were isolated utilizing Tukey's posthoc test at a 95% certainty span for critical treatment impacts.

Result and Discussion

Outcomes SPAD (leaf greenness) and turners: Pre-rise herbicides altogether ($P < 0.05$) diminished the normal SPAD values at 7 and 14 DAPH beneath the limit worth of 35 [7]. However, when compared to the untreated control (no spray) at 7 DAPH, the mean SPAD values for all pre-emergence herbicides were the same. When compared to pendimethalin, the SPAD value of butachlor was higher (31.8). Pretilachlor had a 25.9 SPAD value at 7 DAPH, which was followed by the plots treated with pendimethalin, which had the lowest value of 25.8. Pre-emergence herbicides had a significant impact on SPAD at 14 DAPH, which was similar to what was observed at 7 DAPH. Butachlor and oxadiazon, on the other hand, did not significantly differ in the SPAD from the control. At 14 DAPH, the pendimethalin and pretilachlor herbicides significantly increased SPAD values by 54.6 and 56.6%, respectively, in comparison to the control.

In a similar vein, the quantity of tillers was significantly affected by pre-emergence herbicides. At the same growth stage, pendimethalin and pretilachlor produced the same number of tillers [8]. At 7 DAPH, the number of tillers produced by the pre-emergence herbicides and the control were identical, with the exception of pendimethalin. Pendimethalin and pretilachlor produced fewer tillers than oxadiazon did at 14 DAPH. On the other hand, there were no critical ($P < 0.05$)

impacts of pre-rise herbicides on SPAD and the quantity of turners at the 7 and 14 DAPH developing seasons. SPAD values were moderately lower than the edge worth of 35 across pre-rise herbicides at the two phases.

Responses of grain yield to various weed management options: Prior to emergence, herbicides had a significant impact on grain yield [9]. The pre-emergence herbicides did not significantly differ in mean grain yield. However, rice yields exceeding 4 t ha-1 were achieved with pendimethalin and oxadiazon. Contrasted and the control, pendimethalin and oxadiazon altogether expanded mean grain yield by 58.5 % (4.1 t ha−1) and 61 % (4.6 t ha−1), separately. When compared to the seeding rate of 40 kg ha-1 (3.3 t ha-1), the mean yield increased by 56.1 percent (4.1 t ha-1). There was no massive impact of pre-development and post-rise herbicide choices on the grain yields of DSR. Butachlor had the most noteworthy mean yield, trailed by pendimethalin contrasted and the control. When bispyribac-sodium was applied, the mean grain yield was 2.8 t ha-1, which was comparable to the control's 2.7 t ha-1 yield.

Assessment of phytotoxicity: This study demonstrated that DSR tillers and rice leaf greenness (SPAD) were sensitive to all pre-emergence herbicides. The decrease in SPAD and turner number when pendimethalin was applied at 7 DAPH means that phytotoxicity. Due to a decrease in the amount of chlorophyll in the leaf, photosynthates may be prevented from moving to the source [10]. Pendimethalin is also very soluble in water, so its presence in standing water in rice fields helped rice plants take in more of it than other herbicides. Our findings are consistent with and, who reported that rice seedlings treated with pendimethalin had more severe visual injury symptoms than untreated plots in wet soil. Moreover, an expansion in the leaf greenness (SPAD) in the ensuing development stage may be credited to the herbicide debasement from sun openness thus rice plants recuperated from herbicide harm. The way herbicides work and the soil conditions in the fields may affect their biological activity on plant growth.

Another study found that pre-emergence herbicides had a negative impact on rice seed germination and root-shoot elongation one day after sowing (DAS) in aerobic conditions. To the best of our knowledge, there is currently no data that uses handheld spectral indices to describe plant stress caused by damage caused by pre-emergence herbicides in the field. From our discoveries, ranchers can get a superior comprehension of the effect of various mixes of herbicides and application rates on rice power and the soundness of plants utilizing the SPAD meter [11]. Due to a lack of in-crop rainfall and high temperatures at the start of the season, crop injury monitoring was likely affected by low soil moisture or dry soil conditions. This indicates that plant roots need better soil-water conditions for herbicides applied in the soil to be absorbed. This suggests that the herbicide's effectiveness on the plant may have been compromised by the drier soil conditions, which is why there were no visible leaf symptoms or poor SPAD reflectance from the leaves [12]. These data back up the findings of those who said that poor soil conditions made it hard to measure plant stress from lactofen and imazethapyr with reflectance sensors. So, our reflectance data showed that using SPAD to get information about chlorophyll by proxy could help direct-seeded rice in wetter soils manage weeds better.

Evaluation of grain yield: Our research corroborated previous findings that rice yield was unaffected by the application of pre-emergence herbicides in the field and that rice plants recovered from herbicide damage as they grew. This indicates that using pre-emergence herbicides to control weeds in DSR rice production systems is safe. For instance, pendimethalin yielded more rice than the control, despite phytotoxicity warning signs like less green rice leaves at the emergence stage. Pendimethalin still gave out the same amount of rice as oxadiazon, which had fewer symptoms of phytotoxicity in rice seedlings [13]. These data are consistent with recent findings that oxadiazon and pretilachlor applications resulted in high grain yield after vegetative plant injury. Pendimethalin and oxadiazon increased grain yield because weeds were reduced, indicating that rice-weed competition for nutrients was under control throughout crop growth. This further suggests that pre-development herbicides are promising in stifling weeds and might be viable in diminishing the expected advancement of weed protection from herbicides in Cambodian rice fields contrasted with utilizing just post-rise herbicides to control weeds. When compared to the 40 kg ha1 (3.3 kg ha1) seeding rate, which was used in this study, the 80 kg ha1 seeding rate led to a grain yield increase of more than 12% (4.1 ha1), while the 40 kg ha1 (3.3 kg ha1) seeding rate led to a 33% increase in grain yield under partially weedy conditions [14].

In dry-seeded rice, the grain yield decreased at 20–22 kg ha1 seeding rate, which was The unfortunate overhang cover related with low cultivating rates (40 kg ha−1) could have straightforwardly impacted the plant photosynthetic rate. The rice farmer could not afford to use the low dry seeding rate of 40 kg ha-1 as a weed management strategy again the following year because of these findings. However, as was mentioned earlier in the growing season, the low amount of in-crop rainfall and the high temperature at the beginning of the season may have prevented the post-emergence application of bispyribac-sodium from affecting rice yield. Contrary to the findings of this study, the application of bispyribac-sodium increased grain yield in aerobic rice plants despite morphological injury [15]. A different study found that applying pre-emergence herbicides and bispyribac-sodium resulted in a higher grain yield of 5.4–6 t ha1 after a significant reduction in rice biomass compared to the untreated plot. Likewise, the utilization of bispyribac-sodium herbicide as a post-weeding choice in direct-cultivated rice was just assessed in one of our two-year examinations and needs further examination.

Conclusion

The utilization of pre-development herbicides worked on the seriousness of rice crops, decreased weed biomass, and expanded direct-cultivated rice yield. Rice farmers can use pendimethalin and butachlor to control weeds in wetter soil conditions and dry soil conditions, respectively, depending on the soil-water conditions. Oxadiazon herbicides increased rice grain yield by more than 61%, and pendimethalin increased rice yield by 58.5 percent after injury to rice seedlings compared to untreated plots. Pendimethalin is safe and effective at suppressing weeds, and it has the potential to maximize the yield of DSR in lowland rice ecosystems under good soil moisture conditions. Sowing at 80 kg ha-1 increased rice yield by 56.1% compared to 40 kg ha-1.

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Conflict of Interest

None

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