

An appraisal of ICAR-IISR released varieties in spices

This study evaluates the performance of ICAR-IISR released spice varieties, focusing on key crops such as black pepper, cardamom, ginger, turmeric, nutmeg, and cinnamon. Employing a range of conventional and modern breeding strategies, including clonal and germplasm selection, hybridization, mutation breeding, and biotechnological tools, the research examines yield, quality attributes (e.g., essential oil, oleoresin, curcumin content), and resistance to biotic and abiotic stresses. Data from multi-location trials reveal that improved varieties such as *Sreekara* and *IISR Girimunda* (black pepper), *Appangala 2* and *IISR Vijetha* (cardamom), *IISR Vajra* (ginger), *IISR Pragati* and *Prathibha* (turmeric), *Viswashree* and *Keralashree* (nutmeg), and *Navashree* and *Nithyashree* (cinnamon) consistently outperform traditional cultivars in productivity, metabolite content, and resilience.

SPICES play a vital role in Indian agriculture, cuisine, and commerce, contributing significantly to the country's economy and export basket. Crops like black pepper, cardamom, ginger, turmeric, nutmeg, and cinnamon are not only valued for their culinary uses but also for their medicinal and industrial applications. However, the productivity and quality of these crops are influenced by a range of factors including genetic potential, pest and disease pressure, and climatic conditions. Developing improved varieties with higher yield potential, better quality attributes, and enhanced resistance to biotic and abiotic stresses is therefore essential for sustaining and expanding spice cultivation. The ICAR-Indian Institute of Spices Research (ICAR-IISR) has played a pioneering role in this domain, systematically breeding and releasing a wide array of superior varieties tailored to the needs of farmers and the industry. These varietal advancements have significantly contributed to the productivity enhancement, quality standardization, and resilience of India's spice sector.

Breeding strategies for improved spice varieties

Crop improvement in spices focuses on enhancing yield, improving quality parameters such as essential oil and oleoresin content, and developing resistance to biotic and abiotic stresses. A combination of conventional and

modern plant breeding strategies has been employed in achieving these objectives. The ICAR-Indian Institute of Spices Research (ICAR-IISR) has been at the forefront of these efforts, utilizing a range of approaches including selection, hybridization, and biotechnological interventions across major spice crops like black pepper, cardamom, ginger, turmeric, nutmeg, and cinnamon.

Selection: Selection plays a vital role in identifying and developing superior genotypes from diverse genetic backgrounds. Selection is carried out at different levels—within a cultivar, across cultivars, and from open-pollinated progenies. Intra-cultivar or clonal selection targets useful variation that arises due to somatic mutations or residual heterozygosity within vegetatively propagated crops. Inter-cultivar or germplasm selection draws from a wide pool of local landraces, wild relatives, and indigenous cultivars maintained in field gene banks. These accessions are evaluated over time for multiple traits including higher yield potential, better quality, adaptability to different agro-climatic conditions, and tolerance or resistance to pests and diseases. Promising selections are further tested across locations before being advanced for commercial cultivation.

Another important approach is selection from open-pollinated progenies, especially in crops that are cross-



IISR Thevam

pollinated and maintained through vegetative propagation. These progenies display considerable genetic variation due to segregation, offering a valuable opportunity to identify individuals with superior combinations of traits. Such variability has been effectively used to develop improved genotypes with better agronomic performance, enhanced secondary metabolite content, and resilience under stress conditions.

Hybridization

Hybridization has become increasingly significant in recent years, particularly for spice crops with feasible flowering and crossability. This method involves the crossing of selected parental lines to combine desirable traits, followed by evaluation of F_1 progenies for target characteristics such as high yield, enhanced quality traits (e.g., higher content of active principles), and resistance to key diseases and pests. The most promising hybrids are then multiplied clonally and subjected to multi-location trials. Hybridization is particularly effective in combining traits from genetically distinct parents, thereby introducing novel variation and enhancing the genetic base of cultivated types.



