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MAJOR DISEASE OF SOYBEAN IN INDIA AND THEIR INTEGRATED MANAGEMENT

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INTRODUCTION

In India, availability of healthy oil and protein are major problem for high rate of increasing population. But continuous exploiting of soil fertility and environment many of disease and disorder reduce the production and quality. Soybean (Glycine max L. Merrill) is one of the most important oilseed and pulse crops in India having 42% protein, occupying about 29.65 million acers per year, mainly grown in Madhya Pradesh (4.89 million tonnes), Maharashtra (4.82 million tonnes), Rajasthan (5.24 million tonnes) and Karnataka (3.78 million tonnes). Despite its capability, soybean productivity in India remains below due to several biotic and abiotic stresses. Disease are major constraint among biotic factors caused 20 – 30 % yield losses based on severity, season and management practices.

Soybean cultivation is threatened by broad spectrum of pathogens encompassing fungi, bacteria, viruses, and nematodes. Among these rust, anthracnose and yellow mosaic virus pose the most serious challenges, often leading to substantial yield losses. Ensuring sustainable soybean production therefore necessitates the adoption of a comprehensive integrated disease management framework, which strategically blends host resistance, refined agronomic interventions, biological antagonists and judicious application of chemical protectants.

MAJOR SOYBEAN DISEASE IN INDIA

Soybean Rust

Soybean rust 1st reported in India in 1970 in Delhi but now is spread widely in central and southern soybean growing states. Phakopsora pachyrhizi is causal microorganism, also known as Asian soybean rust. The disease is characterized by small gray to tan lesions on the underside of leaves, where rust pustules develop and release radish brown uredospores. Under favorable condition of high humidity (>75%, cloudy weather and moderate temperature (20-25°C), the pathogen spreads rapidly through wind dispersed spores, leading to premature leaf drop and potential yield losses of up to 80%.

Fig. 1 pimple like pustules that are filled with tan spores for on the lower surface of infected leaves (Jansen et al. 2024)

Anthracnose

Anthracnose of soybean caused by Anthracnose of soybean, caused by Colletotrichum truncatum, is a seed-borne disease that also persists in crop residues. It produces dark, sunken lesions on pods, petioles, and stems, while infected seeds become shriveled with poor germination. In warm, wet, and humid conditions (25–30 °C), the pathogen spreads rapidly, often showing pink conidial masses on affected tissues.

Fig. 2 Pod damaged by Colletotrichum (Beacorn et al. (2020)

Yellow Mosaic Virus (YMV)

One of the most damaging soybean diseases in India is Yellow Mosaic Virus (YMV), which is

primarily brought on by the Mungbean yellow mosaic India virus and spread by the whitefly (Bemisia tabaci). Stunting, poor pod setting, yellow-green mosaic mottling on leaves, and, in cases of severe infection, crop failure. Warm, humid weather with high whitefly populations is ideal for the disease's growth. Insecticides or biological agents are used to control vectors, resistant varieties, timely sowing, and integrated methods that combine genetic and cultural resistance are all essential components of management.

Fig.3 Yellow bean Mosaic virus in Soybean (Jhariya et al. 2025)

Other important Disease

Charcoal Rot: - common in drought- stressed crop, causes stem and root rot. Major causal organism is Macrophomina phaseolina.

Bacterial Pustule: - small elevated pustules on leaves are the main symptom of bacterial pustule in soybean, which is caused by Xanthoonas axonopodis pv. Glycines.

Some other disease as Frogeye leaf spot (Cercospora sojina) and Soybean mosaic virus also cause loss and reduce the quality of crop.

ECONOMIC IMPACT OF SOYBEAN DISEASES IN INDIA

Indian agriculture is heavily impacted financially by soybean diseases, which have a negative impact on yield and quality. During epidemic outbreaks, the most damaging foliar disease, soybean rust, can reduce yields by 20–60%, significantly lowering farmer income. Due to shriveled, discolored seeds, anthracnose further reduces seed viability, germination, and market value, which results in further financial loss. High whitefly pressure can cause Yellow Mosaic Virus (YMV) to completely destroy crops, destroying the farmer's investment. Therefore, in addition to being biological threats, soybean diseases pose significant economic challenges that call for immediate, integrated management solutions.

