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AROMATIC RICE VARIETIES OF ICAR-NRRI

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Citation

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Published by

Director
ICAR-National Rice Research Institute,
Cuttack-753006, Odisha, India

November 2022

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Printed at:

Print-Tech Offset Pvt. Ltd.
Bhubaneswar

Introduction

Aromatic rice varieties have been most sought-after commodity among the farmers as well as the consumers across the world due to their greater economic returns and palatability, respectively. Many aromatic genotypes exist across the world and among them Basmati and Jasmine rice being the most popular in the international trade. Besides, there is a huge diversity of aromatic landraces meeting the taste and specific quality preferences of many consumers across the world which have gained a little notice in the international forum. Short grained aromatic rice of eastern India, popularly known as 'Bhog' rice is one among the few other groups of non-Basmati aromatic rice prevailing in the country and their trade potential is yet to be realized. The short grained aromatic rice prevailing in the North eastern states of India, especially Assam, form a separate group of aromatic rice, called 'Joha' rice. The *Bhog* rice and *Joha* rice are characterized by their short grains (<4mm) and intermediate amylose content of 15-20%. These two groups of aromatic rice are genetically distinct among themselves as well as from the Basmati group of genotypes which are more popular in the North-Western states of the country. They are quite different from Basmati in terms of their physical and biochemical characteristics as well. These groups of genotypes are popular among the people in the area for making several indigenous dishes like *Paysam*, *pulao*, *fried rice*, *khichdi*, *pitha*, *momos*, *thupka*, many breakfast items and even also used in different rituals. The prevailing diversity remained unexplored and started to get replaced by the high yielding varieties in the region until the ICAR-National Rice Research Institute (NRRI) took initiatives for their genetic improvement to overcome the inherent problems of these genotypes.

Being in the Eastern part of the country and bestowed with the huge diversity of short grained aromatic genotypes of diverse groups, ICAR-NRRI took the initiative to develop high yielding varieties of short grained aromatic rice, suiting the quality preferences of eastern and north eastern states of India. The short grained aromatic landraces from the region were found to be low yielders, photosensitive, tall in height, and therefore prone to lodging during maturity. The Institute took the first initiative to explore and collect the existing diversity of the short grained aromatic landraces in the eastern and north-eastern region of the country including Assam, West Bengal, Odisha, Jharkhand and Chattisgarh. The collected diversity was then documented and submitted in the gene bank of NRRI (earlier known as ICAR- Central Rice Research Institute) and duplicated set to the national gene bank of ICAR-National Bureau of Plant Genetic Resources (NBPGR), New Delhi. The collected

landraces were characterized based on the phenotypic descriptors as well as molecular markers (Roy et al. 2014 & 2016). Population structure and their origin were studied through variation in nuclear and chloroplast DNA (Roy et al. 2016). Integration of participatory plant breeding with marker assisted pureline selection helped in better genetic gain from selection in landraces (Roy et al. 2017). Pureline selection in the local popular landraces of short grained aromatic rice led to the development of Nua Kalajeera from Kalajeera, Nua Dhusara from Dhusara and Nua Chinikamini from Chinikamini (Patnaik et al. 2014). The selected pureline varieties could enhance the yield from 1.5 t/ha in the landraces to 3.5t/ha in their corresponding pureline varieties released. The pure line varieties resembled the landraces in the physical and biochemical characters of the grain and therefore have good acceptability among the producers. However, lodging after maturity remained a drawback in these pure line varieties developed from landraces. Efforts to overcome the drawbacks while maintaining the superior quality of the landrace has been initiated at the institute using different breeding approaches and molecular tools. Marker assisted pedigree selection helped to develop high yielding aromatic genotype, CRSugandh Dhan-907 by crossing Pusa 44 and Dubraj (Patnaik et al. 2015). CR Sugandh Dhan-907 is similar to Dubraj landrace in terms of its grain quality. Besides aromatic short grain varieties, long slender grained genotypes with aroma (Poornabhog and Geetanjali) have been developed through mutation of Basmati genotypes. The Geetanjali variety is popular among the farmers and has been used for establishment of rice value chain in Odisha.

Chronological order of development of aromatic varieties by ICAR-NRRI

Sl. No.	Variety	Year of release, CVRC/ SVRC	Breeding method	Pedigree
1	Geetanjali	2005, SVRC, Odisha	Mutation	Basmati-370
2	Keteki joha	2005, SVRC, Odisha	Pedigree	Badshahbhog/ Savitri
3	Nua Dhusara	2008, SVRC, Odisha	Pureline selection	Dhusara landrace
4	Nua Kalajeera	2008, SVRC, Odisha	Pureline selection	Kalajeera landrace
5	Nua Chinikamini	2010, SVRC, Odisha	Pureline selection	Chinikamini landrace
6	Poornabhog	2012, SVRC, Odisha	Mutation	Pusa Basmati-1

7	CR Sugandh Dhan-907	2013, CVRC	Pedigree	Pusa 44 / Dubraj
8	CR Sugandh Dhan-908	2017, CVRC	Pedigree	Swarna / Geetanjali
9	CR Sugandh Dhan-910	2016, SVRC, Odisha	Pedigree	Swarna / Geetanjali
1	CR Sugandh Dhan-909	2018, CVRC	Pedigree	Pankaj/ Podumoni

Variety: **Geetanjali**

IET No.: **IET 17276 (CRM 2007-1)**

Notification No.: S.O.1572(E), 20/09/2006



Year of release	2005 (SVRC Odisha)
Parentage	Basmati-370 Mutant
Duration	120 days
Plant height	110-115 cm
Panicle	Well exerted long panicles (320-361 per m ²)

Ecology	Irrigated transplanted condition
Identified for states	Punjab & Haryana
Yield	4-5 t/ha
Biotic stress tolerance	Resistant to neck blast, gall midge Moderately resistant to leaf blast, brown spot, yellow stem borer
Grain type	Extra-long slender beaked grain, white belly absent (Non- Chalky)
Test grain weight	22-23g
Head rice recovery (%)	56.40
Elongation ratio	1.74
Aroma	Medium scent
Starch parameters	Intermediate amylose content (25.25%), intermediate alkalispreading value (5.0), soft gel consistency (70 mm)
Plant characters	Photo insensitive, semi-dwarf, erect plant type, non-lodging, easythreshability, erect flag leaf till maturity, fertilizer responsive, tolerates late sowing and transplanting