IISR Chandra

In crops like ginger and turmeric, where natural hybridization is limited due to sterility or poor flowering, alternative breeding techniques such as somaclonal variation and mutation breeding are employed. These methods help in generating variability and have led to the development of improved lines with better yield potential and resistance to major diseases. In crops with

Varietal characteristics of Black pepper

Variety	Pedigree from ICAR-Indian Institute of Spices Research, Kozhikode, Kerala	Mean yield (dry) (kg/ha)	Dry recovery (%)	Quality attributes			Features
				Piperine (%)	Oleoresin (%)	Essential oil (%)	
<i>Subhakara</i>	Selection from Karimunda (KS-27)	2,352	35.5	4.0	10.0	6.0	Suited to all black pepper tract
<i>Sreekara</i>	Selection from Karimunda (KS-14)	2,677	35.0	4.2	13.0	4.0	Suited to all black pepper tract
<i>Panchami</i>	Selection from Aimpiriyam (Coll. 856)	2,828	34.0	4.7	12.5	3.4	Late maturing
<i>Pournami</i>	Selection from Ottaplackal (Coll. 812)	2,333	31.0	4.1	13.8	3.4	Tolerant to root knot nematode
PLD-2	Clonal selection from Kottanadan	2,475	32.5	3.3	15.5	3.5	Suited to Thiruvananthapuram and Kollam districts of Kerala
IISR <i>Shakthi</i>	Open pollinated progeny of Perambramundi	2,253	43.0	3.3	10.2	3.7	Tolerant to <i>Phytophthora</i> foot rot
IISR <i>Thevam</i>	Clonal selection of Thevamundi	2,481	32.0	1.7	8.2	3.1	Tolerant to <i>Phytophthora</i> foot rot; adaptable to both high altitudes and plains
IISR <i>Girimunda</i>	Hybrid, Narayakodi x Neelamundi	2,880	32.0	2.2	9.7	3.4	Suited to high altitude
IISR Malabar Excel	Hybrid, Cholamundi x Panniyur-1	1,440	32.0	4.9	14.6	4.1	Suited to high altitude; rich in oleoresin
IISR <i>Chandra</i>	Hybrid (Cholamundi x Thommankodi) x Thommankodi	2,905	33.5	5.10	8.71	3.2	Regular bearer, early maturing hybrid with high fruit set and long spike
Arka Coorg Excel	Seedling selection	3,267	37.8	2.1	6.9	1.6	High yielding, with long spikes and bold berries

ICAR-Indian Institute of Horticulture Research, CHES, Chettalli and Indian Institute of Spices Research, RS, Appangala, Karnataka

long juvenile periods such as nutmeg and cinnamon, selection from naturally occurring variability remains the primary method of improvement, with breeding efforts focusing on traits like oil composition, tree architecture, and resistance to environmental stresses.

To complement these conventional approaches, IISR also employs modern biotechnological tools such as tissue culture, molecular marker-assisted selection, and genomic analyses. These tools facilitate the rapid multiplication of elite lines, ensure the production of disease-free planting material, and accelerate the breeding process through precise selection. Molecular markers are increasingly used to tag important traits and aid in the early screening of breeding populations. The development of improved spice varieties is achieved through a multi-pronged breeding strategy that integrates conventional selection, controlled hybridization, and biotechnological tools. These efforts aim to address the diverse needs of the spice sector by



IISR Vajra

improving productivity, enhancing quality attributes relevant to domestic and export markets, and ensuring crop resilience under changing environmental conditions.

Varietal features of Cardamom

Selection/ Variety	Cultivar	Important features	Area of adaptability	Average yield (kg/ ha)
<i>Appangala-1</i>	Malabar	Well-suited for intensive cultivation in both monocropping and mixed cropping systems, this early-maturing variety is highly adaptable and produces a high percentage (89%) of bold capsules, with a potential dry capsule yield of 1,322 kg/ha.	Major cardamom-growing regions of Karnataka and Wayanad in Kerala	745
<i>Appangala-2</i>	Malabar	Combines high yield performance with resistance to cardamom mosaic virus (katte)	Major cardamom-growing regions of Karnataka and Wayanad in Kerala	927
IISR <i>Avinash</i>	Malabar	Resistant to rhizome rot, offers high yield potential, and is well-suited for cultivation in valley areas. It produces 51% bold, dark green capsules, with a potential dry capsule yield of 1,483 kg/ha.	Suited for hotspots of rhizome rot and leaf blight prone areas.	847
IISR <i>Vijetha</i>	Malabar	A cardamom mosaic virus (katte) resistant selection, recommended for mosaic-prone areas with moderate to high shade. It has a potential dry capsule yield of 979 kg/ha.	Well-adapted to Kodagu, Hassan, Chikkamagalur, and North Wayanad, this variety is suitable for katte-affected regions and performs well under moderate rainfall and moderate to high shade conditions.	643
IISR <i>Manushree</i>	Malabar	A stable-yielding, moisture stress-tolerant variety producing 50% capsules larger than 8 mm in size. Essential oil content is 8.74% under irrigated conditions and 8.84% under moisture stress.	Well-suited for cultivation in the cardamom-growing areas of Karnataka and Kerala	550 (irrigated condition) 360 (moisture stress condition)
IISR <i>Kaveri</i>	Malabar	A compact flowering variety with 70% of capsules measuring over 8 mm in size. It shows relative tolerance to moisture stress and records high essential oil content—9.08% under irrigated conditions and 9.51% under moisture stress	Well-suited for cultivation in the cardamom-growing areas of Karnataka	482 (irrigated condition) 308 (moisture stress condition)

