BIOINTENSIVE WEED MANAGEMENT IN AEROBIC DRY SOWN RICE– A REVIEW

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ABSTRACT

Effective and efficient weed management practices in time and space are crucial in increasing aerobic rice productivity. There have been increasingly strong economic, social and biological pressures to limit the use of herbicide nowadays. There exists possibility of exploring alternative weed management systems that have the potential to reduce herbicides use on a wide scale through mechanical and cultural methods of weed control. Most of the past researches put forth emphasis on the effectiveness of herbicides in relation to the dominant weed species and soil conditions at the time of application and the combination of herbicides and manual weed control. Whereas in this review, the current researches that pursue the refinement of cultural and biological control technologies for use in integrated weed management systems are discussed.

Key words: Aerobic rice, Cultural, Mechanical, Non-chemical weed management practices

Aerobic rice is defined as high yielding rice grown in non puddled and non flooded aerobic soil (Bouman, 2001). It is usually grown with assured irrigation and with fertilizer inputs and responsive varieties (Wang et al., 2002). Weeds are perceived to be the most severe constraint to this upland aerobic rice production than the conventional production systems, in which weeds are suppressed by standing water and transplanted rice seedlings have a “head start” over germinating weed seedlings. Nowadays, water scarcity threatens the sustainability of irrigated rice ecosystems and it may no longer be feasible for farmers to undertake wet cultivation and flood fields to ensure good crop establishment and control weeds (Johnson and Mortimer, 2005) wherein chemical weed management plays a crucial role. Herbicides are considered to be an alternative/supplement to hand weeding. Though several pre-emergence herbicides alone or supplemented with hand weeding, have been reported to provide a fair degree of weed control, some difficulties are associated with pre-emergence herbicides, such as their limited application duration (0–5 DAS) and requirement of adequate soil moisture at the time of their application. Most of the upland and aerobic rice growers in Asia mechanically weed their crops two or three times per season, which amounts to investing upto 190 mandays ha⁻¹ in hand weeding (Roder, 2001). Hence, the labour requirement for weeding is a major impediment to the adoption of water saving aerobic rice and for increasing the productivity of traditional upland rice based cropping systems (Zhao et al., 2006). Hence, informations on non chemical weed management practices in aerobic/upland rice and their interactions can provide valuable indications of future weed management options that might be indispensable for evolving suitable weed control methods.

1. Weed management in dry sown/upland rice

Weeds by virtue of their wider adaptability and faster growth dominate the crops habitat and
reduce the yield potential (Raju and Reddy, 1986). Weeds are the foremost biotic barrier in enhancing yield of direct seeded rice and the yield losses due to weeds vary from 5 per cent to even complete failure of crop (Kolhe, 1989). High weed infestation in direct seeded rice causing severe reduction in the grain yield is the major constraint for low productivity (Kalia and Bindra, 1996).

Direct seeded rice under rainfed upland situation is prone to severe weed infestation than other situations due to aerobic soil conditions and optimum temperatures (Moorthy, 1997). The effect of weed menace is more pronounced as the weeds and rice crop start their growth together (Mutanal et al., 1997 and Singh et al., 1998). Weed emergence was the highest during 30 days of crop growth (84.6 per cent) in dry seeded rice (Bahar and Singh, 2004). Though there are several advantages under direct seeding, various production obstacles are also encountered and heavy weed infestation is major one (Singh et al., 2005). Efficient weed management, restricting weed growth, particularly within the critical crop growth period of 25 days, after trans planting could induce essential growth dynamics with subsequent yield advantage (Ghosh, 2005). Aerobic soil conditions and dry tillage practices, beside alternate wetting and drying conditions are conducive for germination and growth of highly competitive weeds, which cause grain yield losses of 50-91 per cent (Singh et al., 2006). Hence it is apparent that rice yield can be maximized in direct dry seeded rice with timely seeding, provided weeds are adequately controlled.