Geetanjali

Geetanjali was developed from Basmati 370 through mutation breeding with the objective to develop high yielding, semi-dwarf, non-lodging Basmati 370 while retaining the exotic quality features of the parent. It was recommended by 39th Rice Workshop as promising in North West region (R2) for the states of Punjab and Haryana in 2003. The entry was however released by SVRC- Orissa as Geetanjali in 2005. In 2006, The variety is semi-dwarf, erect, non-lodging, havewell exerted long panicles with extralong slender beaked grain. It retains the erect flag leaf till maturity. It is a medium duration variety resistant to neck blast, moderately resistant to leaf blast and brown spot. It is also resistant to gall midge and moderately resistant to yellow stem borer. It is fertilizer responsive with easy threshability suitable for normal transplanting and performs well even under late transplanted conditions. It possesses long slender kernel (7.50 mm) with no whitebelly, high HRR (59.56%), intermediate ASV (4.66), intermediate AC (25.36 %), soft GC with strong aroma. The seed rate is 20 kg/ acre and photo insensitive. With increased productivity, non-lodging erect plant type, this Basmati type variety with high HRR combined with desirable quality

characteristics is acceptable to farmers, consumers, and industry. It even retains aroma in high temperature. Isolation for purity maintenance and seed production is possible during off season due to its photo insensitive nature.

Recommended Cultural practices

Soil and climatic conditions:

Wet season:

Irrigated ecosystem with assured irrigation and drainage is required for production of this long grained premium quality aromatic rice. During flowering to maturity period, sunny day, cool night temperature, moderate relative humidity and gentle wind in the evening helps in development of better aroma and quality. The sowing should be so adjusted that the crop flowers with the onset of winter. The wet season crop should only be sold as grain for commercial purposes.

Better make a package of practice table

Dry/ Boro/ Delua seasons (only for seed production, not for grain):

Seed bed preparation:

- Plough the soil 3-4 times at appropriate soil moisture regime for a fine tilth or use rotavator after two ploughings.
- Divide the plots into 1m × 10m size by making drainage channels on all the four sides.
- Cover the seed bed with polyethene tunnel in the boro/dry season.

Seed rate and good quality seed selection:

Seed rate: 30-35kg per ha for sowing in nursery.

Good quality seed selection:

- Prepare salt solution of 1.06 specific gravity by dissolving common salt @ 60g per 1 liter of water.
- Pour the seed into the solution and remove the floating materials.
- Wash the selected seed in fresh water.

Seed treatment:

- To prevent some soil borne diseases occurring during dry sowing, treat the seed with Agrosan G.N., Cerasan (Dry)/Bavistine @ 2G/kg of seed. For wet sowing treat the seed with Streptocycline @1.5/gm + 20 g Captan in

20litre of water for soaking 10 kg of seed, soak for 10hrs, shade dry the treated seed before sowing, drain the water, and cover the seed in gunny bags or under shade, for germination. This protects the variety from sheath blight,blast and bacterial leaf blight.

Sowing and Nursery management:

Wet season:

- Sowing should be done in such a time that the variety flowers in winter in a particular location. One tenth of the main field area should be used for raising nursery.
- Irrigate before seeding to help weeds and rice grains to germinate. Apply FYM, level properly and divide the field to convenient size of beds with channel all around for better water management. Apply fertilizer @ 100kg N, 20kg P₂O₅ and 20 kg K₂O with sufficient FYM compost for one ha nursery for getting healthy seedlings. Broadcast sprouted seeds thin but uniformly on the wet/spongy seed bed so that the sprouted seeds will settle into the soft soil and will be protected from bird damage and heat. Layer of water to be used after the seedlings are about oneinch long above soil. Irrigate in the evenings to avoid water being heated in daytime causing injury to the young seedlings. Apply Carbofuran (Furadan 3G) at fifteen days interval after seed germination. Top dress seven days before transplanting.

Dry/boro/delua seasons:

- November last week to mid-December with above procedures for raising seedlings in the nursery.

Land preparation

- Dry ploughing should be done two times in the summer followed by application of FYM @2t/ha.
- Puddle 2-3 times 3-4 days interval for a fine puddle.
- Level the land with a leveler to maintain uniform water level throughout the plot.
- Apply an incorporate basal fertilizer before laddering.

Transplanting:

Wet season:

- Growing other varieties of similar duration should be avoided to maintain seed purity.

- Seedling root dip (with 0.02% Chloropyriphos solution) before transplanting. Transplant 20-25 days old healthy seedlings (2-3 seedlings per hill).

Random planting: 40-50 hills/m²

Line planting: 20cmX15cm (33 hills/m²) or 15cm × 15cm (44 hills/m²)

Dry/boro/delua season:

- 25-30 days old seedlings, spacing 15 cm X15 cm (44 hills/m²), 2-3 seedlings per hill.

Gap filling

- Early (10-15 days after transplanting) gap filling is desirable. Splitting of existing hills to be used for gap filling.

Fertilizer management

- Apply fertilizer depending on initial fertility status of soil.
- Wet season: 80:40:40:25kg of N:P:K:Zn per ha. Dry/boro/delua season: 90:40:40:25kg of N:P:K:Zn per ha.
- Zinc sulphate should be applied in Zn deficient areas.
- Basal: 40% N, 100%P, 50%K, 100% Zn.
- First top dressing: 30%N, 30-40 days after planting, but 10 days before panicle initiation.
- Second top- dressing: 30% N and 50% K at initial grain filling (early milk) stage.
- Use leaf color chart (LCC) based N application for increased N use efficiency.

Weed management

- Apply pretilachlore (@1.6 litre/ha) herbicides within 4 days of planting in wet season and within 6 days of planting in the dry season. While a thin film of water (2-5cm) cover the plot. Mix the herbicide with 20kg sand/acre or 10kg Urea/acre and broadcast in the field uniformly. Do not drain out water for 48 hours to obtain best results.

Water management

- Drain the field once at the maximum tillering stage for production of higher ear bearing tiller and heavier panicles. After draining water, apply Bipul/ Dhan enzyme at maximum tillering stage to ensure high ear bearing tillers.

Insect pest and disease management

Insect pests:

- Soak the seedlings with 0.02% Chloropyriphos overnight before transplanting. Avoid N application near the panicle initiation (PI) stage unless there is N deficiency symptom. Spray Chloropyriphos @ 2ml per liter of spray solution in the nursery, 15-20 days after planting and at the boot leaf stage. Use granular systemic insecticide (carbofuran@30kg/ha) for control of stem borer and leaf folder. For Gundhibug control, dusting of methyl parathion @20kg/ha is recommended.

