

Management in direct seeded rice

for enhancing resource use efficiency

Samar Pal Singh*, Kailash and P K Gupta

Krishi Vigyan Kendra, New Delhi 110 073

Rice is world's most important food crop and the staple food for nearly 4 billion people i.e. about half of the world population. Rice cultivation through the conventional puddled transplanted method faces severe obstacles due to water and labour shortages and climate change in the North-Western Indo-Gangetic Plains. The direct sowing of rice (DSR) refers to the process of establishing the crop from the seeds sown in the field rather than planting the seedlings from the nursery. Direct seeded method of rice cultivation is a viable alternative to conventional puddled transplanted rice with good potential to conserve water, reduce labour requirement, reduce greenhouse gas (GHG) emissions and adapt to climate risks. If the crop is properly managed, the yield can be compared to planted rice. In recent years, efforts have been made by various organizations to promote DSR technology and scientists are focusing on developing suitable varieties with good agronomic packages to promote direct seeded rice practice. Direct-seeded rice with best crop management practices provides equivalent or higher yield, and 30–50% less irrigation water use than farmer-managed puddle transplanted rice (PTR).

Keywords: Direct seeded rice, Irrigation scheduling, Nutrient and Weed management

RICE (*Oryza sativa*) is a staple food for about 800 million people in India. It has an important role in diet, economy and employment. It contributes approximately 40% to the total food grain production, thereby, occupying a prominent position in the food and livelihood security of people. India grows rice in 43 million hectares with production of 112 million tonnes milled rice and average productivity of 2.6 t/ha. The demand for rice is continuously increasing and is projected to reach 140 million tonnes by 2025. This projected demand can only be met by maintaining steady increase in production with judicious utilization of available water for agricultural production. Rice can grow successfully under diverse climatic, edaphic and hydrological situations. A global trend of growing water scarcity has been noticed in recent years where drastic pressure to reduce water use in irrigated agriculture is mounting

and the per capita availability of fresh water is declining continuously and could reach to an alarming situation in most of the Asian countries. Both above and below ground water resources are shrinking and water has become a limiting factor in rice production. Looming water crises, huge water inputs, labour requirement and escalating labour cost with transplanted rice drive the search for alternative strategies for enhancing the profitability and productivity of rice.

Conventional puddled, manually transplanted and flood method of rice production not only uses a lot of water but it is also cumbersome and laborious. In Punjab and Haryana, where agriculture is highly dependent upon migrant labour, labour scarcity for rice transplanting is now a major concern for the viability of puddled transplanted rice (PTR). Unreliable electricity supply to the farming sector due to high demand across other sectors

is also adversely affecting the availability of water for PTR. Labour and water (electricity) shortage can lead to delayed transplanting, which can reduce rice yield and delay sowing of wheat, reducing wheat yield also. Cost of cultivation is increasing continuously but crop yield remains more or less stagnant with the proportional cost of cultivation. So, it is a big challenge for scientists, researchers and farmers to get maximum production with minimum production cost in a sustainable manner with resources conservation for rice-wheat cropping system. Therefore, DSR is the best option to face the above challenges that may also help in increasing adaptation, mitigation of greenhouse gases as under puddled conditions water stagnation remains responsible for emission of greenhouse gases like CH₄ and N₂O.

Direct seeded rice (DSR)

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a common practice in India before the green revolution and is again gaining popularity due to its ability to save water, labour and energy. DSR is an efficient resource conservation technology that holds good promises over rice transplantation in the coming days due to its various benefits. Due to the elimination of transplanting, labour required for nursery raising, uprooting and transplanting the seedling is reduced up to 40%, in turn reducing cultivation cost. Water usage (up to 60%) and energy saving (up to 60% diesel) are eliminated in nursery raising, puddling, seepage and percolation. Fertilizer use efficiency increases due to the appropriate placement/application of fertilizers in the root zone. Early maturity (7–10 days) of rice crop helps in timely sowing of succeeding crops. Methane emissions and global warming from DSR potentially decrease due to little/no water stagnation in the fields. There is no disturbance in soil structure in DSR as seen in puddled transplanted system.

Production technology

In DSR, sowing of rice seeds is done directly in the main field rather than transplanting seedlings. Direct seeding methods are mainly of two types, viz. wet (pre-germinated seeds) seeding and dry seeding. In wet seeding, pre-germinated seeds of rice are broadcast into a puddled and leveled field that is free from standing water. At the time of puddling, basal dose of fertilizer mixture must be added in field. After germination of rice seed, there might be chances of seedling desiccation due to water stress in field which should be avoided by intermittent wetting to the field. When seedlings are about 5 cm tall (about a week after sowing), water is impounded to prevent germination of weed seeds and desiccation of rice seedlings. In initial stage after sowing, the stand establishment by this method varies with the quality of land preparation, weed competition, water management and rainfall. Agronomic practices contribute significantly in achieving

the optimum productivity of rice crop through DSR method under irrigated condition.

