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Innovative methods to manage sheath blight of rice*

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Sheath blight of rice caused by *Rhizoctonia solani* which was known from the begining of this century in some eastern and south-eastern Asian countries justifying the nomenclature 'oriental sheath and leaf blight' had now spread in many other parts of the globe. It is now considered second in importance after blast in Japan, Taiwan and the USA. In India, sheath blight was first reported from Punjab in 1963 (Paracer and Chahal, 1963) and is now prevalent in almost all the rice growing tracts causing concern to the rice farmers. Butler (1918) recorded 'banded sclerotial disease' of sugarcane caused by the same fungus and producing similar symptom but is occurrence on rice had been reported only lately which particularly coincides with the introduction of high yielding varieties and the changed agricultural practices. There are various estimates for yield losses from negligible to 50% when the infection reaches to the uppermost flagleaf. Yield losses from 10 to 36% depending on the growth stage of the plants have been recorded from Assam (Roy, 1979). Management of sheath blight poses a problem since commercial varieties resistant to the disease are unknown and although there are some effective chemicals, their use is limited due to pollution problem and cost-factor. This necessitates exploring other possibilities to manage the disease which I am going to discuss today.

Biological control measures

R. solani is attacked by many fungi, bacteria and also by nematodes (IRRI, 1978; Roy, 1989). Among the biological agents, *Trichoderma* spp. and fluorescent pseudomonads are potent. *T. viride*, *T. harzianum* (Roy, 1977, Roy and Sayre, 1984), *T. brachiatum*, *T. polysporum* (Hashioka and Fukita, 1969) and a few other spp. of *Trichoderma* (Nagamoni and Mew, 1987) have been reported antagonistic to *R. solani*. Besides, few other fungi, viz. *Aspergillus terreus* (Roy, 1984, 1991a), *A. niger* (Gokulapalan and Nair, 1994) *Neurospora crassa*, *Laetisaria arvalis* (Burdsall *et al.* 1984), *Penicillium ehrlichii*, *P. vermiculatum* and *Pycnidiophora multisporum* (Roy, 1991b), are also antagonistic to the sheath blight fungus. Incidence of sheath blight has been reduced by soil application of *T. viride* (Roy, 1977, Bhagawati, 1994), *T. harzianum* (Borah, 1992; Bhagwati, 1994) and *A. terreus* (Gogoi, 1989; Das, 1992) with increase in plant growth and yield. Fungal inocula

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grown on wheat bran-peat medium is more effective than maize-meal sand medium.

Trichoderma can actively invade *R. solani* mycelium (Chet *et al.*, 1981) and produce lytic extracellular enzymes-chitinase and β-1, 3 glucanase *in vitro* (Elad *et al.*, 1982). Vacuolation, coagulation (Rosales and Mew 1982) and lysis of cytoplasm of *R. solani* hyphae (Roy, 1989) against *Trichoderma* have been observed. Elad *et al.* (1983) showed that *Trichoderma* hyphae bind with *R. solani* hyphae through a lectin mechanism suggesting that binding may be a precursor to parasitism. This corroborates with the observation of Roy and Sayre (1984) that before parasitizing *R. solani* hyphae by forming coils, hyphae of *T. harzianum* run parallely adpressed the host hyphae.

Water regime is a very important factor for fluctuation of population of *Trichoderma*. In a study at IRRI, *Trichoderma* could be isolated from dryland and wetland field soil but not from standing water (IRRI, 1983). Bhagawati (1994) observed that population of *Trichoderma* was maximum at 100% saturation of field soil followed by 50% saturation and least in submerged soil. Population was highest in April after which it declined with increase in rainfall although temperature was congenial, a second peack was observed in October. Multiple regression analysis between *Trichoderma* population and soil/weather parameters showed 93.6% flucturation due to soil parameters and 61.5% due to weather parameters. Some anastomosis groups of *R. solani* are very sensitive to CO_2 concentration of soil (Gangopadhyay and Chakrabarti, 1982), however, no significant difference in viability of sclerotia collected from 5 to 15 cm depth could be found by Roy (1980). The sclerotia retrieved from 5 cm depth were colonized more by *T. viride* than those from 15 cm and this was considered to be responsible to narrow down the difference between the inhibitory effect of *Trichoderma* and adverse effect of CO_2, if any, at the deeper layer.

