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Timeline of Isabgol Improvement in India

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SUMMARY

Isabgol, as renowned medicinal crop gaining its attention among farmers of hot arid climate owing to its adaptability towards the higher temperature, its drought tolerance, salinity tolerance in cool season as well as its economic impact. Despite its importance, there is very limited improvement work has been conducted in India in this important crop. Thus, there is urgent need to synchronize all the breeding work done in this crop which further can help researchers in Isabgol improvement in directional way forward.

INTRODUCTION

Isabgol (*Plantago Ovata* L Forsk.), belonging to plantiginaceae, is a cross-pollinated rabi crop considered as medicinal plant and increasing its economic importance among marginal farmers of the hot arid climate regions where irrigation facilities are limited in nature. India is the sole exporter of this crop to the world market. Isabgol husk, the seed epidermis having muco-polysaccharide layers, is widely used against constipation, diarrhoea and intestinal irritation. Isabgol is also an excellent source of dietary fiber and has hypocholaesterolemic activity (Kawatra et al., 1990) and is widely accepted as food additive in several processed materials like cookies, ice-cream, bread, etc. (Trautwein et al., 2000). This crop is mainly cultivated in arid and semi-arid regions of Gujarat, Rajasthan and parts of Madhya Pradesh. Moreover, its adaptation towards saline water and drought in cool season coupled with its higher economic values bountiful increased its acreage in these in recent years.

Isabgol improvement: gradual timeline

- Collection of isabgol germplasm and evaluation for yield related traits. (Many accessions identified for improved seed yield through natural course of time)
- Mutagenesis. (Niharika, a mutant variety was developed by Lucknow is still popular among isabgol farmers)
- Simultaneous evaluation of putative as well as improved genotypes against the contemporary best checks.
- Its Pollination behaviour was studied thoroughly. (Cross-pollinated nature)
- Use of wide range of chemical hybridizing agents for artificial emasculation. (GA3, reported as best CHA)
- Concurrent evaluation of genotypes for seed swelling factor (important economic criteria)
- By mutagen treatment with DES, EMS and colchicine, DPO 1 to DPO 439 (DPO = Directorate Plantago ovata). An early flowering (30–35 DAS) and maturing (80–85 DAS) mutant, DPO 14 was identified.
- From the colchicines treated plant progenies of GI-2 variety, a tetraploid plant was isolated. Tetraploids plants were more vigorous than the diploids.
- Screening for physiological parameters under water stress was carried out.
- Male sterility was identified in isabgol.
- DUS characters were identified and reference varieties were denoted for different traits.
- Entomological and pathological studies were carried out for many insect pests and revealed that aphid is the major insect as well as downy mildew is the major disease in isabgol creating major part of yield losses with comparison to other biotic factors and concurrent evaluation of accessions were carried out against these biotic stresses.
- Molecular breeding aspects were screened and 16 SSR markers showed polymorphism in Isabgol.(2013-14)
- Based on the four years multi-location evaluation, the isabgol mutant line, DPO 1 was found high yielding across locations and recommended for release as “Vallabh Isabgol -1”.
- Segregating generations, RILs were created using different cross combinations to isolating different transgressive segregants. (The parent DPO-185 and DPO-14 were crossed and a total of 160 progenies were advanced from F4 to F5 by selfing. The population showed segregation for leaf tip drying, leaf curling and other morphological traits. Transgressive segregants were identified among the RIL lines for various traits)

- Amplification of 75 markers were tested, 72 (96%) markers showed amplification. However, only one marker showed polymorphism between the parents of RIL mapping population.(2014-15)
- The genetic map comprises of 30 RAPD markers spreading across 11 linkage groups (PO-1 to PO-11) with a total map distance of 75.6 cM was created.
- Inheritance of the petalloidy gene was studied and single recessive genic control was reported for petaloid mutant.
- Thorough studies were carried out 2015-16 for structural and cytogenetic investigations of male sterility.
- (2016-17) Based on the four years' multi-location evaluation trial, mutant line DPO 174 and DPO 385 were recommended for release as "Vallabh Isabgol-2" and "Vallabh Isabgol-3", respectively.
- A total of 200 mutant lines were characterized using DUS descriptors. DPO9, a distinct mutant line with morphological marker trait *i.e.*, extended bract was sent to NBPGR for its registration.
- Genetics of morphological characters were reported.
- DTPO6-6 is a tetraploid line (2n = 4x = 16) of isabgol which was developed from the variety GI 2 using colchicine (0.1 to 0.5%) seed treatment. The tetraploidy was confirmed through flow cytometry, root anatomy, phenotypic observation and cytology.
- Germplasm registration. **(**Two accessions *viz*., DPO-185 (IC 0627267, INGR 19025) and DTPO-6-6 (IC 0627269, INGR 19026): were registered with ICAR-NBPGR, New Delhi)
- Genetic mapping of genome: The first genetic map was constructed using single nucleotide polymorphism (SNP) markers to unearth quantitative trait loci (QTL) for the agronomic traits and comparative mapping of Plantago. The genetic map was constructed using DPO-14 x DPO-185 recombinant inbred lines mapping population (160) of isabgol.
- Exploration of maturity genes (Transcriptome sequences of DPO-14 (earlymaturing) and DPO-185 (latematuring) genotypes were explored for various maturity genes.
- Mode of inheritance of male sterility was studied in 2020-21, and single recessive genic control for male sterility was reported.

CONCLUSIONS

Changing climate includes unseasonal rain, high dew deposition at maturity of the crop enhances the moisture absorption in seed husk further creating its seed husk higher in weight, resulting its drop off became major unsolved problem in this crop. This is, in other words, denoted by seed swelling factors. Thus, studies are lacking in contrast with this factor. In biotic stress, early sowing (For escaping the climatic effect) results in more vegetative growth and downy mildew susceptibility. Yet there are meager studies with respect to genetic and *omic* approaches for identification of genes responsible, this creates a research area in this crop. In conclusion, keeping its importance in hot arid climate condition, research should be focused in this crop at priority. For which this timeline presented in the article can facilitate the isabgol researchers a way forward.

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