Diseases:

- Brownspot aggravates under potash deficiency and responds well to potash application. Apply 50%K as basal dose and 50%K 10 days before panicle initiation/ as soon as brownspot appears. Sheath blight appears after PI and is more serious at boot leaf and flowering stage. Avoid N application near PI stage unless there is a Nitrogen starvation symptom. Validamycin, Tilt or any other recommended fungicide @ 2.5ml/L at the appearance of the disease symptoms or spray solution immediately after first top dressing. Bacterial leaf blight and Bacterial leafstreak are serious when high dose of N fertilizer is applied near the PI stage. Avoid application of N fertilizer near PI stage. Apply streptocyclin @ 1.5g + CuOCl 10g in ten liters of water just at the appearance of the disease symptoms. 500litres of solution is required for spraying 1ha of crop area.

Harvesting, drying and milling

- Gradually reduce the water level 10 days before harvesting leading to complete drying of the plot at the time of harvesting at 33 to 35 days after 50% flowering. Dry the harvested paddy in shade to bring at 12% moisture for seed purpose and 14% moisture for consumption and selling purposes. Milling should be done in rubberized sheller to get high head rice recovery.

Cropping system

- After the wet season, the farmers may grow wheat, potato, mustard, and other winter crops with the residual moisture since harvesting is completed by October end.

Variety: **Ketekijoha**
IET No.: **IET 18669**
Notification No.: S.O.1572(E), 20/09/2006



Year of release	2005,SVRC Odisha
Parentage	Badshahbhog/Savitri
Duration	145-150 days
Plant height	130 cm
Panicle	Dense (356 panicles/m ²), fully exerted, long, non-shattering panicle, short awn occasionally present
Ecology	Favourable rainfed lowland in Kharif
Identified for states	Odisha
Yield	3.5-4.0 t/ha
Biotic stress tolerance	Moderate resistant to sheath blight, bacterial leaf blight Moderate resistant to stem borer and gall midge, highly tolerant to storage pests
Grain type	Medium slender grain with translucent rice without chalkiness

Test grain weight	15.12 g
Head rice recovery (%)	63.3
Elongation ratio	1.67
Aroma	Medium scent
Starch parameters	Intermediate amylose content (20.33 %), high alkali spreading value (6.5), medium hard gel consistency (40 mm)
Plant characters	Photosensitive, medium tall and erect plant type, non-lodging, responds to fertilizer up to 80:40:40 Kg. N:P:K respectively. performs well under organic farming, tolerates submergence

Ketekijoha

Aromatic Rice variety Ketekijoha was developed through hybridization of Badshahbhog and Savitri. The variety was released in 2005 by the SVRC Odisha and notified by CVRC during 2006. This photosensitive variety, with aromatic medium slender translucent grain without chalkiness is suitable for cultivation during the wet season in shallow rainfed lowlands of Orissa in wet season.

It is having semi-tall (130 cm), non-lodging and erect plant type, matures in 145-150 days with high head rice recovery (63.3%) and is tolerant to bacterial blight, sheath blight, stem borer and gall midge. The grain quality is well accepted by consumers, millers and farmers. The kernel length is 4.98 mm, Kernel breadth-1.70 mm, Kernel length after cooking-8.3mm, Elongation Ratio-1.67, Head Rice Recovery 63.3%, Volume Expansion Ratio-5.3, Water uptake-190ml, Alkali spreading value 6.5, Amylose content 20.33 %, GC- 40 -with excellent eating and cooking qualities. The variety is used as quality check in the ASG trials of AICRIP.

Recommended cultural practices

Seed Selection and seed rate

- Prepare salt solution of 1.06 specific gravity (dissolve 60 grams of common salt in one liter of water).
- Pour the seed and remove the floating materials.
- Wash the selected seed in fresh water.
- Seed rate: 25-30 kg/ha for sowing in the nursery.

Seed treatment

- Dry sowing: Treat the seed with Bavistin@2g/kg of seed.
- Wet sowing: Treat the seed with Streptocycline@1.5 g+20gm captan in 20 liters of water sufficient for 10 kg of seed for 8-10 hours and after soaking drain the water. Shade dry treated seed before sowing and cover the seed in gunny bags or under shade for germination.

Sowing time

- For direct seedling in nursery: The optimal time is from the 2nd for night of June.

Land preparation

- Dry plough 3 weeks before transplanting and submerge the field with 5-10cm of standing water.
- Puddle the field twice. Give a gap of at least 7-8 days between initial and final puddling for better weed control and nutrient availability.
- Apply and incorporate basal fertilizer dose before laddering.
- Level the land with a leveler to maintain uniform water level throughout the field.

Transplanting

- Crops of similar duration should be avoided to maintain seed purity.
- Normal planting: Use of 25-30 days old seedling is better for seedling establishment.
- For late planting (up to last week of August): 40- 50 days old seedling.
- In case of delayed planting, practice closer spacing and increase the number of seedlings from 2-3 to 5-6 per hill.
- Seedling root dipping in 0.2% chloropyrifos overnight before planting helps in controlling rice whorl maggot, stem borer etc. Alternatively apply carbofuran granules 5-7 days before pulling out the seedlings.

Spacing

- Row planting: 44 hills/m², at a spacing of 15cm × 15cm, with 2 to 3 seedlings per hill.
- Random planting: 40-50 hills/ m² with 2 to 3 seedlings per hill.

Gap filling

- Early gap filling is desirable. Splitting of existing hills to be used for gap filling.

Fertilizer management

- For growing the crop organically apply FYM@10t/ha + Dhaincha (seed@ 8 kg/ha and incorporate at 45 days). This variety yield more than 3.5t/ha under organic management.
- Apply NPK@60:30:40 kg/ha. Soil test based fertilizer application especially for P and K is preferred over blanket dose.
- Apply half of total N (30 kg), entire amount of P(30kg) and two third of K (20 kg) as basal after draining out the standing water but before final puddling. Top dress the remaining N (30 kg) in two equal splits each at 3 weeks after transplanting and at panicle initiation. Also apply remaining one third of K (20 kg) at panicle initiation.
- The field should be drain prior to top dressing with nitrogen and irrigated after 24-36 hours.
- Apply Zn @25 kg /ha in zinc deficient soils.
- Use leaf colour chart(LCC)for adjustment in the N dose.