2. Loss due to weeds in direct sown upland rice

Weed competition is one of the prime constraints that restrain the productivity of upland rice and the yield losses caused by weeds vary from 50-60 per cent and even sometimes complete failure of the crop is a common feature (Singh and Mani, 1981). The extent of decline in the yield of upland rice due to weeds has been reported from 87.5 to 94.0 per cent (Bhan et al., 1986; Saxena et al., 1990) and 5-100 per cent (Kohle 1989). Weed competition lowers the crop yield in rainfed lowland rice to the tune of 74 per cent (Nyarko and De Datta, 1991) and upland rice by 37-79 per cent (Umrani, 1995).

3. Weed management alternatives

The choice of weed control should take into consideration the technology available, system of rice cultivation and farmer resources as well (Islam and Molla, 2001). A weed control method that could be accepted by farmers must be agronomically feasible, economically viable and within the farmers managerial capability (Subramanian, 2003). Therefore, weed control in dry sown aerobic rice could certainly be accomplished through a combination of chemical, manual/mechanical and/or cultural methods.

3.1. Hand weeding

Hand weeding is the traditional method of weed management in rice cultivation. If done at right time, the number of hand weedings that provide season long weed control can be reduced to only one in transplanted rice, two in wet seeded rice and three in dry seeded lowland or upland rice (De Datta and Baltazar, 1996). Keeping the rice fields weed free exclusively by manual weeding may not be feasible because of high cost, more time and other difficulties involved (Kandasamy et al., 1999). It had been reported that hand weeding twice significantly reduced weed density, dry matter and N uptake (Manjulatha and Reddy, 1998). The common practice of hand weeding to control weeds in rice, though time consuming, painstaking and cumbersome, would continue till to be the effective and safe and economical herbicides are easily available for farmers use (Singh and Rath, 2000). Amongst several weed management techniques practiced in rice cultivation, manual weeding appears to be the most effective method by keeping the crop under near-weed free situation for a considerable period of time (Ghosh, 2005).

Though manual weeding is the general practice adopted by the farmers, it is becoming more
and more cost prohibitive and causes drudgery (Saha et al., 2005). It was observed that grain yield was significantly lower in dry seeded rice where only hand weedings were applied because of early competition of weeds and crop at early stage rather than application of pre-emergence application of herbicide supplemented with hand weedings (Singh et al., 2005). It is to be noted that time consumption for hand weeding varies according to weed density and the success of preceding weed control measures (Melander et al., 2005 and Tripathi and Lal, 2006).

3.2. Cultural methods of weed control
3.2.1. Weed control by nitrogen management

Manipulation of crop fertilization may be a means of reducing weed interference in crops (DiTomaso, 1995). Nitrogen fertilizer application can affect weed germination and establishment (Egley and Duke, 1985). Weeds not only reduce the amount of N available to crops, but the growth of many weed species also is enhanced by higher soil N levels (Blackshaw et al., 2003). Hence, it is imperative that crop-weed competitive interactions can be altered by N fertilizer dose (Cathcart and Swanton, 2003), application timing (Angonin et al., 1996; Blackshaw et al., 2004) and application method (Mesbah and Miller, 1999).

Application of N without control of weeds aggravated weed problems with high weed infestation (Hassan and Rao, 1996 and Bayan, 2000), whereas, increased level of N application with weed control considerably reduced the weed density and dry weight and increased rice grain yield (Patro et al., 1999). Placement of nitrogen, 1-5 cm from the row and 5 cm deep in the soil, may improve early nitrogen uptake and crop growth; thus, the crop gains an initial competitive advantage over weeds (Petersen, 2001 and Petersen and Mortensen, 2002) and this may result in upto 50 per cent reduction in weed biomass (Rasmussen et al., 2000). Increasing the supply of N can increase the ability of cereals to suppress weeds leading to a decline in the number of weed density and biomass. But, it is not always recognized that altered soil N levels can affect crop-weed competitive interactions (Blackshaw, 2005).

3.2.2. Weed control by legume intercropping

Intercropping has the ability to suppress weeds because of its rapid ground cover; it not only suppressed weeds, but also reduced weed growth and gave additional yield (Bhan and Kumar, 1996). Intercrops can also improve the utilization of natural resources by the canopy and prevent the removal by weeds. Intercropping suppresses weeds better than sole cropping and thus provides an opportunity to utilize crops themselves as tools of biological weed management (Subramanian et al., 2005). Since the change in rice crop establishment from transplanting to direct seeding has resulted in substantial changes in the types and intensity of weed infestation, growing of suitable weed smothering intercrop, especially green manure crops could be used well to suppress weeds (Prabhakaran and Chinnusamy, 2006).