Ginger varieties developed for IISR

Varieties	Average yield (t/ha) fresh	Maturity (days)	Dry recovery (%)	Crude fibre (%)	Oleoresin (%)	Salient features
IISR <i>Varada</i>	22.6	200	20.7	3.3-4.5	6.3	Plumpy rhizomes, high yielding variety.
IISR <i>Mahima</i>	23.2	200	23.0	3.3	4.5	High yield, resistance to nematodes & low fiber
IISR <i>Rejatha</i>	22.4	200	20.8	4.0	6.3	Plumpy & bold rhizome with low fiber content
IISR <i>Vajra</i>	26.4	220	20.7	5.6	5.8	Produces bold, plump rhizomes with low fibre content and a desirable flavour profile with high zingiberene content of 29.83%

Salient features of Turmeric varieties of IISR

Varieties	Mean yield (fresh) (t/ha)	Duration (days)	Dry recovery (%)	Curcumin (%)	Salient features
Suvarna	17.4	180-200	20.0	4.3	Rhizomes with a deep orange colour
Suguna	29.3	180-200	15.0	5.3	Reddish- yellow rhizomes
Sudarsana	28.8	180-200	15.0	5.3	Thick plumpy rhizomes
IISR Prabha	37.5	210-240	19.5	6.5	Reddish-yellow rhizomes derived from seedling progeny
IISR Prathibha	39.1	210-240	18.5	6.2	Developed from seedling progeny, plumpy and bold rhizomes
IISR Alleppey Supreme	35.4	210-240	19.3	6.0	Consistent in curcumin content
IISR Keadram	34.5	210-240	18.9	5.5	Reddish-orange rhizomes, tolerant to leaf blotch
IISR Pragati	38.0	180-200	18.0	5.1	Short duration, stable curcumin across locations, tolerant to root knot nematode
IISR Surya	29.0	240	21.0	2-3	Rhizomes with a light-yellow colour and a unique aroma, characterized by significantly high levels of minor volatile compounds. Ideally suited for the powdering industry.

Black Pepper

Black pepper (*Piper nigrum* L.) belongs to the family Piperaceae and is one of the most economically significant spice crops in India. The main breeding objectives in black pepper include high yield, bold berries with high piperine content, and resistance to diseases such as foot rot (*Phytophthora capsici*) and pollu beetle. Being a self-

pollinated perennial propagated through cuttings, clonal selection and selection from open-pollinated progenies have been the predominant strategies. Inter-variety hybridization has also gained prominence in recent years, aiming to combine desirable traits such as yield and disease resistance.



IISR Varada

Character	Navashree	Nithyashree
Regeneration capacity (shoots/plot of 4 plants)	25.45	18.90
Fresh weight of bark (g)	488.95	511.15
Dry weight of bark (g)	201.10	194.60
Yield of bark/ha (kg)	55.56	54.16
Recovery of bark (%)	40.60	30.70
Bark oil (%)	2.70	2.70
Yield of bark oil (l/ha)	1.50	1.46
Bark oleoresin (%)	8.00	10.00
Yield of oleoresin (kg/ha)	4.44	5.42
Leaf oil (%)	2.80	3.00