Weed management

- Apply Pretilachlore @ 1.6 lt /ha at 3-5 DAT to suppress grassy weeds and sedges at beginning.
- Use cone weeder for weeding in row planted crop.
- Hand – weeding twice or thrice at three, six and nine weeks after planting depending upon the weed problem.

Insect-pest management

- The insects with potential to threaten the crop are stem borer,case worm,leaf folder and gundhibug.
- On observing the symptom, spray chlorpyrifos@2ml/ltr of spray solution, 15-20 days after plating and at the boot leaf stage.
- For Gundhibug dusting of Methyl Parathion at 20kg/ha.

Disease management

- To control bacterial blight, avoid application of N fertilizer near panicle

initiation (PI) stage. Apply streptocycline @ 1.5 gm + copper oxychloride @ 10 gm in 10 lts of water just after noticing the appearance of disease symptoms (500 lts of solution/ha).

- For leaf blast adopt seed dressing with carbendazim(bavistin 50 WP@ 4g/kg seed) to control leaf blast. At pre-tillering to mid- tillering (2-5 % disease severity) apply ediphenphos 35 EC (1ml/l) or carbendiazim 50 WP @0.1 % (1gm/l) twice at an interval of 7 days.
- For control of sheath blight spray Validamycin @ 2.5 ml/lt or any other recommended fungicide just at the appearance of disease symptoms (500 lts of solution/ha).

Harvesting, Drying, Milling and Cooking

- Harvest 30-35 days after flowering when stalks remain green to avoid grain shattering. Moisture content of paddy should be 20-24 % harvest.
- Thresh immediately after harvest and shade dry gradually up to 12% moisture content for seed purpose and 14% for milling.
- Can be milled in traditional huller but fetch higher price if milled in rubberized sheller.

Cropping System

- After harvest in the first week of December, green gram can be grown with the residual moisture.

Variety: **Nua Dhusara**

IET No.: **IET 18395**

Notification No. S.O. 2458(E), 16/10/2008





Year of release	SVRC, 2008
Parentage	Pureline selection of Landrace Dhusara from Orissa
Duration	145-150 days
Plant height	142 cm
Panicle	Dense and fully exerted long panicle with high number of grains per panicle and non-shattering grains
Ecology	Favourable rainfed lowland and irrigated late condition during <i>kharif</i> season.
Identified for states	Odisha
Yield	3.0-3.3t/ha
Biotic stress tolerance	Resistant to neck blast, sheath rot and RTV Moderately resistant to gall midge
Grain type	Short bold grains
Test grain weight	10.46g
Head rice recovery (%)	67.7
Elongation ratio	2.05
Aroma	Medium scent
Starch parameters	Intermediate amylose content (22.32%), intermediate alkali spreading value (5.0), soft gel consistency (62mm)
Plant characters	Photosensitive, medium tall plant type with thick culm, lodging prone, low responsiveness to fertilizer (NPK-60:40:40), performs higher under organic nutrient management, tolerates flooding for short period (3-4 days)

Nua Dhusara

Nua Dhusara was developed from landrace Dhusara from Orissa through pure line selection. It is a photosensitive, medium tall variety with dense and fully exerted long panicle. It has short medium straw-colored grain with aroma. It is a late maturing variety (145-150 days) suitable for Kharif season only. The variety possess medium tall plant type, is lodging prone, have thick productive culm, with short medium type grain, straw color husk, long panicle with high number of grains/ panicles. When planted timely the variety flowers during 1st week of November. It is resistance to neck blast, sheath rot and rice tungro virus. It is also moderately resistant to gall midge. No significant damage was noticed under field condition from any other pest and disease.

Nua Dhusara is photosensitive variety with long and heavy panicles with non-shattering grains with high head rice recovery, no grain chalkiness (translucent kernel), high elongation ratio (>2), soft GC and aroma. It is less responsive to fertilizer application (NPK-60:40:40) but yields higher under organic nutrient management. It is a late maturity variety and possess productive plant type with thick culm but prone to lodging.

The variety has to be grown with close spacing, > 50 hills/m², need less water during grain maturity, harvesting to be done 35 days after 50% flowering and need isolation from non-aromatic varieties of same duration. Favourable rain fed lowland and irrigated late conditions are suitable for the variety. It has the potential to cover area of favorable rain fed lowlands of coastal Orissa during *kharif* season. Popular with farmers of coastal districts of Orissa and Keonjhar who have widely accepted this variety due to its improved yield, medium grain, high HRR, translucent kernel with strong aroma, excellent cooking and eating quality, and high economic returns due to its high sale value and easy marketability.

Variety: **NuaKalajeera**
IET No.: **IET 18393**
Notification No.: S.O. 2458(E), 16/10/2008



Year of release	2008 (SVRC Odisha), jointly by ICAR-NRRI and OUAT
Parentage	Pureline selection of Kalajeera Landrace
Duration	145-150 days
Plant height	140 cm (tall), prone to lodging, Low fertilizer response to Nmanagement
Panicle	Long and dense panicle (29 cm) fully exerted long panicle
Ecology	Wet season in shallow rainfed lowlands of Orissa
Identified for states	Odisha
Yield	3000-3300 kg/ha, 3.2 t/ha
Biotic stress tolerance	Moderately susceptible to sheath blight, bacterial leaf blight, stemborer, plant hopper, gall midge Moderately resistant to leaf blast, sheath rot Resistant to rice tungro virus
Grain type	Short bold, black hulled grain but deep purple during flowering initiation, white kernel, abdominal white is absent

Test grain weight	12.73g
Head rice recovery (%)	61
Elongation ratio	2.01
Aroma	Medium scent
Starch parameters	Intermediate amylose content 22.58%, intermediate alkali spreading value (4.7), intermediate gel consistency (58 mm)
Plant characters	Photosensitive, tall, lodging prone, easy threshability, low fertilizer response to N management, performs well under organic nutrient management, field tolerance to submergence

NuaKalajeera

Aromatic short grain Rice variety NuaKalajeera (IET18393) was developed through pureline selection from the popular land race Kalajeera by the Central Rice Research Institute (Indian Council of Agricultural Research), Cuttack and was released jointly with the Department of Plant Breeding & Genetics, Odisha University of Agriculture and Technology, Bhubaneswar, through Orissa State Sub-committee on Crop standards, Notification and Release of Variety and was Notified during 2008. This photosensitive variety is suitable for cultivation during the wet season in shallow rainfed lowlands of Orissa. It has tall plant type (140 cm), long and dense panicle (29 cm) and short bold black hulled spikelets and matures in 145-150 days. During national multi-location testing (2003-2005) it gave a mean yield of 3.2 t/ha. It is resistant to RTV and moderately resistant to leaf blast and sheath rot. This popular short grain aromatic rice variety is well accepted by consumer, miller and farmer due to the desirable grain quality features. This variety has Kernel length-3.95 mm, kernel breadth-2.12 mm, kernel length after cooking- 8.0mm, elongation ratio-2.01, high head rice recovery (61%), Volume expansion ratio-5.3, water uptake- 187ml, alkali spreading value 5.0, amylose content 22.58%, GC- 58 mm with strong aroma. NuaKalajeera is popular and well accepted in many districts of Odisha for its excellent eating and cooking qualities, aroma and absence of chalkiness.

