USAID IFAD BILL & MELINDA GATES foundation

Guidelines for Dry Seeded Rice (DSR) in the Eastern Gangetic Plains of India




IRRI CSISA CIMMYT International Maize and Wheat Improvement Center

Guidelines for Dry Seeded Rice (DSR) in the Eastern Gangetic Plains of India

Sudhir Yadav, R.K. Malik, Elizabeth Humphreys, Virender Kumar, S.S. Singh, Bhagirath S. Chauhan, B.R. Kamboj, Mahesh Gathala, M.L. Jat, Andrew J. McDonald and Ranjan Laik

International Rice Research Institute

2013

The Cereals Systems Initiative for South Asia (CSISA) is mandated to enhance farm productivity and increase incomes of resource-poor farm families in South Asia through the accelerated development and inclusive deployment of new varieties, sustainable management technologies, partnerships and policies. The project is being implemented by the CGIAR institutions of IRRI, CIMMYT, IFPRI, and ILRI and supported by USAID, and the Bill & Melinda Gates Foundation.

Citation

Sudhir-Yadav, Malik RK, Humphreys E, Kumar V, Singh SS, Chauhan BS, Kamboj BR, Gathala M, Jat ML, McDonald A, Laik R. 2013. Guidelines for dry seeded rice (DSR) in the Eastern Gangetic Plains of India. CSISA and IFAD joint publication. International Rice Research Institute (IRRI) and the International Maize and Wheat Improvement Center (CIMMYT). 32 p.

Contents

Guidelines for Dry Seeded Rice (DSR) in the Eastern Gangetic Plains of India

1. Introduction

Dry seeded rice (DSR) is becoming an attractive option for farmers as it has a much lower labor requirement than manually transplanted rice. Labor for transplanting rice has become scarce and costly because laborers are shifting from agriculture to industry, public works, and services. DSR can be readily adopted by small farmers as well as large farmers, provided that the required machinery is locally available (e.g., through custom hire). Best practice involves using a 2- or 4-wheel tractor-drawn drill to seed in rows in nontilled or dry tilled soil, as for wheat. Because the soil is not puddled, DSR also has a lower water requirement for crop establishment.

2. Soil suitability

DSR can be grown on the same soils as puddled transplanted rice, which typically range from sandy loam to heavy clay.

Don't grow DSR on light textured soils such as loamy sands and sands

3. Field preparation

a. Land leveling

Key check 1. Fields must be accurately leveled

Land leveling using laser guidance

Good land leveling helps ensure high yield and reliable production of DSR. This is best achieved using laser-assisted land leveling. A level field allows planters/drills to place seed more precisely and enables more uniform irrigation, leading to a uniform crop stand and improved weed control and nutrient use efficiency. Leveling also helps to reduce irrigation water application.

b. Tillage

DSR can be sown into soil tilled as for wheat ("conventional tillage") or into nontilled soil ("zero tillage"). The decision on whether or not to cultivate the soil depends on site-specific factors, such as the need for leveling and the risk of rodent attack.

i) Conventional tillage (CT): The soil should be cultivated to a depth of 5–10 cm to achieve a fine enough tilth for good seed-to-soil contact as for wheat. Depending on soil type and field conditions, this might involve 1–2 discings followed by 1–2 runs of a tyne cultivator and a planking.

ii) Zero tillage (ZT): For ZT-DSR, existing weeds should be killed by a nonselective herbicide such as glyphosate or paraquat (see Table 3 for application details). In situations where weed infestation is not uniform, the herbicide can be applied as a spot treatment rather than a blanket application. Both glyphosate and paraquat can be applied 2–3 days before sowing. Apply glyphosate when weeds are actively growing and not under stress. If weeds are under moisture stress, a light irrigation should be given before herbicide application for a better weed kill.

Don't apply paraquat if perennial weeds are present. In such situations, apply glyphosate.

Key check 2.

- Use clean water and a plastic container to make spray solution as herbicides bind with suspended soil particles and metal surfaces (e.g., iron bucket)
- Use a multiple-nozzle boom fitted with flat-fan nozzles for full coverage (see later)

4. Cultivars

Many of the inbred varieties and hybrids bred for puddled transplanted rice have also been found suitable for DSR. Shorter duration varieties or hybrids are preferred to reduce the irrigation requirement and to enable timely planting of wheat after the rice harvest. However, shorter duration cultivars are not necessarily an advantage where inadequate drainage is the primary factor preventing timely wheat planting. The inbreds and hybrids suitable for DSR in the Eastern GP are given below.