Land preparation

Land preparation is an essential pre-requisite for good crop in DSR condition. Plowing the fields during summer followed by harrowing helps in controlling the weeds. For direct seeded rice, precision land leveling has been proved to be advantageous for better seed germination, controlled weeds emergence, uniform water distribution throughout field which saves considerable amount of water, increasing water use efficiency along with fertilizer productivity which ultimately increases the grain yield.

Time of sowing

Time of sowing plays an important role to achieve the success in DSR crop in the main rice growing *kharif* season. Sowing of rice crops should be accomplished before 10–15 days of onset of monsoon. The crop should attain the stage of 2–3 leaves per plant before rain starts for better growth. This would also facilitate the early root establishment so that crop could compete easily with emerging weeds in field and also help in timely sowing of succeeding wheat crop in winter. Since the time of monsoon arrival in the Indo-gangetic plain varies from West Bengal to Punjab, it is best to schedule the sowing time between the end of May to the third week of June.

Selection of varieties

Selection of varieties plays an important role in achieving the desired yield in direct sown rice. The choice of varieties always depends on the availability of irrigation water and soil type. In light textured sandy loam soils irrigated, early to medium term varieties (100–135 days) may be preferred, whereas in case of heavy textured soils, medium to late maturing varieties (135–165 days) should be sown. High yielding improved varieties with early vigour, herbicides tolerance should be selected according to the local environment/region. Basmati types and hybrids have been shown

to be suitable for direct seeded rice. Basmati types: Pusa 1121, CSR 30, Pusa Basmati 1, Pusa 2511, Basmati Super, Basmati 385, Coarse and Hybrid types: Arize 6129, PR 113, PR 114, PR 124, PRH 10, RH 664, Pusa 44, RH 2014, HKRH 1, HKRH 401, Sahyadri etc. are suitable for direct seeded rice practice.

Seed priming

To increase seed germination, the seeds should be soaked in water overnight and then dried in shade before sowing. Seed treatment with 2.5 g/kg carbendazim should be done to prevent seed borne diseases.

Seed rates, row spacing and seeding depth

With zero till ferti-drill sowing, the optimum seed rate is 15–20 kg/ha for fine varieties of basmati, 20–25 kg/ha for coarse grains and 8–10 kg/ha for hybrids. Planters with inclined plate devices or cupped metering systems are very useful for proper spacing (20 cm) and reduce the seed rate compared to broadcasting seed rate (25–30 kg/ha). The depth of the seed plays an important role for good germination therefore the depth should not be more than 3 cm for the desired level of crop stand. The placement of seeds below 3 cm adversely affects the dynamics of seed emergence due to rapid drying of soil moisture of the upper layer.

Water management

If the adequate pre-monsoon rains are received before sowing of rice, non-selective herbicides (glyphosate and paraquat) can be utilized for killing the first flush of weeds and after that rice seed should be sown through zero till machine. Under moisture stress condition in the field, a pre-sowing surface irrigation is required for better germination of seed. In fact, after seedling to crop emergence, no irrigation is required and soil should be moist but not saturated from sowing till emergence.

During the transit period of crop emergence and onset of monsoon, 1–2 irrigations are required. After the rain begins, there is no need for

further irrigation unless there is a dry spell in the field. During the dry spell, irrigation can be given in the form of life-saving irrigation, especially during important developmental stages, such as tillering, panicle initiation, flowering, milking and grain filling. Alternate wetting and drying system of irrigation under DSR has been considered effective and economical as it improves aeration in soil, rooting systems and reduces crop lodging.

Nutrient management

The nutritional requirement of the crop should be met based on the analysis of the soil of the crop field. A blanket application of 120–150 kg N/ha, 60 kg P/ha and 40 kg K/ha should be applied with 25 kg ZnSO₄/ha. In light textured soil, one-fourth N and full amount of P and K should be applied basally. The remaining quantity of N should be applied as the top dressing in two parts at the stage of maximum tillering and panicle initiation. In clay loam soils, half dose of N and the entire amount of P and K along with Zn and S should be given as a basal dose and the remaining half of N may be given in two splits i.e. at maximum tillering and at panicle initiation stage of rice. In direct seeded rice, iron deficiency usually occurs in light textured sandy loam soils, causing iron chlorosis in the leaves. Deficiency of iron can be overcome

Table 1. Important weeds associated with direct seeded rice crop under irrigated condition

