

Swarna Shakti Dhan: A high yielding multiple stress tolerant aerobic rice variety for water-scarcity areas

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*Under climate changing scenario, water scarcity is a major challenge to sustain rice production in water limited irrigated and drought prone rainfed areas. A high yielding, multiple stress tolerant aerobic rice (*Oryza sativa* L.) variety, Swarna Shakti Dhan (IET 25640) has been released. It is suitable for cultivation under direct-seeded aerobic condition in water limiting irrigated as well as drought-prone rainfed areas. In addition, it has shown moderate resistance to sheath blight, false smut, leaf blast, bacterial leaf blight, neck blast, brown spot, sheath rot, RTD diseases, stem borer and leaf folder insect pests. It produces short-bold grain therefore, more number of grains per panicle. As compared to transplanted puddle rice, this variety saves 35–40% water. Furthermore, adoption of this variety increases net income of ₹15000–20000/ha of farmer's over local cultivars. Thus, this variety will contribute to increase rice productivity and alleviating the socio-economic status for farmers of Bihar, Jharkhand, Odisha, Haryana, Chhattisgarh, Gujarat and Maharashtra.*

Keywords: Aerobic rice, Swarna Shakti Dhan, Water scarcity

RICE (*Oryza sativa* L.) is one of major staple food crop for nearly two-third of world's population and plays an important role in world's economy. Among the abiotic stresses, water scarcity is one of the most severe limitations to rice cultivation. Recent estimate on climate change predicts water deficit to deteriorate further in years to come, and intensity and frequency of drought are predicted to worsen the rice production. It has been estimated that one fifth of Asia's flood-irrigated rice will face water shortage by the end of 2025. Being an extravagant consumer of water, rice crop uses around 3000–5000 litre of fresh water to produce 1 kg of rice. Increase in depletion of freshwater resources is a major threat to traditional way of rice cultivation. Because of day-day increasing water scarcity, there is a need to develop an alternative system that requires less water for rice crop production. In such situations, development of high yielding, drought tolerant, aerobic rice variety becomes



Aerobic rice variety Swarna Shakti Dhan

very important. Aerobic rice is grown as direct seeded in well-drained, non-puddled and non-saturated (aerobic) soils with the supplemental irrigation and high external inputs. It is efficient water

saving rice growing technology for water limited irrigated and drought-prone rainfed areas.

An aerobic rice variety, Swarna Shakti Dhan (IET 25640) has been developed by the ICAR-Research

Complex for Eastern Region, Patna in collaboration with International Rice Research Institute (IRRI), Philippines. It has been released and notified by Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops, Govt. of India (notification number S. O. 99(E) dated 6th January 2020) for cultivation under aerobic situation in the states of Haryana, Odisha, Bihar, Jharkhand, Chhattisgarh, Gujarat and Maharashtra. Water scarcity is the major challenge to sustain rice production in these areas. This rice variety is an early-duration (115–120 days), semi-dwarf, high yielding (4.5–5 t/ha), multiple stresses (drought, disease and insect pest) tolerant with desirable cooking quality traits and high micronutrient contents. It is suitable for cultivation under direct-seeded aerobic condition in water limiting irrigated and drought-prone areas. This variety has shown desirable quality parameters like high head rice recovery, intermediate amylose content, alkali spreading value and a soft GC with very occasionally chalkiness. It has semi-erect flag leaf, short-bold grain, long and well exerted compact panicle, moderate tillering (8–10 tillers/hill), with test weight of 23.8 g. Rice crop grown in these states invariably suffers due to moisture stress in one or the other stage. Therefore, Swarna Shakti Dhan recommended for these states



Kernels and grains of Swarna Shakti Dhan

will not only increase the yield levels but also stabilize moisture stress at higher level.

Yield potential and agronomic adaptation

Rice genotype RCPR-22 (Swarna Shakti Dhan) was entered as IET 25640 under IVT-Aerobic trial in AICRIP coordinated programme during wet season of 2015 and this entry has consistently outperformed the national, zonal, local checks and qualifying genotypes during 4 years (2015–2018) AICRIP testing. This variety exhibited the stable yield in zone II, III, V and VI. It was found promising for states of Haryana, Odisha, Bihar, Jharkhand, Chhattisgarh, Gujarat, and Maharashtra during testing under AICRIP programme. Based on 4 years of testing, IET 25640 has recorded an overall mean grain yield of 4962 kg/ha and showed yield gain of 13.9, 18.9 and 18.6%

over the national (CR Dhan 201), zonal and local checks, respectively (Table 1). During testing in state of Haryana, IET 25640 recorded yield superiority over national, zonal and local checks 10.1, 9.64 and 55.1%, respectively with mean grain yield of 7447 kg/ha. In Jharkhand, It recorded mean grain yield of 5578 kg/ha and showed yield advantage of 40.2, 7.72 and 59.8% over the national, zonal and local checks, respectively. Furthermore, in Bihar, yield superiority of IET 25640 over national, zonal and local checks was 7.31, 7.9 and 27.7% respectively with mean grain yield of 4827 kg/ha. During testing in Odisha, it recorded mean grain yield of 4690 kg/ha and showed yield advantage of 11.6, 6.47 and 32.7% over national, zonal and local check, respectively. During AICRIP testing in Gujarat, it recorded mean grain yield of 5127 kg/ha and showed yield advantage of 27.8, 58.0