Suitable inbred varieties/hybrids for the Eastern GP

(see Table 1 for details)

Inbreds (eastern UP)	Inbreds (Bihar)	Hybrids (eastern UP & Bihar)
NDR-359	Rajendra Mahsoori-1	Arize 6129
Shabhagi dhan[a]	MTU1001	Arize 6444
BPT-5204	NDR- 359	Arize 6444 Gold[d]
MTU-7029	Prabhat	Arize Dhani
Moti	MTU-7029	Arize Prima
Swarna-Sub1[b]	Rajendra Bhagwati & Satyam	PHB-71
	Swarna-Sub1[b]	
	Rajshreei[c]	
	Shabhagi dhan[a]	

[a]For drought-prone environments

[b]Submergence-tolerant—can survive complete submergence of up to 2 weeks after transplanting (information not yet available for DSR)

[c]For waterlogged conditions

[d]This is a bacterial leaf blight (BLB)-resistant version of Arize 6444

5. Sowing date

Key check 3.

– Sowing date May 20 to June 30

– Earlier in this range is better if water is available

Where irrigation is available, or timely premonsoon showers occur, the best date for sowing DSR is 10–15 days prior to the onset of the monsoon. The optimum time of dry seeding rice in the Eastern Gangetic Plains is late May, as the later the crop is sown, the greater the risk of heavy rain shortly after sowing. Heavy rain, especially on heavy (clayey) soils, can seriously impair establishment. Therefore, it is safer to sow earlier. However, the earlier the crop is sown, the greater the need for irrigation.

6. Sowing

a. Crop establishment

DSR can be sown in dry or moist soil: (1) rice seeded in dry soil requires a light irrigation to germinate the seed, and (2) seeding in moist soil (*vattar* sowing) is done after a presowing irrigation or rainfall. In *vattar* sowing, planking after seeding helps to conserve soil moisture and improve establishment. When using conventional tillage, rice can be established by either of these two methods. However, for ZT-DSR, *vattar* sowing is better as the soil is softer.

Seeding in nontilled soil (ZT-DSR)

Seeding with strip tillage using a PTOS (“power tiller–operated seeder”—a seeder with tiller powered by a 2-wheel tractor)

b. Machinery for sowing

For precise seeding, rice should be drilled using a multicrop planter fitted with an inclined-plate seed-metering mechanism (see photo), and with the ability to drill both seed and fertilizer simultaneously. DSR can also be sown with a conventional seed-cum-fertilizer drill with a fluted-roller seed-metering mechanism; however, the seeds will not be spaced evenly and a higher seed rate is required to avoid seed breakage. The inclined-plate seed-metering mechanism also provides the opportunity to use primed seed as there is no problem of seed breakage in contrast with the use of fluted-roller seed metering.

Seed drills with inverted-T tines are suitable for seeding into both tilled and nontilled soil.

Inclined-plate (left) and fluted-roller (right) metering systems

There should be good coverage of the seed with soil to prevent desiccation and predation by rodents and birds. Therefore, it may help to use chains or flaps behind the tines.

Coverage of seeds with soil using chains or flaps

For ZT-DSR, when no or only anchored residues of the previous crop (e.g., wheat) are retained, the same multicrop planter can be used for seeding if fitted with suitable tines (e.g., inverted T, as commonly provided on multicrop planters in India). However, if loose or bulky crop residues are present on the soil surface (e.g., mungbean, loose straw), the Turbo Happy Seeder should be used.

DSR being sown into residues using the Turbo Happy Seeder

Seed-cum-fertilizer drills for 2-wheel tractors are now also available in India, commonly attached to a power tiller. These drills are available with inclined-plate seeding mechanisms, and sowing can be done in a single pass with full tillage or strip tillage (achieved by removing at least 50% of the rotor blades and aligning the remaining rotor blades so that they till a narrow strip in front of the seeding tines, with the curved ends angled towards the sowing line). No prior tillage is needed. The new seed-cum-fertilizer drills/planters for 2-wheel tractors are an improvement on the "power tiller–operated seeders" (PTOS) that have been available for some time. The standard PTOS has a seed box but no fertilizer box, and a fluted-roller seeding mechanism.

Crop being sown by a seed-cum-fertilizer drill with inclined-plate seeding mechanism, using full tillage, powered by a 2-wheel tractor. Tillage and seeding are done in a single pass.

c. Seed quality, rate, sowing depth, row spacing

Key check 4.