Group	Weed species
Grasses	<i>Echinochloa colona</i> , <i>Echinochloa crus galli</i> , <i>Dactyloctenium aegyptium</i> , <i>Digitaria sanguinalis</i> , <i>Eleusine indica</i> , <i>cynodon dactylon</i> , <i>Paspalum distichum</i> , <i>Ischaemum rugosum</i> , <i>Leptochloa chinensis</i>
Broad leaf weeds	<i>Trianthema monogyna</i> , <i>Ammania baccifera</i> , <i>Commelina benghalensis</i> , <i>Caesulia axillaris</i> , <i>Sphenoclea zeylanica</i> , <i>Marsilea minuta</i> , <i>Ludwigia spp.</i> , <i>Monochoria vaginalis</i>
Sedges	<i>Fimbristylis littoralis</i> , <i>Cyperus rotundus</i> , <i>Cyperus iria</i> , <i>Cyperus difformis</i> , <i>Scirpus juncoides</i>

by the foliar application of iron sulphate (Fe₂SO₄). Diammonium phosphate and NPK are basal applied through the zero till fertilizer drill machine. Fertilizer drilling is not done properly due to the hygroscopic nature of urea. So, the remaining dose of N through urea can be applied as the top dressing. Leaf color chart (LCC) has proved to be very beneficial in determining the dose of nitrogen for enhancing its use efficiency. N application should be based on critical LCC value of 4 for hybrid and high-yielding varieties of rice. However, a critical LCC value of 3 is used for aromatic basmati type rice varieties. LCC values should be recorded 3 weeks after sowing and continue to the till heading.

Weed management

Weed management in DSR plays an important role for the harvest of desired yield level. In the rainy season, weeds are a major risk in direct sowing paddy and there is

a huge loss in grain yield due to inadequate weed management. In DSR, conditions are more favorable for germination of weeds (Table 1), which compete with rice crops for nutrients, moisture and sunlight leading to large yield losses.

Different agronomic/cultural methods for weed control in DSR condition are as given here:

Stale seedbed method: The weeds are made to germinate before sowing directly seeded rice by giving one prior irrigation in field and then the weeds are killed by application of a non-selective herbicide or by deep tillage. This technique can suppress weed population and it is possible under dry-DSR due to the availability of 45–60 days window duration of fallow period after harvesting of *rabi* crop and sowing of successive rice crop in *kharif* season.

Sesbania co-culture: At the time of seeding rice, *Sesbania* crop (*Sesbania rostrata*) is sown together in same field. After 25–30 days, spray of 2,4-D ester should be done for



Direct Seeded Rice in field

Table 2. Effective herbicides against different weed species

Herbicide	Dose (g/ha)	Time of application	Remarks
Pendimethalin (stomp 30% EC)	1000–1500	Pre-emergence	Control of mostly grasses, broadleaf weeds and annual sedges.
Oxadiargyl (Top star 80% WP)	90	Pre-emergence	Control of mostly grasses, broadleaf weeds and annual sedges.
Bispyribac sodium 10% SL (Nominee gold)	25	Post emergence 20–30 DAS	Broad-spectrum weed control of grasses, broadleaves and annual sedges. Good control of <i>Echinochloa</i> species.
Pyrizosulfuron 10% WP (Sathi)	25	Post emergence	Control of broadleaves weeds.
Azimosulfuron (50% WGG)	35	Post emergence 20–30 DAS	Control wide variety of weeds, including broadleaves and sedges like <i>Cyperus rotundus</i> and <i>Dactyloctenium</i> spp.
Ethoxysulfuron 15% WGG (Sunrise)	15	Post emergence 20–25 DAS	Effective on broadleaves and annual sedges such as motha (<i>Cyperus rotundus</i>).
Fenoxaprop ethyl + safner 6.7 EC (Rice star)	55–60	Post emergence 20–25 DAS	Excellent control of annual grassy weeds, safe on rice at early stage, good control of Barnyard grass. Does not control broadleaves and sedges.

or bispyribac + azimsulfuron or bispyribac + pyrizosulfuron at 1–3 fb 20–30 DAS. Herbicide should be sprayed by flat fan nozzle for uniform weed control in DSR field. Herbicides, alone or in combination are found effective against different weed species in DSR field (Table 2).

SUMMARY

DSR, with appropriate conservation practices appears to be a viable alternative to overcome the problem of labour and water scarcity. Despite the controversies, if managed properly, comparable yields can be obtained from DSR compared to transplanting. If not managed effectively, weeds can cause partial to complete failure of DSR crops. In DSR technology, water use efficiency (WUE) and water and fertilizer productivity can increase if proper leveling of land is done. Early crop vigour, short stature and short duration can also improve WUE. This method can be predominantly practiced in rainfed or deepwater ecosystems.

*Corresponding author's e-mail: samarpalagro@gmail.com

killing *Sesbania*. For 1 ha area, 10 kg *Sesbania* seeds are sufficient. *Sesbania* grows rapidly and suppresses weed population and minimizes weed completion.

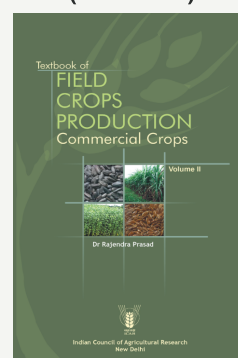
weed population can be effectively controlled by application of pendimethalin/oxadiargyl (top star) as pre-emergence followed by post-emergence application of bispyribac (nominee gold) or azimsulfuron

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