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Soybean: Know Your Beneficial and Harmful Microorganisms

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SUMMARY

Soybean production is facing enormous challenges from plant pathogens in terms of yield and monetary aspects. To manage the soybean plant pathogens, it is essential to know the phytopathogens and the beneficial microbes. So, in this article, we have highlighted the key beneficial and harmful microorganisms associated with soybean crops.

INTRODUCTION

Soybean is a leading oilseed crop in central India grown in the *Kharif* season. The major soybean-growing states are Madhya Pradesh, Maharashtra, Rajasthan, Telangana, and Karnataka. Soybean seed contains approximately 20% oil and 40% protein hence,-termed as the golden been. Due to the non-genetically modified nature of the Indian soybean, it has a high export potential for foreign exchange. However, the average productivity of the Indian soybean is less than the soybean grown in other countries like the USA, Brazil, and Argentina. Several abiotic and biotic stresses associated with the soybean lead to low average productivity (Agrawal *et al*., 2013). The soybean crop is prone to many plant pathogens, which can severely decrease the grain yield. The harmful microorganisms include various bacterial, fungal, and viral phytopathogens. More than 40 diseases have been reported in India, and out of these, 13-15 diseases are the most significant ones causing about 12-20 % yield loss.

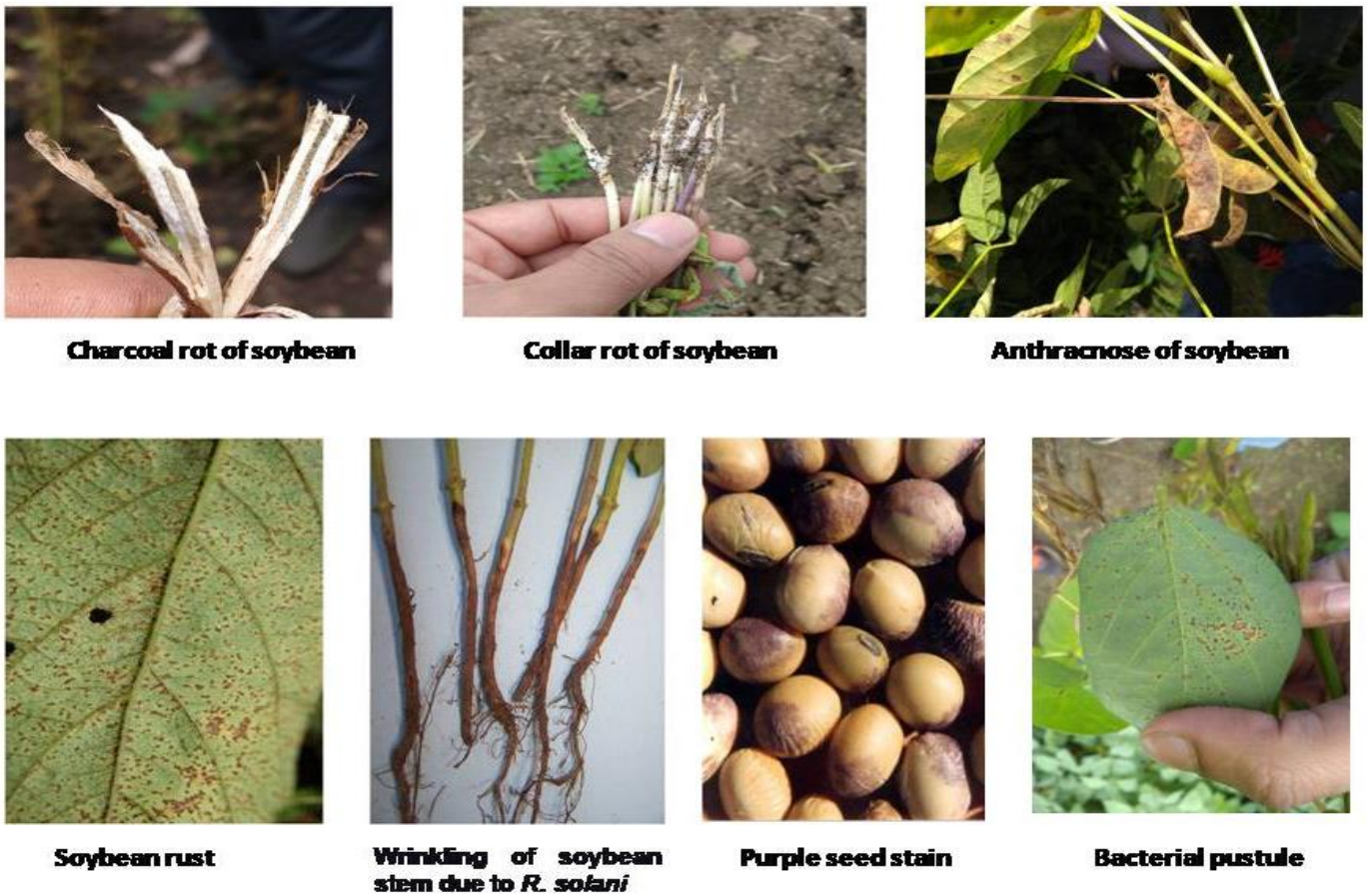

Fig: Important Diseases of Soybean Caused by Phytopathogens

The key fungal phytopathogens are *Macrophomina, Sclerotinia, Rhizoctonia, Phytophthora, Fusarium, and Colletotrichum*. The bacterial pathogens include *Pseudomonas syringae* pv. *glycinea* and *Xanthomonas axonopodis* pv *glycines*. Other agents infecting soybean crops include nematodes and many viral pathogens. These pathogens could be managed using chemical agents, but long-term usage of the toxic chemical may damage the agroecosystem. The poisonous chemical residue can bioaccumulate in the food chain and can cause many human health hazards. Thereby, we should look for beneficial microorganisms capable of increasing plant growth and control phytopathogens' growth and development. These biocontrol agents employ mechanisms such as hyperparasitism, predation, production of cell wall degrading enzymes, antibiotics, and competition for nutrients and space. Another group of microorganisms having the plant growth-promoting traits is termed as plant growth-promoting rhizobacteria (PGPR). The PGPR are chemoattracted by the plant root exudates and help in plant growth promotion via various direct and indirect mechanisms. PGPR