Recommended cultural practice

The optimal sowing time for direct seeding in nursery is from the 2nd fortnight of June. For growing the crop organically apply FYM @10 t/ha + Sesbania aculeata (seed @ 8 kg/ha and incorporate at 40 days). This variety yields more

than 3.5 t/ha under organic management. Apply NPK @ 40:20:20 kg/ha. Soil test-based fertilizer application especially for P and K is preferred over blanket dose. Apply half of total N (20 kg), entire amount of P (20 kg) and half of K (10kg) as basal after draining out the standing water but before final puddling. Top dress the remaining N in two equal splits (10 kg) each at 3 weeks after transplanting and at panicle initiation. Also apply remaining half of K (10 kg) at panicle initiation. The field should be drained prior to top dressing with nitrogen and irrigated after 24-36 hours. Apply Zn @ 25 kg/ha in zinc deficient soils. Harvest 30-35 days after 50% flowering, when stalks remain green to avoid grain shattering. Moisture content of paddy should be 20-24% at harvest. Thresh immediately after harvest and shade dry gradually up to 12% moisture content for seed purpose and 14% for milling. After harvest in the first week of December, green gram can be grown with the residual moisture.

Variety: **NuaChinikamini**
IET No. **IET 18394 (CR 2580)**
Notification No. S.O.632(E), 25/03/2011



Year of release	2010 (SVRC, Odisha)
Parentage	Pure line selection of landrace Chinikamini from Odisha
Duration	145-150 days
Plant height	140cm
Panicle	Compact and fully exerted long panicle with high number of grains per panicle with non-shattering habit and easy threshability
Ecology	Favorable rainfed lowland and Irrigated late condition. Recommended for <i>kharif</i> season only
Identified for states	Odisha
Yield	3.2-3.5t/ha
Biotic stress tolerance	Resistant to neck blast, sheath rot, RTV Moderately resistant to brown spot, Leaf blast Resistant to Gall midge and moderately resistant to shoot borer
Grain type	Short bold grain
Test grain weight	11.37g
Head rice recovery (%)	66.5
Elongation ratio	2.01
Aroma	Strong scent
Starch parameters	Intermediate amylose content (23.86%), intermediate alkali spreading value (5.0) and medium gel consistency (57.66 mm)
Plant characters	Photosensitive, uniform, productive plant type with thick culm

NuaChinikamini

NuaChinikamini was developed from the landrace Chinikamini from Orissa through pure line selection with an objective to select for productive uniform plant type with good morphological features and uniform grain type combined with desirable grain quality traits and aroma. The variety is photosensitive, tall, uniform, productive plant type with thick culm, long and compact fully exerted long panicles with non-shattering habit, easy threshability with uniform short bold, straw color grain with aroma. It possesses a high head rice recovery on milling, kernel with high elongation ratio (>2), intermediate amylose and GC

besides strong aroma. It is resistant to neck blast, sheath rot, rice tungro virus, and moderately resistant to brown spot and leaf blast. It is also resistant to gall midge and moderately tolerant to stem borer. No significant damage was noticed under field condition from any other pest, disease, and other abiotic stress.

NuaChinikamini is a late maturing variety recommended for Kharif season only. It is favorable for rainfed lowland and irrigated late condition. Standard seed production practices should be followed with isolation from rice varieties of same duration. The variety has potential to spread in areas of favorable rainfed shallow lowlands and irrigated late condition of Orissa during Kharif season only. It is popular with farmers of Orissa who have widely accepted this variety for its high economic returns due to yield improvement, high head rice recovery during milling, high sale value of rice and easy marketability. The variety fetches higher profitability to the miller. Presence of aroma with excellent cooking and eating quality contributes to consumer acceptability.

Variety: Poorna Bhog or CR Basna Dhan-902

IET No.: IET 18008 (CRM-2203-4)

Notification No. S.O. 10/04/2012



Year of release	2012(SVRC Odisha)
Parentage	Mutant of Pusa Basmati-1
Duration	140-145 days
Plant height	100 cm
Panicle	Compact long full exerted panicles (351 per m ²)
Ecology	Rainfed shallow lowland and irrigated late ecosystem under transplanting conditions.
Identified for states	Odisha
Yield	4.5-5.0 t/ha
Biotic stress tolerance	Resistant to neck blast, gall midge Moderately resistant to sheath rot, stem Borer.
Grain type	Long slender grain
Test grain weight	19.0g
Head rice recovery (%)	68.8
Elongation ratio	1.76
Aroma	Medium scent
Starch parameters	Intermediate amylose (23.81%), high alkali spreading value (7.0) and medium gel consistency (46mm)
Plant characters	Photo insensitive, semi dwarf, non lodging, erect leaf type, dark green leaf, erect flag leaf, awnless.

Poorna Bhog

Poorna Bhog was developed from Pusa Basmati-1, a semidwarf, high yielding popular Basmati variety through mutation breeding. It is a photoinensitive, late maturing (140-145 days) variety which can be grown in both seasons. It is a semidwarf, erect, non-lodging, good tillering plant type with dark green leaf, long slender grain, erect flag leaf, long panicles, non-shattering habit, and easy threshability. It is resistant to neck blast and moderately resistant to sheath rot. It is also resistant to gall midge biotype-3 and moderately resistant to stem borer. No major damage due to abiotic stress was observed. Seed rate of 40 kg/ha is recommended for the variety. It is recommended for rainfed shallow lowland and irrigated late ecosystem under transplanted conditions.