Table 1. Summary of mean grain yield (kg/ha) data (all India) in coordinated varietal trials (Aerobic trial, 2015–18)

	Name of the trial	Year of testing	No. of locations	IET 25640	National check	Zonal Check	Local Check	Qualifying genotypes				
								IET 25613	IET 25633	IET 25636	IET 26170	IET 26200
Mean yield (kg/ha)	IVT-Aerobic	I year 2015	7	5148 (1)	3814	3846	3763	3546	4096	3712	NT	NT
	AVT 1-Aerobic	II year 2016	9	4856 (2)	4056	4069	4253	4345	4461	3846	NT	NT
	AVT 2-Aerobic	III year 2017	11	4705 (2)	4558	4319	3841	3082	4187	4065	NT	NT
	AVT 2-Aerobic	IV year 2018	14	5140 (3)	4663	4292	4622	NT	NT	NT	4315	4013
	weighted mean		41	4962	4357	4174	4185	3623	4255	3900	4315	4013
Per cent increase/decrease over weighted mean					+13.90	+18.88	+18.57	+36.95	+16.62	+27.22	+14.99	+23.65
Frequency in the top group				24/41	10/41	5/41	7/41	4/27	3/27	2/27	0/14	2/14

Mean yield data given in table is pertaining to all tested states. Source: ICAR-IIRR, Annual Progress Report 2015, 2016, 2017 & 2018 Vol. 1, Varietal Improvement; NT, not tested in the respective year.

Table 2. Summary of mean grain yield (kg/ha) data (all India) in coordinated varietal trials (Aerobic trial, 2015–18)

State	Weighted mean data/ Per cent increase or decrease over weighted mean (WM)	IET 25640	National check	Zonal Check	Local Check	Qualifying genotypes				
						IET 25613	IET 25633	IET 25636	IET 26170	IET 26200
Bihar	Weighted mean	4827	4498	4474	3780	3967	4553	3889	4766	4162
	Per cent increase decrease over weighted mean		+7.31	+7.88	+27.68	+21.67	+6.03	+24.12	+1.28	+15.98
Odisha	Weighted mean	4690	4202	4405	3534	4151	3633	3462	4165	4488
	Per cent increase decrease over weighted mean		+11.62	+6.47	+32.71	+12.98	+29.08	+35.48	+12.61	+4.50
Jharkhand	Weighted mean	5578	3978	5178	3489	1756	4133	3889	NT	NT
	Per cent increase decrease over weighted mean		+40.22	+7.72	+59.87	+217.65	+34.96	+43.43	NT	NT
Chhattisgarh	Weighted mean	5003	4146	4656	4027	4097	4818	4347	3213	3557
	Per cent increase decrease over weighted mean		+20.66	+7.46	+24.24	+22.13	+3.85	+15.08	+55.71	+40.65
Gujarat	Weighted mean	5127	4011	3244	4039	3568	3829	3943	4142	3011
	Per cent increase decrease over weighted mean		+27.84	+58.03	+26.95	+43.71	+33.92	+30.03	+23.78	+70.28
Maharashtra	Weighted mean	3805	3197	3227	3211	2524	2637	3561	3271	2675
	Per cent increase decrease over weighted mean		+19.04	+17.91	+18.52	+50.75	+44.29	+6.85	+16.33	+42.24
Haryana	Weighted mean	7447	6765	6792	4801	NT	NT	NT	5483	4528
	Per cent increase decrease over weighted mean		+10.08	+9.64	+55.11	NT	NT	NT	+35.82	+64.47

Source: ICAR-IIRR, Annual Progress Report 2015, 2016, 2017 & 2018 Vol. 1, Varietal Improvement; NT, not tested in the respective year.

and 26.9% over national, zonal and local checks varieties, respectively. In Maharashtra, IET 25640 recorded mean grain yield of 3805 kg/ha and showed yield advantage of 19.0, 17.9 and 18.5% over national, zonal, and local checks, respectively (Table 2).

Swarna Shakti Dhan shows high response to fertilizer application as compared to checks. Irrespective of the fertilizer dose, it showed mean grain yield of 5017 kg/ha and proved yield advantage over check varieties. There was increase in grain yield of IET 25640 with successive increase in fertilizer doses. However, significant response was noticed up to 120:60:40 kg/ha (N:P:K). Swarna Shakti Dhan is a semi-dwarf (105–110 cm) genotype, which flowers in 85 days and matures in 115–120 days. This genotype has shown non-lodging plant type and produce thick culm. Swarna Shakti Dhan can be successfully grown in direct seeded aerobic condition during 2nd fortnight of June with seed rate 25–30 kg/ha. It also has capacity to withstand moderate

drought at different growth stages of crop. Weeds are one of the major constraints to aerobic rice production. Sequential application of pre-emergence herbicide pendimethalin 30 ec @1.5 kg a.i./ha within 1–2 days of sowing followed by bispyribac sodium 10% sc @20 g a.i./ha at 3–4 leaf stage of weeds between 18–20 DAS is advisable. If required one or two hand/mechanical weeding at 40 and 60 DAS may be done.