- Use certified seeds
- 20–30 kg/ha (with inclined-plate seeding mechanism)
- 35–45 kg/ha (with fluted-roller seeding mechanism)
- Seeding depth: 1–2 cm

Seed quality greatly influences germination rate; therefore, it is recommended to use certified seeds. A seed rate of 20–30 kg/ha (using good-quality seeds with more than 95% germination) is optimal for DSR with a row spacing of 20 cm sown with a multicrop planter. Under good establishment conditions, the rate can be at the lower end of the range. However, where there is risk of reduced establishment due to factors such as suboptimal leveling, waterlogging, or seed predation, the seed rate should be at the higher end of the range. There is no yield penalty for sowing at higher rates up to about 50 kg/ha. The seeding depth for rice is critical and the rice should be sown at 1–2 cm, and definitely not deeper than 3 cm.

d. Seed treatment

1. Priming

As DSR needs to be sown at a shallow depth (<2 cm) in advance of the monsoon rains, inadequate soil moisture can be a major constraint to rapid establishment of a good

crop stand. Sowing with primed seeds into moist soil can assist rapid establishment. Priming (soaking the seeds for 10–12 hours in a gunny-bag [burlap] in water) accelerates crop emergence. After soaking, the seeds are air dried for a couple of hours, which facilitates free flow of seeds through the seed drill. Further, seeds can be incubated for an additional 8–12 hours for pregermination if sowing is to be done into moist soil (after rain or presowing irrigation), that is, *vattar* sowing. The seeds should be sown shortly after priming and incubation. Emergence of pregerminated seeds will be adversely affected if sown into dry soil.

Don't sow primed seeds into dry soil unless you can irrigate immediately after sowing

2. Seed treatment with fungicides and insecticides

Seed treatment with fungicides is recommended to manage diseases such as loose smut, flag smut, root rot, collar rot, and stem rot. For this, a weighed quantity of seed is soaked in water treated with fungicide (tebuconazole—Raxil Easy® at 1 mL/kg seed, or carbendazim—Bavistin® at 2 g/kg) for 24 hours. The volume of water used for soaking is equivalent to the volume of seed. The seeds are then removed from the fungicide solution and dried in the shade for 1–2 hours before sowing.

Where soil-borne insect pests (e.g., termites) are a problem, seed treatment with an insecticide is beneficial [imidacloprid—Gaucho 350 FS® at 3 mL/kg), alone or in combination with tebuconazole—Raxil Easy® at 0.3 mL/

kg seed)]. The combination treatment will protect the seed from both soil-borne fungi and insects. The use of imidacloprid, or in combination with tebuconazole, is also suitable for treating dry seeds. Mix the chemicals in 15 mL water/kg seed.

7. Fertilizer management

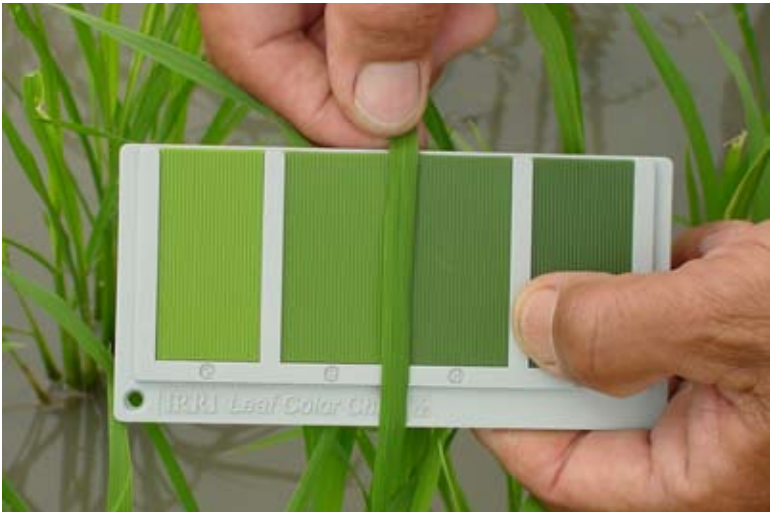
Key check 5.

- Avoid basal dose of urea
- Use a minimum of three splits of N fertilizer

a. *Nitrogen (N), phosphorus (P), potassium (K), and zinc (Zn)*

The N fertilizer requirement varies depending on variety from 80 to 120 kg N/ha (Table 3). The requirement for other fertilizers is P_2O_5 at 60 kg/ha, K_2O at 60 kg/ha, and $ZnSO_4$ at 25 kg/ha. The nitrogen dose for CT-DSR can be reduced by 25% by green manuring—this involves growing *Sesbania* (*Dhencha*) and incorporating it 2–3 days prior to sowing DSR. All fertilizer except urea (N) should be applied at sowing. Compound fertilizers (DAP or NPK formulations) should be placed in the soil at the time of sowing using the seed drill. If Zn is not applied at sowing, it can be applied as a foliar spray (0.5% zinc sulfate and 1.0% urea) 30 days after sowing (DAS) and at panicle initiation (PI), which occurs approximately 3–4 weeks prior to heading. The remaining nitrogen should be applied as urea in three or four splits, evenly spaced, starting 2–3 weeks after sowing

and with the last split at PI. Apply N prior to irrigation. Use of the leaf color chart (LCC) to determine the N fertilizer requirement enables more precise N application according to the crop requirement, and often results in a reduction in the amount applied while maintaining yield. The standardized LCC developed by IRRI (photo below) is five inches long, made of high-quality plastic, with four color shades from yellowish green (No. 2) to dark green (No. 5). For high-yielding varieties/hybrids, N application should be based on a critical LCC value of 4.