Variety	Breeding method	Yield and other characters
Viswashree	Selected through clonal propagation from superior performing mother trees	A compact variety with drooping branches, producing bold nuts with a dry nut weight of 9.0 g and dry mace weight of 1.33 g. At the 8 th year, it yields 3122 kg/ha of nut and 480 kg/ha of mace. Nut and mace recovery are 70% and 35% respectively. The variety records 7.14% nut oil, 7.13% mace oil, and 13.8% oleoresin content in mace
IISR Keralashree	Clonal selection from a single elite tree identified through a participatory breeding programme.	A high-yielding, quality nutmeg variety producing extra bold fruits with excellent nut and mace characteristics. It yields 7,560 kg/ha of nut and 1,512 kg/ha of mace, with dry nut weight ranging from 9.1–11.2 g and dry mace weight from 1.6–2.1 g. Nut and mace recovery are 70% and 35% respectively. The variety contains 5.9% nut oil, 7.5% mace oil, 9.1% oleoresin in mace, and 24.9% butter in nut. Suitable for cultivation in Kerala and other nutmeg-growing regions of India.



IISR Pragati

Cardamom

Cardamom (*Elettaria cardamomum* Maton.) is an important spice crop in India, belonging to the Zingiberaceae family and originating from the Western Ghats. Its cross-pollinated nature and ability to propagate both sexually and asexually offer good potential for genetic improvement. Breeding efforts in cardamom have utilized selection, heterosis breeding, mutation, and polyploidy to enhance yield and develop resistance to major diseases such as cardamom mosaic virus and rhizome rot. Moisture stress being a key limiting factor, tolerant lines have been identified through clonal selection. Current research efforts are focused on developing varieties resistant to leaf blight and tolerant to thrips.

Ginger

Ginger (*Zingiber officinale* Rosc.) is a rhizomatous spice crop belonging to the Zingiberaceae family. The primary objectives of ginger improvement include the development of high-yielding varieties with broad adaptability, superior quality traits such as high essential oil and oleoresin content, low fiber, and resistance to major pests and diseases like shoot borer and rhizome rot. As ginger does not produce viable seeds, conventional recombination breeding is not feasible. Therefore, varietal development relies on methods such as introduction, clonal selection, mutation, and polyploidy breeding.

Turmeric

The turmeric (*Curcuma longa* L.) belongs to family zingiberaceae. The main breeding objective of turmeric crop improvement was yield potential, high curing percentage, and high curcumin content. Clonal selection, seedling selection, and induced mutation were the breeding strategies followed in turmeric for many years. With the recent report on viable seed set in turmeric, recombination breeding program is also attempted in this clonally propagated crop.

Nutmeg

Nutmeg (*Myristica fragrans* Houtt.) belongs to the family Myristicaceae and is a dioecious, tree spice crop valued for both its kernel (nutmeg) and aril (mace). The major

objectives in nutmeg improvement include high yield, regular bearing, early flowering, high oil content, and identification of true female plants at an early stage. Conventional breeding is challenged by the crop's long juvenile phase and dioecious nature. Hence, selection from naturally occurring seedling populations has been the most widely used approach. Clonal selection of elite female trees is also practiced.

Cinnamon

Cinnamon (*Cinnamomum verum* J. Presl), a member of the Lauraceae family, is cultivated for its bark and essential oil. The primary breeding goals in cinnamon include higher bark yield, better bark quality with desirable aroma and oil content, and resistance to leaf spot and die-back diseases. As the crop has a long juvenile phase and is mainly propagated through cuttings and seed, selection from seedling populations and clonal selection have been the traditional breeding approaches.

Future Prospects

Future of spice crop improvement lies in the integration of advanced genomic tools, precision phenotyping, and climate-resilient breeding strategies to meet the growing global demand for high-quality spices. With increasing challenges from emerging pests, diseases, and climate variability, breeding programs will need to prioritize the development of varieties that are not only high-yielding and rich in quality traits but also tolerant to abiotic stresses like drought, heat, and salinity. The use of molecular markers, genome-wide association studies (GWAS), and genomic selection will accelerate the identification of key



IISR Manushree



IISR Kaveri

traits and enhance the efficiency of breeding pipelines. Additionally, pre-breeding and wild species introgression will play a crucial role in widening the genetic base of cultivated spices. A stronger emphasis on value addition, functional quality traits, and organic compatibility will also drive future breeding goals, aligning with market trends and consumer preferences. Collaborative research, public-private partnerships, and farmer-participatory breeding

approaches will be key to ensuring the timely release and adoption of improved spice varieties.

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—Editor