Water management

Aerobic rice crop does not require continuous flooding as in case of irrigated transplanted rice. Swarna Shakti Dhan being a multiple stress (drought, disease, and insect pest) tolerant aerobic rice variety does not require more water if rainfall is normal and well distributed. However, in drought, field should be irrigated at critical stages i.e. active tillering, panicle initiation, flowering and grain filling. As compared to transplanted rice, adoption of aerobic rice cultivation

system can successfully save water by 35–40%.

Reaction to major diseases and insect pests

Rice variety Swarna Shakti Dhan (IET 25640) possesses high resistance to sheath blight and moderate resistance to leaf blast, bacterial leaf blight (BLB), neck blast, RTD, brown spot, false smut and sheath rot diseases under natural screening. Under artificial screening, IET 25640 also showed moderate resistance to leaf blast and sheath rot. Swarna Shakti Dhan has shown moderate resistance against major insect-pests under natural conditions, but need based application of insecticides is recommended to manage the insects. For plant protection of Swarna Shakti Dhan, prophylactic sprays of one dose of any systemic insecticide need to be sprayed as and when required. Soil application of carbofuran in case of nematode incidence is necessary. For controlling stem borer, application of thiacloprid 21.7 sc @500 ml/ha

or chlorpyrifos 20 EC @1.2 litre/ha is recommended. To control leaf folder, application of quinalphos 25 EC @1.6 litre/ha or triazophos 40 EC @0.5 litre/ha is recommended. For controlling the termite, seed treatment with chlorpyrifos 20 EC @3.75 litre/100 kg seeds is required or application of chlorpyrifos 20 EC @2.5 litre/ha is recommended.

Quality characters

Quality wise, Swarna Shakti Dhan shows high hulling recovery (76.3%), head rice recovery (63.2%), intermediate amylose content (22.5%) and alkali spreading value (ASV=4.0). IET 25640 has soft GC (65.5 mm) with occasional chalkiness indicating good cooking quality. In addition, grain of Swarna Shakti Dhan also contained high micronutrient i.e. Zinc (23.5 ppm) and Iron (15.1 ppm).

Economic benefit

In water scarce area of Bihar, Jharkhand, Odisha, Haryana, Chhattisgarh, Gujarat and

Maharashtra farmers used to harvest rice during *kharif* and crop yield varied between 3.0–3.5 t/ha. While adopting this variety farmers have a yield advantage of 1.0–1.5 t/ha over their local cultivated cultivars and they get a net benefit of ₹15000–20000/ha/annum. In this regard, this variety is having much importance and potential in improving the livelihood of farm families in water scarce region, where frequent drought is common phenomenon.

SUMMARY

Under changing climate situations, challenge of day by day increasing water scarcity and frequent occurrence of drought has been identified as the key factor to low rice productivity in limited water irrigated and rainfed lowland ecosystems, threatening the food security. Released aerobic rice variety Swarna Shakti Dhan shows significant yield superiority over national (CR Dhan 201), Zonal (CR Dhan 202), and local check varieties. This rice variety also

shows moderate resistance to sheath blight, false smut, leaf blast, bacterial leaf blight, neck blast, brown spot, sheath rot, RTD diseases and stem borer and leaf folder insect pest. As compared to transplanted rice, Swarna Shakti Dhan saves water by 35–40%. In addition, adoption of this variety also increases net income (₹15000–20000/ha) of farmer's over local cultivars. Adoption of high-yielding, good grain and nutrient quality, multiple stresses tolerant, input-responsive aerobic rice variety Swarna Shakti Dhan will play pro-active and decisive role in increasing rice productivity and lead to food security among farm families in the water scarce areas of Bihar, Jharkhand, Odisha, Haryana, Chhattisgarh, Gujarat and Maharashtra.

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Multiple-stress tolerant rice Swarna Samriddhi Dhan for lowland ecosystem of Bihar

A multiple-stress tolerant rice variety Swarna Samriddhi Dhan (IET 24306) developed by ICAR–RCER, Patna was notified and released for cultivation in irrigated as well as rainfed lowland ecosystems of Bihar. Swarna Samriddhi Dhan is a medium duration (135–140 days), high-yielding (5.56.0 tonnes/ha), multiple-stresses (drought, submergence, disease and insect pest) tolerant, lodging resistant with desirable cooking quality traits and long slender grain type. Quality wise, Swarna Samriddhi Dhan possesses 77.8% hulling, 62.0% milling, 55.6% head-rice recovery (HRR) with desirable intermediate alkali spreading value (ASV=7.0), amylose content (24.33%) with long slender grain type. Beside drought tolerant, this variety can also tolerate 810 days submergence.