This aromatic long slender variety possesses desirable grain qualities like high HRR, intermediate amylose and soft GC with no grain chalkiness. Combination

of high yield, excellent grain quality and presence of aroma makes this variety suitable to be considered as premium grade rice to fetch high return in the market for augmenting farm income. Therefore, this variety can be adopted by the farmers of the state and promoted by appropriate agencies. Farmer of Odisha thus will have the choice of cultivating a premium grade aromatic variety with better yield. The rice is easily marketable and commands premium price. The long slender aromatic rice with intermediate amylose, desirable GC, combined with aroma contributes to consumer's acceptability. High head rice recovery, high market value of rice and easy marketability after milling is expected to fetch higher profitability to the millers also.

Purity of seed must be maintained through rouging, isolation during seed production and avoiding threshing floor contamination so as not to lose grain quality and aroma. Sowing in wet season to be adjusted for crop to flower in winter for better quality and aroma. Drainage of excess of water during ripening and shade drying for gradual reduction of moisture is recommended. As it is a long slender quality rice, milling in a rubberized sheller will lead to lesser breakage of grains and HRR will be high. The grain produced during wet season should be used for consumption. Production can be done during dry season for seed purpose only.

Variety: CR Sugandh Dhan-907

IET No.: IET 21044 (CR 2616-3-3-3-1)

Notification No.: S.O. 2817 (E), 19.09.2013





Year of release	2013, CVRC
Parentage	Pusa 44 / Dubraj
Duration	152 days
Plant height	95 cm
Panicle	Fully exerted compact (273 per m ²) panicle
Ecology	Favorable lowlands and irrigated late condition. Suitable for both high and low fertility
Identified for states	Chhattisgarh, Odisha, Gujarat and Andhra Pradesh
Yield	4.0-4.2 t/ha
Biotic stress tolerance	Resistant to Stem borer Moderately resistant to leaf blast, neck blast brown spot and sheath rot, leaf folder
Grain type	Medium slender, white translucent grain
Test grain weight	18.7 g
Head rice recovery (%)	63.7
Elongation ratio	1.85
Aroma	Medium scent
Starch parameters	Intermediate amylose content (24.3%), intermediate alkali spreading value (4.5), hard gel consistency (22)
Plant characters	Semi dwarf, nonlodging, dark green leaf, erect flag leaf, awn is present

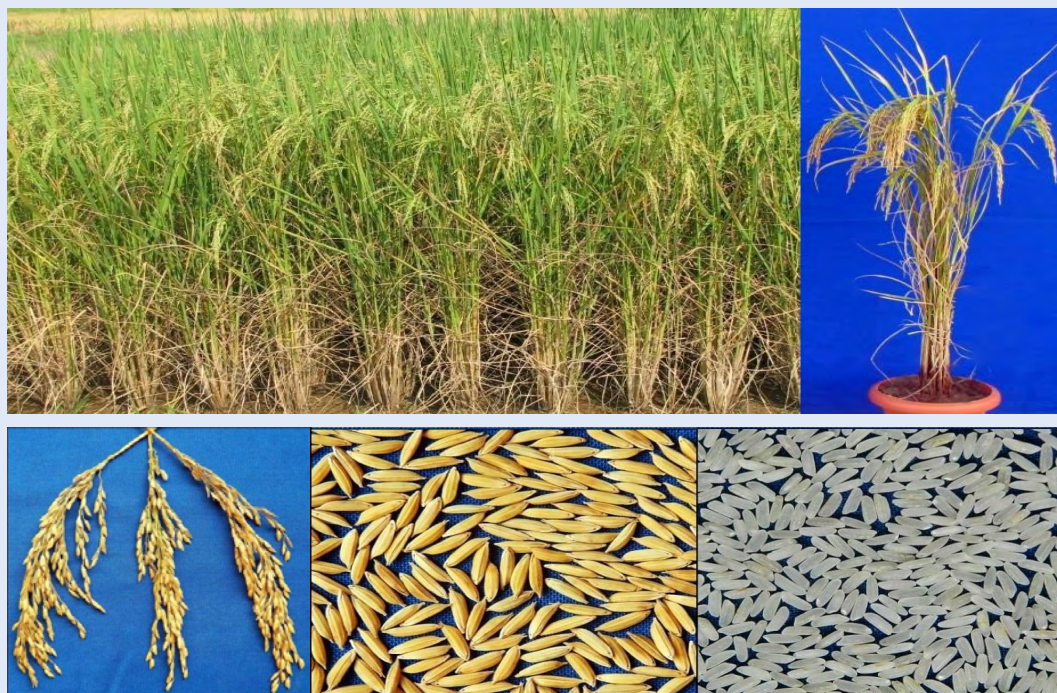
CR Sugandh Dhan-907

CR Sugandh Dhan-907 is the first semi dwarf, short grain aromatic rice variety with high yield and wide adaptability released in India at central level (for three

zones) that can greatly help in enhancing the income of the farmers. CR Sugandh Dhan-907 is a high yielding short grain aromatic variety with semi dwarf stature, erect flag leaf, dark green leaf with awned grains. It was developed with an objective to replace Dubraj (an awned aromatic genotype), the most popular aromatic landrace of MP and Chhattisgarh. This semi dwarf variety was derived from the cross, Dubraj \times Pusa 44. It is a non-lodging variety and responds well to high dose of nitrogen application and possesses grain quality traits similar to popular variety Dubraj. It has a medium slender (MS) grain with high HRR (62%), good kernel elongation after cooking, intermediate amylose (23.38%) and ASV (score 4) and pleasant aroma. It recorded convincing yield superiority of 30.8%, 38.1% and 7.1% over Badshahbhog, Kalanamak and local check respectively in all India trials. It responded well up to 150% of RDN and also found to be promising at 50% of RDN with a mean maximum grain yield of 4.20 t/ha. (DRR Annual Progress Report 2011, Vol.3 – Agronomy, pp-4.2). It has a mean flowering duration of 122 days and matures in 150-152 days. With medium slender grains it showed best milling and cooking quality traits. It has moderate resistance to leaf blast, neck blast, brown spot and sheath rot. It is also moderately resistant to Leaf folder and resistant to stem borer under the natural condition. No damage was observed against abiotic stresses related to the ecology where the variety can be grown. The variety was released by CVRC and identified for the states of Chhattisgarh, Odisha, Gujarat and Andhra Pradesh.

This high yielding aromatic culture with a non-lodging semi dwarf plant type and excellent grain quality traits is highly acceptable to the farmers. Presence of aroma with excellent grain quality traits contributes to high consumer acceptability. High head rice recovery, short slender aromatic rice assists in easy marketability and fetches higher profitability to the miller. Standard seed production practices like time isolation and rouging of mixture is to be followed to maintain the seed purity.