Growing of green manure crops along with rice as intercrop suppresses weeds due to faster canopy cover. It has been reported that cowpea intercropping suppressed the weed population and minimized the weed infestation (Dutta and Gogoi, 1994). Intercropping Sesbania in semidry rice and manual incorporation at 35 DAS recorded lower weed dry matter and higher grain yield compared to sole rice crop with weed control efficiency of 77 per cent in the former (Mathew and Alexander, 1995). Growing Sesbania as intercrop followed by mechanical incorporation created a weed-free condition, which had a positive influence on the yield components viz., panicles m\(^{-2}\), panicle length and filled grains panicle\(^{-1}\) and obviously on the grain yield too.

Angadi et al., (1993) reported that intercropping of Crotalaria juncea, Vigna sinensis, Glycine max and Sesbania aculeata in lowland rice combined with inter cultivation at 15 DAT and hand weeding at 40 DAT suppressed the weeds effectively and resulted in yields comparable with those of
butachlor application together with hand weeding. Also Ramamoorthy et al. (1997) found that in the rice + blackgram intercropping system the increased level of yield attributes and yield were due to lesser crop weed competition, reduced nutrient depletion by weeds and increased uptake by crops that have resulted in better grain filling and better weed control efficiency.

At Pusa, ground coverage by growing cowpea as intercrop under direct seeded upland situation was to an extent of 59-66 per cent, which helped in reducing weed growth. At 45 DAS cowpea as intercrop lowered the weed dry weight (13 g m⁻²) as compared with unweeded control (64 g m⁻²) (Dubey and Varshney, 2006). In dry-seeded rice, Sesbania intercropping for 30 DAS pendimethalin (1 kg ai ha⁻¹) and pretilachlor plus safener (0.5 kg ai ha⁻¹) as pre emergence application followed by hand weeding are equally effective in controlling weeds, increasing grain yield and net returns (Singh et al., 2007).

3.2.3. Mechanical control of weeds

Soil cultivation after crop sowing and before the crop emergence has the potential to control early germinating weeds (Rasmussen, 1996). Mechanization of the intra row weed control would not only lower the direct costs for hand weeding but also release time and labour to be used elsewhere in the production. Inter row weeds can be removed by ordinary inter row cultivation relatively easily although intra row weeds constitute a major challenge (Melander et al., 2005). Mechanical weeding at 15 and 30 DAS using finger weeder and wheel hoe supplemented with one hand weeding gave effective and economical weed control (Moorthy and Mishra, 2004).

Increasing the number of harrowings increased the percentage of weed control (Rasmussen, 1991). The rotary hoe was observed to effectively reduce weed density in agronomic crops (Bowman, 1997) and found to be as effective as herbicides in controlling weeds. Inter row hoeing controls weeds growing in the inter row area almost completely under favourable circumstances, whereas those growing in the intra row area are only partly controlled.

Rotary hoeing is most effective just before or shortly after weeds emerge (Gunsolus, 1990 and Oriade and Forcella, 1999). Small weeds are more easily uprooted and desiccated compared to larger and more established weeds. Rotary hoe is an effective implement for managing weed populations in poorly competitive cropping systems. Efficacy depends on careful timing of rotary hoeing relative to weed emergence and weather conditions. Multiple passes are required when weather conditions inhibit rapid desiccation of seedling following rotary hoeing (Boyd and Brennan, 2006).

CONCLUSION

Direct sown aerobic rice suffers more due to weeds menace as the weeds and rice compete for growth factors together. Sometimes dry seeded rice gives equal yields if weeds are controlled effectively. Regarding weed management practices, each method has its own advantages and disadvantages and none is applicable to all systems. Similarly no single weed management practice gives continuous and effective control of all weed species. Since in many of the experiments it had been proved that chemical weed control methods are unavoidable non chemical methods like legume intercropping are equally effective in controlling weeds and increasing grain yield of dry seeded rice, possibility of reducing the dosage of herbicides and the cost through the integration of non chemical methods needs to be explored.

REFERENCES