Leaf color chart

Don't broadcast urea on moist soil after irrigation or rain. Apply urea before irrigation (or rain if likely).

b. Iron (Fe)

Dry seeded rice often suffers from iron deficiency when grown on lighter soils (sandy loams and loams), and the deficiency is worse in low-rainfall seasons. The symptoms generally appear during the early vegetative stage in the form of yellowing, stunted plants, and seedling death. The crop should be sprayed with 1% ferrous sulfate solution as soon as the symptoms appear (with repeat applications after a week if the symptoms persist). For severe symptoms, try to keep the field flooded/saturated for a few days at the time of ferrous sulfate application. If iron deficiency symptoms appear later during crop growth, they may be due to cereal cyst nematodes—check the roots for galls to determine whether this is a likely cause. If galls are present, avoid using this field for DSR in the future.

Symptoms of iron deficiency (foreground)

Root galls indicating nematode infestation

8. Irrigation management

Key check 6.

- Keep the soil in the seed/root zone moist during establishment
- Keep the soil close to saturation from the start of heading to the start of grain filling

The goal of irrigation management is to minimise the use of irrigation water while maintaining yield because of increasing water scarcity and/or the high cost of pumping groundwater. Rice does not need to be continuously flooded

for good growth and yield. It can be grown with periodic irrigation, allowing the soil surface to dry for a few days between irrigations. However, if the soil becomes too dry too often, the rice crop will suffer and there will be a loss of yield. Therefore, irrigation needs to be managed carefully. The irrigation requirement for DSR depends very much on the weather and the soil type. The lighter (less clayey, more sandy) the soil, the more frequently it will need irrigation in the absence of adequate rain.

DSR needs an assured water supply for the first 3 weeks after sowing for good establishment. When DSR is established in hot and dry conditions, the next 1–2 irrigations are required at intervals of 3–5 days to keep the soil moist in the root zone. During the active tillering phase, that is, 30–45 DAS, and the heading to grain-filling stage, the topsoil (0–15 cm) should be kept close to saturation, with irrigation applied as needed. At other stages the topsoil can be allowed to become drier, but never to the degree that the leaves show signs of rolling (no longer flat) in the early morning. For clayey soils the appearance of hairline cracks on the soil surface is a general indication of the need to irrigate.

Punjab Agricultural University has developed a simple, cheap instrument (tensiometer) for helping farmers to decide when to irrigate. The tensiometer is filled with water and installed in the soil with the ceramic tip at 15–20 cm depth. As the soil dries, it sucks water out of the tip into the soil and the water level in the tube drops. When the level drops from the green to the yellow band, it is time to irrigate to ensure that the soil does not become so dry that the rice crop would suffer.

Farmer-friendly tensiometer for scheduling irrigation

9. Weed management

Weed management is usually the biggest challenge for successful production of DSR. A much larger range of weeds occurs in DSR than in puddled transplanted rice, and, if uncontrolled, the degree of infestation can be great enough to reduce rice yield to zero. There are three broad classes of weeds—grasses, broadleaves, and sedges. Table 2 lists the weeds commonly found in DSR in eastern India.

Don't grow DSR in fields used for fodder crops or with a history of heavy weed infestation

a. Cultural practices

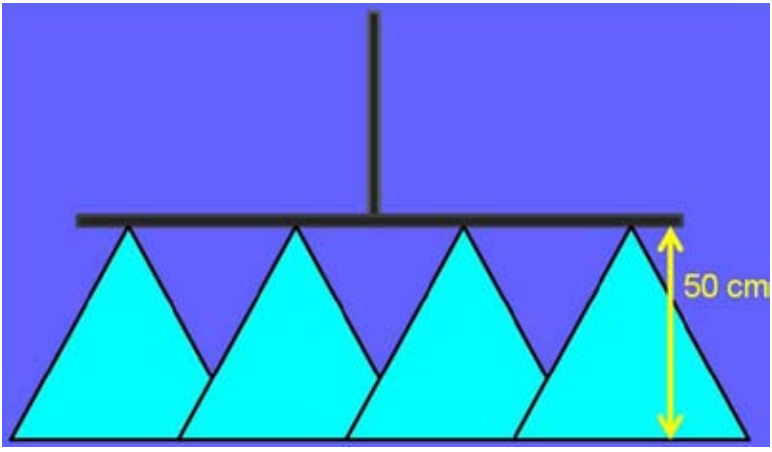
Stale seedbed technique: This technique is highly desirable if the field has a large weed seed bank (i.e., lots of weed seeds in the soil as a result of weed infestation in the past). Weeds are germinated by giving one or two irrigations about 1 month prior to sowing, and then killed by either a nonselective herbicide (paraquat or glyphosate) or tillage. If the soil condition is suitable for sowing, use a nonselective herbicide to kill the weeds and sow the crop without any tillage (tillage brings more weed seeds near the soil surface and thus promotes their germination). Note that the weeds must be actively growing at the time of herbicide application, so, if the soil is dry, an irrigation will be needed prior to herbicide application. This method has great potential for reducing weeds in DSR because of the 2-month fallow period between wheat harvest and rice sowing. This technique is also helpful in managing weedy rice, which is an emerging problem in lowland rice in the Eastern Gangetic Plains.