Variety:CR Sugandh Dhan **908**
IET No.: **IET 23189 (CR 2713-35)**
Notification No. S. O. 2805 (E)25.08.2017



Year of release	2017, CVRC
Parentage	Swarna /Geetanjali
Duration	143-148 days
Plant height	92-96 cm
Panicle	Compact panicle (250-290 per m ²)
Ecology	Irrigated ecology during kharif season, Suitable for both high and low fertility
Identified for states	Odisha, West Bengal, Uttar Pradesh, Assam and Maharashtra
Yield	4.2-5.2 t/ha
Biotic stress tolerance	Moderately resistant to bacterial leaf blight, leaf blast, neckblast, brown spot and stem borer, leaf folder and WBPH
Grain type	Medium slender grains, no kernel chalkiness, white kernel, lightbrown husk colour

Test grain weight	17.4g
Head rice recovery (%)	63.8
Elongation ratio	1.61
Aroma	Strong scent
Starch parameters	Intermediate amylose content (24.3 %) , intermediate alkali spreading value (4.5), medium gel consistency (56.7)
Plant characters	Semi dwarf, non lodging, erect plant type, erect flag leaf

CR Sugandh Dhan 908

CR Sugandh Dhan 908 was developed through hybridization of Swarna and long slender aromatic rice variety Geetanjali (a mutant of Basmati 370). The variety was developed with an objective to combine the high yield of mega variety Swarna and the excellent grain quality traits of Geetanjali, a basmati type variety. Selection was carried out to identify semi-dwarf non-lodging nitrogen responsive plant type with medium slender aromatic grain possessing good eating and cooking qualities. It has shown superior yield than the check varieties in multi-location trials during 2012-2014 and was found promising in the states of Odisha, West Bengal, Bihar, Chhattisgarh, UP, Assam under Zone III (4531 kg/ha) and Maharashtra under Zone IV (3752), with an overall mean grain yield of 4168 kg/ha. The frequency in top three positions for grain yield of this promising variety across the states of Odisha, West Bengal, Bihar, Chhattisgarh, UP, Assam and Maharashtra was the highest (26) as compared to national, regional, local check and the other qualifying entries.

The maturity duration is 143-148 days and the plant type is semi-dwarf and erect with good number (250-290/ m²) of compact type of panicles. It takes 115-118 days to 50% flowering. It is moderately resistant to bacterial leaf blight, leaf blast, neck blast, brown spot and stem borer, leaf folder and WBPH. In the N response trial, the variety responded well up to 100 Kg of N and found to yield in low nitrogen level with maximum mean grain yield of 6.21 t/ha and ranked overall first in the trial (Draft Proceedings of 51st Annual Rice Research Group Meetings, 2016 Page 68). The medium slender grain of the variety has a test weight of 17.4g with no kernel chalkiness, has high HRR (63.8%). It possesses soft GC, intermediate amylose content and ASV. The variety with its high yield combined with superior quality aromatic rice, will fetch a premium market value to the farmers. It was identified for release under irrigated ecology in the

states Odisha, West Bengal, Uttar Pradesh, Assam and Maharashtra. It is also suitable both for high and low fertility. Standard seed production practices like time isolation, rouging of field mixture and avoiding threshing floor mixtures should be followed. This high yielding aromatic culture with a non-lodging semi dwarf plant type and excellent grain quality traits is expected to be highly acceptable to the farmers, consumers, and industry.

Variety: **CR Sugandh Dhan910**
 IET No.: **IET 22649 (CR 2713-180)**
 Notification No.: S.O.399 (E), 24-01-2018



Year of release	2016 (SVRC, Odisha)
Parentage	Swarna / Geetanjali
Duration	142-145 days
Plant height	101 cm
Panicle	Compact (263-277/ m ²) panicle
Ecology	Irrigated late and favorable lowlands for kharif / wet season

Identified for states	Odisha
Yield	3.5-4.2t/ha
Biotic stress tolerance	Moderately resistant to blast, neck blast, sheath rot and RTV Moderately resistant to stem borer, leaf folder and WBPH
Grain type	Medium slender grain, straw coloured husk and white kernel
Test grain weight	17.3g
Head rice recovery (%)	68.8
Elongation ratio	1.68
Aroma	Strong scent
Starch parameters	Intermediate amylose content (24.3%), intermediate alkali spreading value (4.0), soft gel consistency (62 mm)
Plant characters	Non lodging, semi dwarf and erect plant type with erect dark green flag leaf

CR Sugandh Dhan910

CR Sugandh Dhan910 (CR 2713-180)(IET 22649) was developed through hybridization of Swarna and Geetanjali, a basmati type variety with long slender grains with pleasant aroma. The variety was developed with an objective to combine the high yield of Swarna, a mega variety and the excellent grain quality traits of Geetanjali, to develop aromatic variety with medium slender kernels. Selection was carried out to identify semi-dwarf, non-lodging, nitrogen responsive plant type with medium slender aromatic grain with good eating and cooking qualities.

CR 2713-180 has entered the Coordinated testing programme as IET 22649 during WS 2012 (IVT- ASG). It has consistently shown superior yield over the check varieties in the multi-location trials during the testing period (2012-2014) and was found to be promising in Odisha, West Bengal, Bihar, Chhattisgarh, UP, Assam under Zone III (4437 kg/ha) with an overall mean grain yield of 3782 kg/ha. In Odisha, average grain yield was 4385 kg/ha over three years. The maturity duration of the variety is 142-145 days and the plant type is semi-dwarf. The variety has good number (263-277/ m²) of compact type of panicles. It is moderately resistant to blast, neck blast, sheath rot, RTV, stem borer, leaf folder and WBPH. In the fertilizer response trial, IET 22649 gave a mean maximum grain yields of 4.8t/ha with superiority over the checks

and qualifying varieties. The variety responded well to higher dose (180 kg) of fertilizer application. The medium slender grains of the variety has a test weight of 17.3g with no kernel chalkiness and has high HRR (68.8%). It possesses soft GC, intermediate amylose content and ASV. The proposed variety with its high yield combined with superior grain quality and aroma, is expected to fetch a premium market value to the farmers. This variety with wider adaptability has been released by Odisha state as CR Sugandh Dhan 910. The variety is also used as local check in ASG trials of AICRIP due to its superior yield.