acts as bioprotectants for disease suppression, as biofertilizer for nutrient acquisition, and as biostimulants by releasing plant hormone-like IAA, GA3, and cytokinins, siderophore production, ethylene inhibitor. Soybean plants are associated with beneficial microorganisms such as *Bradyrhizobium* sp., *Sinorhizobium* sp., Arbuscular mycorrhizal fungi (AMF), and various free-living plant growth-promoting bacteria (PGPR) (Sugiyama, 2019).

Beneficial Microbes

Plant Growth-Promoting Bacteria-

- *Burkholderia arboris*- nitrogen fixer
- *Bradyrhizobium*: It is a gram-negative bacterium, and soybean nodule harbors many such species such as *B. japonicum, B. daquingense, B. lioaningense, and B diazoefficiens* (AMAAS report 2018).
- *Bacillus aryabhattai* strains MDSR 7, MDSR11, and MDSR 14 - Phosphorus solubilizer and mineralizer
- Zinc solubilizer*: Bacillus cereus, B. tequilensis, B. thuringiensis*.

Plant Growth-Promoting Fungi-

- *Trichoderma harzianum, T. viridae, Aspergillus niger*- for controlling soil-borne pathogen.
- *Glomus, Gigaspora*, and *Acaulospora*- Arbuscular mycorrhizal fungi (AMF) are critical in phosphorus mobilization, provide nitrogen, suppress plant pathogens, and boost plant growth by colonizing plant roots.
- Biocontrol agents and disease control (source: Table 20.1, Alori *et al*., 2020 book chapter edited by Amaresan *et al*., 2020)
- *Bacillus sp.,* and *Burkholderia sp.* - for controlling *Sclerotinia sclerotiorum, Rhizoctonia solani,* and *Phomopsis sojae*
- *Trichoderma harzianum*- for controlling *Macrophomina phaseolina* and *Sclerotium rolfsi*
- *Streptomyces* - for controlling *Phytopthora sojae*
- *Pantoea agglomeranse, Bacillus sp.* and *Trichoderma harzianum*- against *Macrophomina phaseolina*
- *Methylobacterium aminovorans, Bradyrhizobium japonicum, Bacillus megaterium var. phosphaticum* - against *Rhizoctonia solani*
- *Bacillus* sp. and *Pseudomonas* sp. - against *Fusarium* sp.

Harmful microorganisms

Fungal Phytopathogens and Diseases

- *Macrophomina phaseolina:* charcoal rot. It is a seed and soil born pathogen. The dry soil conditions and high temperature > 35 °C) favor the development of the disease. It can cause up to 77% yield loss and is more common in Madhya Pradesh, Maharashtra, Rajasthan, and Delhi.
- *Sclerotium rolfsii:* It is a soil-borne pathogen. The hot and humid climate favors the development of the disease. It can reduce the yield up to 30-40%. It is more common in Madhya Pradesh.
- *Colletotrichum truncatum*: It causes anthracnose or pod blight. It is more severe under high soil temperature and humidity in the field. It can cause 16-25% damage and sometimes up to 100% yield loss. It survives under the seed and crop residue of the previous season.