b. Chemicals

A wide range of herbicides is available for controlling weeds (Table 3). All herbicides need to be mixed with water prior to application. Clean water should be used, as muddy water reduces herbicide efficacy. Spray tanks, booms, and nozzles should be cleaned properly with clean water after use. Chemicals should not be mixed together unless recommended, as this may reduce their effectiveness on weeds and/or be harmful to the rice plants. Chemicals should always be applied at the recommended rate.

Uniform application of the spray across the entire field is needed to avoid “misses” (costly follow-up hand weeding needed) and overspraying (waste of costly chemicals). The best way of achieving this is with a multinozzle (e.g., three) boom with flat-fan nozzles and slightly overlapping spray patterns at the soil surface. The overlap is achieved by holding the boom at the right height (approximately 50 cm) above the target (for preemergence, the soil surface is the target, and for postemergence, weeds are the target, so the boom should be 50 cm above the top of weeds).

Use of multinozzle boom for herbicide application



Boom height for desired spray pattern with slight overlap at ground level to avoid "misses"

All herbicides and pesticides are dangerous. Proper safety precautions should be followed. These include

- Wearing gloves, a breathing mask, and goggles when handling neat (undiluted) chemicals and when spraying
- Wearing protective clothing while spraying (e.g., made from washed fertilizer bags).

i) Preplant/knockdown herbicides

These herbicides are used to kill existing vegetation prior to rice sowing under ZT-DSR. Glyphosate (1.0 kg a.i./ha or 1% by volume) and paraquat (0.5 kg a.i./ha or 0.5% by volume) are recommended. If fields are infested with perennial weeds, use glyphosate, not paraquat.

Protective clothing for spraying—in the lower photo, the clothes are made from washed fertilizer bags.

ii) After crop sowing

Key check 7.

- Ensure that the soil is moist before applying preemergence herbicide
- Apply irrigation 24 h after postemergence herbicide application if the soil is not moist

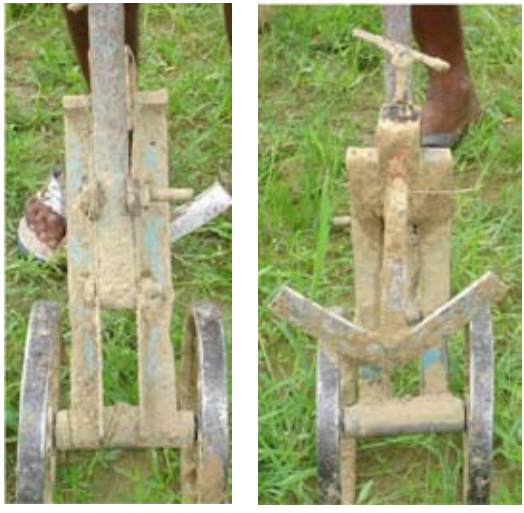
The choice of herbicide depends on the types of weeds, and no single herbicide can control all weeds in the rice crop. In many situations, the best method for effective weed control is application of a preemergence herbicide (1–3 DAS, before the weeds and rice emerge), followed by a postemergence application 15–25 DAS. This will typically involve the use of pendimethalin or oxadiargyl as preemergence followed by a postemergence application of bispyribac-sodium or azimsulfuron or bispyribac-sodium plus azimsulfuron. However, in cases where the preemergence herbicide is missed (e.g., due to rain) or fails (e.g., due to management errors, such as soil too dry at the time of spraying), early herbicide application at 15 DAS should be made based on types of weeds present.

Don't apply preemergence herbicide on dry soil; irrigate first if needed

Don't allow water stress after application of postemergence herbicide

c. Physical

Physical weed control consists of removing weeds by hand (manual weeding) or by machine (mechanical weeding). It is practically and economically impossible to control weeds solely by hand weeding because of labor scarcity and rising labor wages. However, one or two spot hand weedings are strongly recommended to remove weeds that escape herbicide application, to prevent weed seed production and the accumulation of weed seeds in the soil. Mechanical weeding can be useful in reducing labor use in weeding. Motorized cono and other hand weeders are available in the region and can be included as part of integrated weed management.