Variety: **CR Dhan 909**

IET No.: **IET 23193 (CRL 74-89-2-4-1)**

Notification No.: S.O.399 (E), 24-01-2018



Year of release	2018, CVRC
Parentage	Pankaj/Podumoni
Duration	140 days
Plant height	105-110 cm

Panicle	Compact and well exerted
Ecology	Irrigated late
Identified for states	Assam, Bihar, UP, Maharastra
Yield	5.0 t/ha
Biotic stress tolerance	Moderately resistant to blast, neck blast, bacterial leaf blight, and brown spot, moderately resistant to stem borer, leaf folder and WBPH
Grain type	Medium slender grain, straw coloured husk and white kernel
Test grain weight	23.5
Head rice recovery (%)	70.0%
Elongation ratio	1.63
Aroma	Strong scent
Starch parameters	ASV 7.0, intermediate amylose content (24.02), GC (47 mm)
Plant characters	Semi dwarf in stature, non-lodging, sturdy culm, moderate tillering, well exerted compact panicle, medium slender grain, kernel length 5.80 mm, kernel breadth 2.19 mm, L/B 2.65, white kernel with strong aroma

CR Dhan 909

CR Dhan 909 (CRL74-89-2-4-1) was developed from the cross Pankaj/ Padumoni by pedigree method of selection. Hybridization, selection, evaluation, and testing was done at the Regional Rainfed Lowland Rice Research Station of ICAR- National Rice Research Institute, Gerua, Assam. It was nominated to Initial Variety Trial- Aromatic Short Grain of AICRIP during kharif 2012 wherein this culture was tested as IET No. 23193 from 2012 to 2014.

During all the testing years in AICRIP, IET 23193 has recorded consistently superior performance by not only outyielding national, regional and local checks but also other entries of the trials with an impressive yield margin in states of **Assam, Bihar, Uttar Pradesh and Maharashtra** during all three years of testing (2012-2014) and was further released for these states vide Notification No.: S.O.399 (E), 24-01-2018, under irrigated condition. The genotype recorded an overall mean grain yield of 4453 kg/ha (averaged over three years for all the above mentioned 10 states) and surpassed the Badshabhog (national check),

Kalanamak (regional check) and local check with an impressive yield margin of 51.77%, 53.76% and 27.74% respectively.

It also maintained a yield superiority over all the checks in all the years and occupied place among top ranking entries 50 times out of 54. In region wise performance, IET 23193 recorded outstanding performance in region 3 and 4 by registering yield gain of 31.8% and 19.71% over the best check (LC) respectively. It ranked among top entries 30 times out of 32 in region 3 and 11 times out of 11 in region 4. In state wise performance, IET 23193 recorded yield gain of 20.78% in Uttar Pradesh, 57.37% in Bihar, 22.6% in West Bengal, 53.43% in Assam and 19.71% in Maharashtra in Western region (R-4).

As compared to the checks and qualifying varieties, the genotype was found to response higher dose of fertilizer application.

The entry was tolerant to leaf blast, neck blast, sheath rot and RTD. It recorded moderately tolerant score (2.3) against stem borer (dead heart as well as white ear head), leaf folder (2.0) and whorl maggot (3.0) under natural screening.

It has high Head Rice Recovery of 70.0%, intermediate amylose content (24.02%) with medium GC (47 mm). It has medium slender grains with strong aroma and alkali spreading value (ASV) of 7.0 and therefore may be considered as excellent in terms of quality parameters.

Future prospects of aromatic rice breeding at ICAR-NRRI

The institute has been working towards development of high yielding short grained aromatic varieties. Efforts have been initiated towards reducing the plant height while increasing the yield and maintaining the superior quality using different breeding techniques assisted with molecular markers and genomics assisted tools. Reducing the plant height and maturity duration while maintaining the aroma will remain a major focus for the coming decades at the institute. Biotic stress tolerance will be simultaneously considered while breeding for aromatic varieties as blast, bacterial blight, stem borer, gall midge causes significant crop losses in these premium quality varieties. Speed breeding techniques need to be incorporated in the program to reduce the time of breeding for varieties. High throughput genotyping and phenotyping facility will lead towards precision breeding with least effect of the background.

India's success story of aromatic rice breeding remains limited with basmati rice. The mega basmati varieties like Pusa Basmati 1 and Pusa 1121 manifolds enhanced the export potential of Indian Basmati and have now reached a peak which needs to be sustained further. However, short grain aromatic rice

is also gaining attention now and breeding efforts along with national level initiative for popularization, market assessment and product profiling needs special impetus. Due to lack of organized markets, differential price fixation for different grades and qualities of rice, awareness about genuine rice samples of specific variety and availability of their authentic seeds, low yields, and yield losses are some major bottlenecks to popularize ASG rice among the farmers. These landraces are cultivated in small pockets, huge diversity prevails across smaller geographical area, multiple variants exist in same name and all of these make it difficult to formulate policies for their better marketing. This has led to a vicious circle among the growers, traders, and policy makers, leading to accelerated loss of cultivation area under ASG and extinction of these varieties from farmers' fields. There is need of developing high yielding genotypes in ASG category with yield levels like other varieties but quality wise similar or better than the most popular landraces and further promote cluster production to ensure bulk production suitable for marketing and export.

To increase the area under Aromatic short grain rice varieties, they may be promoted through creation of "Aroma villages" having all supportive infrastructure and support integrated with availability of pure seed in seed chain. Thrust has to be given on export since growth in export would lead to increase in domestic trade and income augmentation of farmers (like the tie up between Orissa Govt. and NAFED to procure process and market this high value aromatic short grain rice Kalajeera from farmers).

Efficient seed production technology may be developed for availability of quality seed for popularization as well as commercial use of short grain aromatic rice for their commercialization. To maintain the unique quality characters of these aromatic rice, use of traditional short grain aromatic rice as one of the parents should be made mandatory during a varietal development program, as it is practiced for development of Basmati variety.

Effort should be made to incorporate Bacterial blight resistance gene in to the high yielding ASG through MAS so that they can yield better in endemic areas.

Research efforts should be made to develop implementable cultivation practices for organic farming and its effect on quality

Overall, there is huge scope of improvement in performance of these genotypes in all aspects. Aromatic short, grained genotypes cater a huge set of diversity for its improvement. Working out the variety specific cultural practices, economic returns and market dynamics of the short grained aromatic varieties will be useful to formulate better marketing strategy for them.

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