- *Phakopsora pachyrhizi*: It causes rust diseases in the soybean. The congenial climate for disease development is 22-27°C temperature and 80-90% relative humidity and leaf wetness. It can reduce the yield by 40-80%.
- *Rhizoctonia solani:* It causes seed rot, seedling rot, stem rot, and root rot. The disease development is favored by high moisture in the field. It can reduce the yield up to 30-55 % or even more. The pathogen is seed and soil born.
- *Cercospora kikuchii*: It causes purple seed stain in soybean. It is more severe during the flowering stage on short-duration varieties. It can cause a 15-30 % yield loss. The pathogen overwinters in seeds and crop debris of the previous season.
- *Septoria glycines*: Brown spot
- *Pythium aphanidermatum*: Damping-off
- *Cercospora sojina*: Frogeye leaf spot
- *Fusarium* spp.: Root rot
- *Phomopsis* spp.: *Phomopsis* seed decay
- *Phyllosticta sojaecola*: *Phyllosticta* leaf spot
- *Rhizoctonia solani* : *Rhizoctonia* root rot
- *Diaporthe phaseolorum*: Stem canker
- *Nematospora coryli*: yeast spot

Bacterial Phytopathogens and Diseases

- *Xanthomonas axonopodis pv. glycines*: It causes bacterial pustule diseases and can reduce the yield up to 20%. The warm and humid conditions and frequent rain provide the congenial climate for disease development. The bacterium survives in weeds, crop debris, and seeds. It can reduce the yield by up to 20%. It is more severe in Madhya Pradesh, Rajasthan, Uttaranchal, Himachal Pradesh, and Northeastern states.
- *Pseudomonas syringae* pv. *glycines*: It causes bacterial blight in the soybean. The cool and rainy weather provides a congenial climate for disease development. It can cause a 5-18% yield loss. The pathogen overwinters in the previous season diseased, infected seed.
- *Ralstonia solanacearum*: bacterial wilt
- *Pseudomonas syringae pv. tabaci*: wildfire

Viral Phytopathogens and Diseases

- Mung bean yellow mosaic virus and Mung bean yellow mosaic India virus (MYMV): It can cause approximately 15-75% loss. This virus is transmitted by whitefly. It has a wide host range from pulses and weed crops.
- Soybean mosaic virus (SMV): The primary infection occurs from infected seeds, and secondary spread occurs by aphids. The viral infection is favored by cool and humid conditions, especially when the temperature exceeds 30°C.
- Tobacco ringspot virus (TRSV)- Tobacco ring spot
- Soybean dwarf virus- Soybean dwarf

Management of Phytopathogen Recommended by ICAR-IISR, Indore, Madhya Pradesh (Source: Weekly Advisory).

- Deep summer plowing (once in 2-3 years) followed by two criss-cross harrowings and planking to prepare the desired seedbed. It kills the many soil born phytopathogens.
- Application of fully decomposed FYM @ 10 t/ha or Poultry Manure @ 2.5 t/ha before the last harrowing. It will enhance the beneficial microbial number and activity.
- Seed treatment with thiram + carboxin (3 g/kg seed) and seed inoculation with *Bradyrhizobium japonicum* and phosphorus solubilizing cultures both @ 5 g/kg seed. The *Trichoderma* 10 g/kg seed may be treated to kill the phytopathogens.

- Anthracnose, *Myrothecium* leaf spot, *Rhizoctonia* Aerial Blight (RAB), and *Rhizoctonia* root rot managed by spraying with Tebuconazole (625 ml/ha) or Tebuconazole + Sulphur (1 kg/ha) or Pyroclostrobin 20 WG (500 g/ha) or Hexaconazole 5% EC (800 ml/ha) or pre-mixed Pyroclostrobin 133 gm + Epoxiconaxole 50 gm/lit (750 gm/ha) or Fluzapyroxad 167 g/lit + Pyroclostrobin 333 g/lit (300 ml/ha) or Kresoxim-methyl 44.3% SC (500 ml/ha).
- Yellow Mosaic Virus disease in soybean could be managed by seed treatment with Thiamethoxam 30 FS (10ml/kg seed) or Imidacloprid 48 FS (1.25 ml/kg seed).
- Propper drainage for the soybean field to avoid water logging conditions. The use of a subsoiler at the 10-meter interval in the summer would be good for proper drainage by breaking the hardpan and thereby increases the water infiltration. As low moisture allows the development of charcoal rot and brown spot. In comparison, high soil moisture favors the development of *Phytophthora*, *Pythium*, and collar rot. Adequate irrigation can reduce diseases like bacterial blight, anthracnose, and pod stem blight.
- Grow AMF host crops in crop rotation with soybean.
- Follow scientific crop rotation after growing soybean.
- Use the recommended seed rate **(**55 to 75 kg/ha), appropriate time of sowing (Middle of June to the First week of July), and spacing (row spacing of 45 cm). As these conditions may favor or renders the disease development. Early planting minimizes the charcoal rot and mosaic, while late planting reduces pod and stem blight.
- Apply the recommended dose of fertilizer (25:60:40:20 kg/ha N: P: K: S). A high dose of nitrogen and a low dose of potassium favor the chances of disease occurrence.

CONCLUSION

Soybean is a cash crop grown in central India during Kharif. The use of the proper recommended package of the practice of ICAR- IISR, Indore/ The use of practice packages recommended by ICAR-IISR, Indore, could reduce the chances of pathogen development and enhance the number of beneficial microorganisms.

Disclaimer: The content of this article is a personal opinion and experience of the authors, not necessarily an endorsement or suggestion of the institute where they are associated with.

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