Hand-operated weeder for in-row weed control in DSR (front and back views)

Motorized weeder

d. Surface residue retention

Retention of crop residues on the soil surface in zero-tillage systems also helps to suppress weeds.

10. Pests and diseases

a. Nematodes

Cereal cyst nematodes tend to be a problem on lighter soils, more so in drier years. The problem initially appears as small patches of stunted growth, reduced tillering, and pale green-yellowish plants. The problem is likely to be exacerbated by continuing to grow nonflooded DSR in the same field. It is better to avoid growing DSR in fields where nematode problems begin to appear.

b. Insects and pest management

The common insects and pests of rice in the region, and chemicals for controlling them, are listed in Table 4.

Table 1. Suitable cultivars for DSR in the Eastern Gangetic Plains.

Cultivar	Duration (days)	Yield potential (t/ha)	Nitrogen requirement (kg/ha)	Days to heading	Region/situation
Inbred					
Eastern Uttar Pradesh					
Sahbhagi dhan	110–115	4.0–5.0	80	85–90	Rainfed lowland and upland
NDR-359	125–130	6.0–6.5	80	90–95	Rainfed upland and lowland
Sambha Mahsuri (BPT-5204)	140–145	5.0–6.0	100	100–110	Irrigated and favorable lowland
Moti	145	5.0	100	110	Irrigated lowland
Swarna (MTU-7029)	155–160	6.5–7.0	120	115–120	Irrigated and favorable lowland
Swarna-Sub1	155–160	6.0–6.5	100	115–120	Flood-prone districts adjoining Nepal
Bihar					
Prabhat	90–95	4.0–4.5	100	60–65	Multiple-cropping area of rainfed lowland
Sahbhagi dhan	110–115	4.0–4.5	80	85–90	Rainfed lowland and upland (Aurangabad, Jamui, Nawada, and Gaya)
Rajendra Bhagwati & Satyam	125–130	4.0–4.5	100	90–95	Irrigated midland and lowland
MTU1001	130–135	4.5–5.0	100	95–100	Irrigated midland
Rajshreei	140–145	5.0–5.5	90	115–120	Irrigated and rainfed lowland
Swarna (MTU-7029)	155–160	6.0–6.5	120	115–120	Irrigated lowland and favorable lowland
Swarna-Sub1	155–160	6.0–6.5	100	115–120	Districts adjoining Nepal (Madhubhani, Sitamarhi, East Champaran)
Rajendera Mahsoori-1	155–160	5.0	100	115–120	Tirhut region
Hybrid (for both EUP and Bihar)					
Arize 6129	115–120	5.0–6.0	120	90–95	Irrigated and rainfed lowland
Arize 6444	135–140	6.5–7.0	120	105–110	Irrigated and rainfed lowland
Arize 6444 Gold	135–140	6.0–6.5	120	105–110	Irrigated and rainfed lowland
Arize Prima (HRI-157)	140–145	6.0–6.5	120	110–115	Irrigated and rainfed lowland
PHB-71	130–135	6.5–7.0	120	105–110	Irrigated and rainfed lowland
Arize Dhani	140–145	5.5–6.0	120	110–115	Irrigated and rainfed lowland

Table 2. Common weeds of rice in the Eastern Gangetic Plains.

Grass		Broadleaf		Sedge	
Botanical name	**Local name**	**Botanical name**	**Local name**	**Botanical name**	**Local name**
Brachiaria reptans	Para ghas, Bhosi	*Alternanthera sessilis*	Dabhi	*Cyperus difformis*	Motha
Cynodon dactylon	Doob	*Caesulia axillaris*		*Cyperus iria*	Motha
Dactyloctenium aegyptium	Makra	*Celosia argentea*	Sumari	*Cyperus rotundus*	Motha
Echinochloa colona	Sawank, Sawa	*Commelina benghalensis*	Kankawa, Kanna	*Fimbristylis miliacea*	Jhirua
Echinochloa crus-galli	Barata, Masta	*Cucumis spp.*	Ghurmi	*Fimbristylis quinquangularis*	Chhoti dili
Eleusine indica	Balraja	*Digera arvensis*	Junkhunna		
Eragrostis tenella	Chiria ghas, Sihul	*Eclipta prostrata*	Jalbhangra, Bhangraia		
Ischaemum rugosum	Kanki	*Physalis minima*	Bhutkuiyan		
		Stellaria media	Buch-bucha		
		Oxalis corniculata			

Table 3. Major knockdown and preemergence herbicides for weed control in DSR in the Eastern Gangetic Plains (adapted from Kumar and Ladha 2011).

