

DIFFERENT CROP ESTABLISHMENT METHODS AND WEED MANAGEMENT OPTIONS AVAILABLE IN WET SEEDING IN RICE – A REVIEW

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Realization of yield potential of rice crop largely depends on the crop establishment technique to ensure optimal population. Constant decline in rice yield and consequent reduction in profit is experienced in irrigated lowlands of Asia because more than 21 per cent of total cost of production is accounted for transplanting operation alone. Therefore, adoption of alternative rice culture, which requires less input and possible increase in yield, is highly desirable. The methods of direct wet seeding are manual broadcasting, drum seeding and direct planting system. This review was briefly explained about to two establishment methods namely, direct planting system and drum seeding of rice. The transformation in crop-establishment technique from transplanted to wet-seeded rice cultivation has resulted in dramatic change in the type and degree of weed infestation. Various weeds management options are available to control the weeds in wet seeded rice are described in detail. Integrated weed management which involves the combination of two or more weed control practices has been identified as a viable alternative to the current methods of weed control.

Direct wet seeding as an alternative crop establishment method

Advances in varietal improvement, nutrient application, pest and disease management practices have increased the yield potential of rice. Realization of this potential largely depends on the crop establishment technique to ensure optimal population. In India, the principal systems of rice cultivation are wet, semi dry, dry [1]. Under wet system of rice cultivation, the crop is established either by transplanting of seedlings raised in a nursery or by direct seeding of sprouted seeds on well puddled soil.

In Malaysia, wet seeding is normally preferred. The practice of transplanting is being increasingly replaced by direct seeding as labour becomes scarce and cost prohibitive [2], [3]. Constant decline in rice yield and consequent reduction in profit is experienced in irrigated lowlands of Asia because more than 21 per cent of total cost of production is accounted for transplanting operation alone. Therefore, adoption of alternative rice culture, which requires less input and possible increase in yield, is highly desirable [4].

Though wet seeding is popular and is a viable alternative to transplanted rice, many researchers emphasized the multitude of pre requisites such as levelled land, effective weed control, efficient water management and timely water supply to ensure successful wet seeded rice crop [5], [6]. Manual broadcasting of pre-germinated seeds on puddled soil is the common practice [7]. The improvement over broadcasting is seeding in lines using drum seeder [8].

The transformation in crop-establishment technique from transplanted to wet-seeded rice cultivation has resulted in dramatic change in the type and degree of weed infestation [9]. Weeds in direct seeded rice cause 73% loss in yield, and the farmers may be using most of the labour saved by wet seeding to control weeds [10]. The greater weed problem generally associated with the saturated water regime can be overcome by using herbicide at appropriate rates [11].

Benefits of direct wet seeding

- i. It is a faster and easier method of crop establishment [12].
- ii. Less labour requirement (1-2 man days for wet seeded rice against 50 for transplanted rice which includes 10 for uprooting of seedlings) and less drudgery, reduction in field duration by 7-10 days are the added advantages of wet seeded rice [13]
- iii. Is more conducive for mechanization [14].
- iv. There is saving in overall production cost and increased profit [15].
- v. Labour saving, reduction in population risk, crop intensification facilities and water saving are the other few advantages listed by [16].

Constraints of direct wet seeding

- i. Damage of surface sown seeds by birds, rats, snails etc., seed desiccation exposed to direct sunlight or dry weather and disturbance or damage of seeds by torrential rain or flood are some of the drawback [17].
- ii. High level of pest and disease incidence because of dense canopy is a common drawback in broadcast sown rice [18].

Methods of direct wet seeding of rice

Methods of direct wet seeding are manual broadcasting, drum seeding and direct planting system (DPS). This review was briefly explained about to two establishment methods namely, Direct Planting System (DPS) and Drum Seeding of rice.

Drum seeding of rice

The advantages of using drum seeder include sowing in lines, optimum plant stand and possibility of growing *azolla* as a dual crop for incorporation and using rotary weeder for weed incorporation [19].

Direct seeding with drum seeder not only helps in maintaining optimum plant population but also eliminates the drudgery of manual planting besides reducing the duration of crop by seven days and thus helps to avoid water stress at later crop growth stages [20]. Drum seeding method required only eight persons whereas line sowing of sprouted seeds and transplanting methods required 20 and 40 person ha⁻¹ respectively. Thus, there is a significant saving of labour in the drum seeding method [21].