INTEGRATED DISEASE MANAGEMENT (IDM) IN SOYBEAN

The most efficient and environmentally friendly method of managing soybean diseases is an integrated strategy that combines chemical interventions, biological agents, agronomic techniques, and host resistance.

Development of resistant Variety

Use of resistance varieties is most common and environment sustainable method for minimize the soybean's disease. Example of some popular resistant varieties are given below.

1. Rust Resistant varieties: - NRC 7
2. Anthracnose resistant varieties: - NRC 37, MACS series varieties
3. YMV: - NRC 86, JS 95-60, RKS 24.

Agronomic and Cultural Practices

1. **Crop rotation:** Switch up your crops by growing maize or sorghum instead of soybeans all the time.
2. **Sanitation:** To lessen the inoculum, remove and destroy crop residues that are contaminated.
3. **Adjusting the Sowing Time:** Early sowing can help YMV avoid the peak vector population.
4. **Plant Density:** To minimize humidity and the spread of disease, maintain ideal spacing.

Use bioagents (Trichoderma, Pseudomonas fluorescens) or fungicides (Carbendazim, Thiram, Captan) to treat seeds.

Biological Control

Trichoderma harzianum and Bacillus subtilis are used in seed biopriming to combat anthracnose and other seed-borne infections. Entomopathogenic fungi, such as Metarhizium anisopliae and Beauveria bassiana, can lower whitefly populations, which in turn lowers YMV. Plant Growth-Promoting Rhizobacteria (PGPR) that are Rhizosphere Competent: Increase plant resistance to foliar diseases.

CHEMICAL MANAGEMENT

As a precaution, chemicals must be rotated to prevent the development of resistance. For rust, sprays of triazoles (Tebuconazole, Propiconazole), strobilurins (Azoxystrobin), or premix formulations are advised; for anthracnose, carbendazim,

thiophanate-methyl, or combination fungicides should be applied at flowering or pod formation; for YMV, insecticides like imidacloprid, thiamethoxam, or Flonicamid are used to control whitefly vectors, with systemic seed treatment also working well.

Integrated approaches

Using resistant varieties, treating seeds properly, adopting cultural practices, and applying fungicides or insecticides on time are all components of an integrated strategy that is necessary for effective disease management in soybeans. Furthermore, rust outbreaks can be predicted and farmers can be guided in taking preventive action by using disease forecasting models based on weather data. Integrated Pest Management (IPM) techniques should be used to reduce crop losses and sustainably control whitefly populations for vector-borne diseases like Yellow Mosaic Virus (YMV).

FUTURE STRATEGIES

The integration of cutting-edge technologies and supportive policies is a key component of future soybean disease management strategies. The goal of breeding and biotechnology techniques like transgenic development, marker-assisted selection, and molecular breeding is to produce long-lasting resistance against serious illnesses. Modern techniques such as genome editing and CRISPR enable accurate alteration of susceptibility genes to improve resistance to YMV and rust. With nano-formulations of insecticides and fungicides that increase efficacy while lowering chemical load, nanotechnology shows promise. Meanwhile, improved disease monitoring and early detection are made possible by digital tools like drones, remote sensing, and AI-driven forecasting models. Strengthening soybean disease management in India requires policy support through certified seed distribution, farmer training, and strong disease surveillance networks to guarantee broad adoption.

CONCLUSION

Soybean production in India continues to face formidable challenges from destructive diseases such as rust, anthracnose, and yellow mosaic virus, all of which inflict considerable yield and quality losses. It is evident from the intricacy and diversity of these pathogens that depending solely on one control strategy is neither viable nor efficient. Instead, a comprehensive Integrated Disease Management (IDM) framework that balances host resistance, optimal agronomic practices, biological antagonist deployment, and the prudent use of chemical protectants is required for long-term management. To further improve resilience against new pathogen pressures, this strategy should be strengthened with contemporary innovations like precision agriculture, molecular breeding, and disease forecasting tools. India can achieve national food and oilseed security, safeguard farmer livelihoods, and ensure soybean productivity by combining traditional methods with innovative technologies and encouraging policies.

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