Herbicide (active ingredient, a.i.)	Product (trade) name*	Concentration (g a.i./ha)	Product dose (g/ha or mL/ha)	Application time (DAS)	Strengths	Weaknesses
Knockdown/nonselective						
Glyphosate	Roundup	1,000	2,500 mL		Good control of most grasses, some broadleaves and annual sedges	Weak on *Ipomoea triloba* and *Commelina* species
Paraquat	Gramoxone	500	2,000 mL		Good control of most grasses, some broadleaves and annual sedges	
Preemergence						
Pendimethalin	Stomp/Stomp xtra	1,000	3,330 mL 2,580 mL	1–3	Good control of most grasses, some broadleaves and annual sedges. Has residual control.	Sufficient moisture is needed for its activity
Oxadiargyl	Topstar	90	112.5 g	1–3	Broad-spectrum weed control of grasses, broadleaves, and annual sedges. Has residual control.	Sufficient moisture is needed for its activity

**Does not imply endorsement of the product*

Table 4. Major postemergence herbicides for weed control in DSR in the Eastern Gangetic Plains (adapted from Kumar and Ladha 2011).

Herbicide (active ingredient, a.i.)	Product (trade) name*	Concentration (g a.i./ha)	Product dose (g/ha or mL/ha)	Application time (DAS)	Strengths	Weaknesses
Postemergence						
Bispyribac-sodium	Nominee Gold/ Adora	25	250 mL	15–25	Broad-spectrum weed control of grasses, broadleaves and annual sedges. Good control of *Echinochloa* species.	Poor on grasses other than *Echinochloa* species, including *Leptochloa chinensis*, *Dactyloctenium aegyptium*, *Eleusine indica*, *Eragrostis* species. No residual control.
Penoxsulam	Granite	22.5	93.75 mL	15–20	Broad-spectrum weed control of grasses, broadleaves, and annual sedges.	Poor on grasses other than *Echinochloa* species, including *L. chinensis*, *D. aegyptium*, *E. indica*, *Eragrostis species*.
Fenoxaprop-ethyl + safener	Rice star	60–90	870–1,300 mL	15–20	Good control of annual grassy weeds, safe on rice at early stage.	Does not control broadleaves and sedges.
Azimsulfuron	Segment	17.5–35	35–70 g	15–20	Broad-spectrum control of grasses, broadleaves, and sedges. Good control of sedges, including *Cyperus rotundus*.	Poor on *Echinochloa* species.
Ethoxysulfuron	Sunrice	18	120 g	15–20	Effective on broadleaves and annual sedges.	Does not control grasses and poor on perennial sedges.
2,4-D ethyl ester	Weedmar	500	1,250 mL	15–25	Effective on broadleaves and annual sedges. Economical. Has no residual control	Does not control grasses.
Carfentrazone	Affinity	20	50 g	15–20	Effective on broadleaf weeds. Has no residual control.	Does not control grasses.

contd...

Table contd...

Herbicide (active ingredient, a.i.)	Product (trade) name*	Concentration (g a.i./ha)	Product dose (g/ha or mL/ha)	Application time (DAS)	Strengths	Weaknesses
Chlorimuron + metsulfuron	Almix	4 (2 + 2)	20 g	15–25	Effective on broadleaves and annual sedges.	No control of grassy weeds and poor on *C. rotundus*.
Bispyribac sodium + azimsulfuron		25 + 17.5	250 mL + 35 g	15–25	Broad-spectrum weed control of grasses, broadleaves, and sedges, including *C. rotundus*.	Poor on grasses other than *Echinochloa* species.
Bispyribac sodium + pyrazosulfuron		25 + 25	250 mL + 250 g	15–20	Broad-spectrum weed control of grasses, broadleaves, and sedges, including *C. rotundus*.	Poor on grasses other than *Echinochloa* species.
Fenoxaprop + ethoxysulfuron		60 + 18	645 mL + 120 g	15–25	Broad-spectrum weed control of grasses, broadleaves, and sedges. Good control of all major grasses, including *L. chinensis* and *D. aegyptium*.	Poor on perennial sedges such as *C. rotundus*.
Propanil + pendimethalin		4,500 + 1,000	12,850 mL + 3,333 mL	10–12	Broad-spectrum weed control with residual effects.	Poor on sedges such as *C. rotundus*.

** Does not imply endorsement of the product.*

Table 5. Common insects, pests, and diseases of rice and chemical treatments.

