Research Study on Sesame Crop Improvement

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Sesame (Sesamum indicum L.) is one of the oldest oilseeds crops widely grown in Africa and Asia, known for its high-quality nutritional seeds. The world sesame production is about 4.8 million tons (2021) behind soybean, groundnut, cottonseed, sunflower, linseed, and rapeseed, in the quantity of world oilseeds production. The majority of the world's sesame area is found in the developing world, with the largest in Myanmar, India, Tanzania, Nigeria, China, Ethiopia, Burkina Faso, Uganda and Niger. With increasing knowledge of sesame's dietary and health benefits, the market demand for its seed and oil has enlisted a continuous steep increase. Likewise, sesame, by low irrigation requirement, adaption to different types of soil and weather conditions, not being labour-intensive and being instead of a highly remunerative crop, is ideally suited to replace low-yield crops, especially in the current scenario of global warming affecting crop productivity in more and more traditional agricultural areas.

Crop Photos

More than 85 per cent of sesame production in India comes from West Bengal, Madhya Pradesh, Rajasthan, Uttar Pradesh, Gujarat, Andhra Pradesh and Telangana. The majority of the sesame production in the country is used for oil extraction (70-75 per cent), and a considerable proportion is consumed as food (20-25 per cent) in various forms. A small quantity is retained for the seeds every year.

Sesame produces quality oil that is edible and used in biomedicine and health care. Sesame oil with 85 per cent unsaturated fatty acids is highly stable and has a reducing effect on cholesterol, and prevents coronary heart diseases. The importance of sesame lies in the quality of the oil, the presence of antioxidants sesamin, sesamol, its antiquity and its use in religious rituals in India, Egypt and the Persian region.

Origin and Domestication

The cultivated sesame derives from wild populations native to the Indian subcontinent and parts of Pakistan. Sesame and the wild forms share the same diploid chromosome number, 2n= 26

Plant Genetic Resources

The Indian region has been rich in diversity, especially in cultivated forms. NBPGR has about 10,000 accessions in its collection, including a large number of duplicates. The morphological variations observed in the accessions maintained have been documented. Evaluation of germplasm should consider the region from which the cultivars that show the most significant morphological distinctiveness are derived.

Development of Ideal Plant Types for Different Situations

Sesame is an ancient oilseed plant endowed with specific desirable characteristics. The primary objectives are higher yield, high oil, improved plant architecture and resistance to diseases and pests, whereas specific goals vary with the regional requirements. In addition, non-shattering cultivars are needed for combined harvest. The confectionery market or the oil mills have different seed size, shape, coat texture, colour, and sweet taste, which are not crucial to the oil industry. Still, these characteristics are critical for confectionery, increasing globally with the growing health concerns. In India, the white seed is prefered for export and domestic use in the northern plains and plateau region. At the same time, brown or black seeded are favoured by domestic consumers on the eastern coast and black seeds in the south coastal region.

The breeding methods such as introduction, selection, and hybridising sesame are widely adopted procedures for developing new plant types.

Plant Types for Stress Intensive Agriculture

It experiences moisture stress in different crop growth stages to varying degrees. The plant types recommended for stress include medium duration, branching, better adaptability, and high regenerative growth after moisture stress and synchrony in maturity.

Plant Types for Input Intensive Agriculture: The agronomic features of the plant types such as short duration, dwarf plant types, photo and thermo insensitivity, higher response to added inputs and irrigation, short internodal length and higher number of effective capsules are required for input-intensive agriculture. Hence, the popularisation of these ideal plant types is the prerequisite for realising a breakthrough in sesame productivity in different agro production situations.

Sesame varieties released for different situations in India

Gowri, Madhavi, Sarada
Swetha til, Hima, Jagtiyal Til-1, DSS-9, DS-5, VRI-2, TMV-7, VRI-3, G Til-10, G Til-5,
G Til-6, TKG 22, TKG 55, TKG 308, PKDS 12, RT 346, RT 351, RT 46, RT-54, Punjab Til-1, Punjab Til-2, Thilarani, Thilak, Thilathara.

The exploitation of Hybrid Vigour in Sesame

Although sesame is largely self-pollinated, substantial levels of heterosis have been reported for certain hybrid combinations from various countries. However, commercial production of hybrids was not successful as male sterility was a constraint.

Resistance Breeding

Biotic stresses: Sesame suffers from various diseases caused by fungi, bacteria, phytoplasma and viruses. The IDM is structured to use resistant varieties, cultural practices, surveillance and need-based chemical control of the regions.

Abiotic Stresses: Sesame faces various stresses such as waterlogging, fluctuations in temperature, photoperiod, salt concentration and drought. The response of genes is monitored following a change in the environmental conditions, be it dehydration, salinity, heat and cold and identify the species which has the potential of donating valuable genes for resistance to drought. Cultivars resistant to diseases, pests, and abiotic stresses would be necessary, mainly because other means of control in developing countries are scarcely used.

Mutation Breeding

Sesame has a wide range of genetic variability; however, certain desirable traits, including resistance to major diseases and better seed retention, have not been found. They are treating seeds with radiations, mainly gamma rays and chemical mutagens, mainly with ethyl methanesulfonate and sodium azide.

Multi capsular types

Variations in flower colour

Biotechnological Approaches for Sesame Improvement

Different molecular marker systems have been developed and applied to sesame genotyping and breeding efforts. The first class of molecular markers, including RAPD, AFLP employed mainly for genetic diversity studies. The second class of markers involved Simple Sequence Repeat (SSR) types such as ISSR, EST-SSR, gSSR and cpSSR. Many of these markers were used for genetic and association mapping, molecular breeding and genetic diversity studies in sesame.

"Omics" Tools in Sesame

With the mounting development of versatile "Omics" tools in sesame, their application and deployment for crop improvement strategies have also yielded conspicuous results. Nowadays, these tools enable high efficiency and resolution in genetic diversity study, gene-trait association analysis using bi-parental or natural diverse populations, gene family study, and RNA-seq based candidate gene identification. Researchers have tagged various plant traits, including oil content and quality traits, yield components, tolerance to drought and waterlogging stresses, disease resistance, good plant architecture, etc.

The next logical step in sesame research is the functional validation of these gene resources through genetic engineering approaches. The genetic transformation would be an ideal opportunity to transfer the functional genes into sesame elite cultivars quickly. Several successful attempts of sesame genetic transformation through Agrobacterium have led to 42.66 per cent of transformation efficiency. However, improvements to the sesame genetic transformation protocol for reaching higher efficiency are imperative.

Sesame has become an emerging crop globally, and its entrance into the "Omics" era has raised it at the "genomic resource-rich crop" level. Invaluable efforts during recent years have engendered several genetic/genomic tools and resources that provide an impetus to research and nurture sesame production for the benefit of smallholder farmers in developing countries.