Early establishment of direct seeded crop in the absence of transplantation shock with better coincidence of nutrient requirement of the crop resulted in higher vegetative growth [22]. Wet seeded rice starts tillering earlier than transplanted rice because its growth proceeds without the set back caused by uprooting injury to the root of seedlings [23].

Drilling sprouted seeds in puddled soil by paddy row seeder gave more number of hills m⁻² than broad casting sprouted seeds [24]. In row seeded rice, leaf area growth starts two week earlier and LAI is higher than that in transplanted rice [25]. The number of tillers per unit area and the leaf area index were more in row sown rice than those in broadcasted and transplanted rice [26]. The rice established through drum seeder recorded significantly more number of panicles m⁻² than transplanted rice [27].

During vegetative phase, tillering, leaf area expansion, N uptake and shoot dry matter accumulation were more rapid in broadcast seeded rice than in transplanted rice. Whereas during reproductive phase from panicle initiation to flowering and grain filling, canopy CO₂ assimilation and crop growth rate of broadcasted rice were depressed due to lower leaf N content and greater mutual shading [28], [25].

Rice established through drum seeder recorded significantly more number of panicles m⁻² than transplanted rice [27], [29]. Wet drum seeding produced similarly high yields and was on par with manual transplanting, machine transplanting and wet broadcasting at Mandya. Drill or direct seeding of sprouted seeds in line gave significantly higher grain yield than broadcasted and transplanted crop [30], [31], [32].

Average yield of 2.48 t ha⁻¹ was obtained with puddled seeder [33]. Higher grain yield was recorded with direct seeding than with transplanting during *kharif* under better management [34]. The drum seeder gave the highest yield even though there was no marked difference between establishment methods [35]. Similarly, increase in grain yield due to surface line seeding compared to broadcast and transplanted crop was reported by many researchers [30], [31], [32].

The direct seeding practices *viz.*, wet seeding by manual broadcasting and drum seeding recorded higher net income (Rs.21,551 and 21,214 ha⁻¹) and BCR (2.51 and 2.48 respectively), against the traditional transplanting practice (Rs.18,666 ha⁻¹ and 2.10) [36]. A study at Tamil Nadu reported that maximum net return and energy use efficiency in direct seeding with drum seeder over broadcasting of seeds and random or line transplanting of seedlings [31]. Among different establishment methods, in which direct seeding recorded the highest benefit cost ratio of 2.4 as compared to 1.6 for line transplanted and 1.3 for random transplanting [27].

Direct Planting System (DPS)

A new method of rice establishment was reported by [37]. The new system was developed with a scope to provide a sound technique easy to adopt by all farmers with minimum energy. The new system is established by broadcasting of sprouted seeds (30 kg ha⁻¹). Then rotary weeder is used at 25 cm apart on either direction at 8-12 DAS. Thus the broadcasted rice is tailored to rows and columns, after rotary weeder usage in both directions. The plants in the intersects are thinned to single, from this point onward the field looks like square planted SRI rice cultivation and also savings in the labour by 40 per cent.

The new system DPS was tested for number of seedlings per intersects. Wider the spacing provided, the tillers per hill produced are higher than closer spacing whereas in cluster planting (two or four seedlings together) initially there were more primary tillers, but the momentum could not be sustained due to mutual competition by already existing tillers and further the tillers in the outer side provided opportunity to produce nearer tillers, ultimately lesser tillers were recorded per hill in the cluster planting [38] and predicted only 40 tillers from a single plant [23]. The total above ground biomass production under DPS ranged very wide between 8.6 tonnes and 16.7 tonnes. Placing of single seed or two seeds at 5 cm apart was found to produce higher biomass than placing the seeds together. The biomass produced under the broadcasting was only 8.6 t which was almost 52% of the single seed placed at 25 x 25 cm [38].