Name of pest	Time of attack	Chemical name and product dose (kg/ha, g/ha, or mL/ha)
Insects		
Yellow stem borer	July to Oct	Cartap hydrochloride 4 G (18.75 kg), fipronil 0.3G (18.75 kg), monocrotophos 36 SL (1,250 mL), triazophos 40 EC (875 mL), chlorpyriphos 20 EC (2,500 mL)
Leaffolder	Aug to Oct	Monocrotophos 36 SL (500 mL), triazophos 40 EC (875 mL), chlorpyriphos 20 EC (1,000 mL)
Leaf- and planthopper	July to Oct	Buprofezin 25 SC (825 mL), imidacloprid 17.8 SL (125 mL), dichlorvos 76 EC (1,000 mL)*, thiamethoxam 25 WG (100 g), quinalphos 25 EC (2,000 mL)
Army cut worm		Methyl parathion (25 kg), quinalphos 25 EC (1,000 mL)
Root weevil	July to Sept	Phorate 10 G (10 kg)
Diseases		
Brown leaf spot	Tillering to flowering	Propiconazole 25 EC (500 mL), Zineb (1–1.25 kg)
Sheath blight		Hexaconazole 5 EC (1,000 mL), carbendazim 50 WP (500 g), propiconazole 25 EC (500 mL)
False smut		Copper oxychloride 50 WP (1,250 g), propiconzole 25 EC (500 mL), tebuconazole 25 EC (600 mL)
Bacterial leaf blight	Just after transplanting	Use resistant varieties and avoid excessive ponding of water and nitrogenous fertilizers or copper oxychloride + streptocyclin (1,250 +15 g)
Blast	Maximum tillering	Carbendazim 50 WP (500 g), tricyclazole 75 WP (300 g)

* Dissolve this in 5 L of water and then mix it with 50 kg of sand and broadcast uniformly in saturated to flooded conditions.

Contributors

Sudhir Yadav	International Rice Research Institute
R.K. Malik	CSISA, International Maize and Wheat Improvement Center
Elizabeth Humphreys	International Rice Research Institute
Virender Kumar	International Maize and Wheat Improvement Center
S.S. Singh	Indian Council of Agricultural Research
Bhagirath Singh Chauhan	International Rice Research Institute
B.R. Kamboj	CSISA, International Maize and Wheat Improvement Center
Mahesh Gathala	International Maize and Wheat Improvement Center
M.L. Jat	International Maize and Wheat Improvement Center
Andy McDonald	International Maize and Wheat Improvement Center
Ranjan Laik	CSISA, International Maize and Wheat Improvement Center

Acknowledgements

We are grateful to Drs. J.K. Ladha, F. Mussgnug, and D.E. Johnson for reviewing the guidelines. We thank Bill Hardy for editorial assistance and Poornima Shankar for the cover design and other publication assistance.

For more details and queries, please contact

Dr. R.K. Malik
CSISA Hub Manager
House No. 09, Awas Vikas Colony, Betiahata, Gorakhpur, UP 273301
Mobile: +91-9161319472, 09006319683, 09161319472
Email: RK.Malik@cgiar.org

Dr. Virender Kumar
Cropping Systems Agronomist, CIMMYT-India
KP Tower, Friends Colony, Digha Road, Asiana, Patna 800025, Bihar
Mobile: +91-9050009911,
Email: virender.kumar@cgiar.org

Further information

Kamboj, B.R., Kumar, A., Bishnoi, D.K., Singla, K., Kumar, V., Jat, M.L., Chaudhary, N., Jat, H.S., Gosain, D.K., Khippal, A., Garg, R., Lathwal, O.P., Goyal, S.P., Goyal, N.K., Yadav, A., Malik, D.S., Mishra, A. and Bhatia, R. 2012. *Direct Seeded Rice Technology in Western Indo-Gangetic Plains of India : CSISA Experiences.* CSISA, IRRI and CIMMYT. 16 pp. available at *http://www.knowledgebank.irri.org/csisa/en/component/k2/item/153-dsr-production-technology-csisa-experiences.html*

Gopal, Ravi, Jat, R.K., Malik, R.K., Kumar, V., Alam, M.M., Jat, M.L., Mazid, M.A., Saharawat, Y.S., McDonald, Andrew and Gupta, Raj. 2010. *Direct dry seeded rice production technology and weed management in rice based systems*. Technical Bulletin. International Maize and Wheat Improvement Center, New Delhi India. pp 28. available at *http://www.knowledgebank.irri.org/csisa/en/direct-seeding/item/8-dsr-production-technology-weed-management-in-rice-based-systems-technical-bulletin.html*

Kumar, V. and Ladha, J.K. 2011. Direct seeding of rice: recent developments and future research needs. *Advances in Agronomy*, **111**: 297-413.




The DSR Series available in English and local languages:

Volume 1: Guidelines for Dry Seeded Rice (DSR) in the Eastern Gangetic Plains of India
Volume 2: Guidelines for *aman* Dry Seeded Rice (DSR) in Bangladesh
Volume 3: Guidelines for Dry Seeded Rice (DSR) in Nepal
Volume 4: Guidelines for Dry Seeded Rice (DSR) in Tamil Nadu

www.knowledgebank.irri.org