Filled grains per panicle decreased gradually as a number of seeds hill⁻¹ increased from two and above. Maximum of 33% reduction in the filled grains was recorded under the broadcasting system (30 kg sprouted seeds ha⁻¹) compared to single seed hill⁻¹ at a spacing of 25 x 25 cm [38]. Higher grain yield (8.9 t ha⁻¹) under Direct Planting System of rice cultivation compared to conventional technique of transplanting (6.1 t ha⁻¹) [39].

Weed management options

Ecological approaches

This is the best method of weed control. It includes a healthy growth of crops by maintaining a crop environment that is detrimental to weeds as possible. They are proper crop stand and early seeding vigour, nutrient based approach, crop based approach, selective crop stimulation, proper planting method, crop rotation, stale seedbed, smoother cropping, summer fallowing, soil solarisation, minimum tillage, flooding and drainage.

Chemical weeding

The success of direct seeded rice is fundamentally dependent on weed control with herbicides [40]. Herbicide usage is one of the most labour saving innovations that has been introduced in rice farming for weed control which served as a panacea for the non-availability of labour during peak season [41], [42]. The frequent and heavy rains usually interfere with the timely and effective weeding. This situation warrants the need for chemical weed control in direct seeded rice.

However herbicide selectivity is marginal because of similarities in morphological characters between rice and grass weeds of same age [40] and its damage to crop is one of the factor limiting its use.

Application of pre-emergence herbicide is an effective method for controlling weeds in the early stage of crop growth [43]. Use of chemicals is probably the only feasible method of weed control in wet seeded rice because of the peculiar field condition and absence of rows for hand or rotary weeding [40].

Mechanical weeding

The implements like conoweeder that helped to save labour, time and the number of person-days required for weeding from 30 to 10 as they become more experienced [44]. Mechanical weeding enabled rice plants to maintain higher root volume than the manual weeding. This is due to the aeration of top horizon of the soil and the regeneration of newer roots due to the pruning effect by mechanical weeder. Japanese Rotary weeder and IRRI Cono weeder commonly used wetland paddy weeders and are becoming increasingly popular among farmers in India. The yield increase in rice due to weeder use 22 to 24 per cent [45]. The weeding efficiency was 79% and 72.5%, respectively for rotary weeder and cono weeder [46]. The increased soil contact and soil inversion capacity of rotary weeder add greater values to its higher weeding efficiency. The rotary weeder gives better performance even in the later stages of weeding. Conoweeder gives better performance on initial stages of weed growth. If the weeds are matured the conoweeder just rolls over the weeds with minimum uprooting and inversion. Plant population density was not affected by mechanical weeders and chemical weeding, indicating that none of the treatments caused crop plant loss [47].

Frequently labourers have expressed severe body pain while operating the cono weeder. To alleviate the drudgery involved in the operation of the cono weeder and to reduce the labour requirement, a motorized weeder has been developed. This weeder promises to be the answer to the demand of the farmers practicing SRI. The machine can cover an area of 1ha d⁻¹. The weeding operation can be done without drudgery.

Integrated weed management

Integrated weed management which involves the combination of two or more weed control practices has been identified as a viable alternative to the current methods of weed control. Integrated weed management diversifies the selection pressure on weed communities, uses resources more efficiently and provides producers with a broader range of management options [48].

The reduction in weed population and dry weight with the use of paddy weeder at 20 and 40 DAT was comparable to the integrated use of herbicide and paddy weeder. Highest weed control efficiency (88%) was obtained from the treatment receiving pretilachlor 0.75 kg ha⁻¹ with paddy weeder at 40 DAT [49]. The maximum weed dry matter reduction was achieved due to herbicide supplemented with two hand weedings in transplanted rice followed by herbicide as pre-emergence supplemented with two hand weedings in wet seeded rice and zero till rice [50]. Pre-sowing application of glyphosate + pre-emergence application of pretilachlor (with safener) followed by two manual weedings effectively controlled a wide spectrum of weeds, and recorded a maximum grain yield of 5872 kg ha⁻¹ [51].

The above review has clearly brought out the need for different methods of crop establishment in wet seeded rice. Farmers switching over from transplanting to wet seeding can be advised to use these methods of establishment and to generate an eco-friendly, agronomically effective, economically viable and practice weed control package which is indeed a challenging task upon the adoption of the practice of wet seeding.

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