Antagonism of *A. terreus* against *R. solani* is through antibiosis and also by direct parasitism (Das, 1992). Volatile gas/(es) released by *A. terreus* inhibited growth of *R. solani*. Culture filtrate of *A. terreus* either heat-sterilized or cold could arrest growth of *R. solani*, the latter being, more effective (Roy, 1984; Das, 1992). *A. terreus*, however, could not inhibit collulolytic activity of *R. solani* (Roy, 1991a). *A. terreus* is more active in neutral soil but *Trichoderma* spp. in acid soils. The antagonists besides adding to soil can also be applied. by treating seeds. Two groups of pseudomonads - fluorescent and nonflurescent, were isolated from field water as well as rice plants at IRRI. Rice seeds when soaked in bacterial suspension of both the groups and then sown could suppress sheath blight, and the suppressive effect was noticed in the succeeding crop as well (Mew and Rosales, 1986). Borah (1992) could reduce sheath blight by treating rice seeds with spores of *T. harzianum* along with a food base-methyl cellulose. Of the three food bases tested by her @ 2% w/w, methyl cellulose gave better result than jaggery (gur) and gum. She further observed that when the antagonist was used with sublethal dose of thiram, the efficacy of control was better than thiram alone at the recommended dose. Alagarsamy *et al.* (1987) used *T. viride* and *T. harzianum* for pelleting seeds of cotton against .*R. solani*.

Sub-lethal dose of fungicide along with the antagonist tolerant to that fungicide to enhance the suppressive effect is desired in the IPM programme. Davet *et al.* (1981) recorded that while benomyl inhibited growth of *T. harzianum*, the thiram enhanced it. It is possible to develop strains of *Trichoderma* tolerant to chlorothalonil, iprodione, procymidon and vinclozolin by prolonged and repeated exposures to these fungicides (Papavizas, 1980;

Abd-El Moity *et al.* 1982). Sclerotia of *R. solani* lose viability in the root zone of some leguminous crops including dhaincha (*Sesbania aculeata*). It was also observed that loss of viability was greater in the root zone of young dhaincha plants in comparison with old plants (Roy 1993).

Crop residue or organic matter can be applied to field to suppress soil-borne diseases. These amendments act by releasing substances/gases during the process of decomposition, adding nutrients to soil and improving its physical condition and also be triggering the activity of soil flora and fauna antagonistic to the disease producing organisms. Sheath blight of rice was reduced significantly when *T. viride* and *T. harzianum* were added along with cowdung and rice straw to chemically-fertilized soil and this was followed by cowdung alone, efficacy of rice straw was less (Bhagawati, 1994). Survival of *R. solani* was more in rice straw-amended soil than in cowdung and cowdung plus rice straw. Plant growth characters were also increased in amended soil and the increase was greater in the combination of cowdung plus rice straw. Similarly, inhibitory effect of *A. terreus* against sheath blight was enhanced by adding pressmud, sawdust and baggase to neutral soil, and the efficacy of the former was better than the others (Das, 1992). Efficacy of the treatments decreased in acid soils. Plant growth and yield of rice were also increased in the amended soil and the increase was greater in pressmud.

Solarization

This consists of exposing the soil surface directly or after hoeing under sun or by applying artificial heat - dry or wet, to kill pathogens. Solarization, at present, indicates covering of soil surface with transparent polythene sheet. It is an effective tool to suppress soil-borne diseases, soil insects, nematodes, mites, weeds etc. This method is now commercially used in the USA, Israel (Ashworth *et al.*, 1983) and Japan (Horiuchi, 1984). Although effect of solarization on pathogens depends on edaphic and climatic factors, certain fungi are very sensitive which can be used as 'reference' (Katan, 1987).

Constant soil moisture provided under polythene tarp enssures better activity of the antagonists and hence better biological control. Volatile gases such as CO_2, ethylene and others accumulate under polythene cover which may be toxic to the pathogen. There is possibility of shift in microbial composition of soil in favour of the antagonist to the detriment of the pathogen. *Trichoderma* populations are increased in solarized-soil but inoculum of *R. solani* and its build up are suppressed (Elad *et al.* 1980). Tarping of soil to control sheath blight pathogen under upland situation had been suggested by Gangopadhyay and Chakrabarti (1982).

Hypovirulence and genetic manipulation

Strain of a pathogen may lose virulance which is able to compete with a virulent one reducing infection. The classical example is suppression of chestnut blight due to mycovirus-infected (ds RNA) strain of *Edothia parasitica* which could be transferred through anastomosis (Anagnostakis, 1982). *R. solani* may become degenerated and lose ability to attack host and this is associated with presence of ds RNA segments of different sizes and molecular weights (Hollings, 1982). Castanho *et al.* (1978) record a ds RNA virus in *R. solani* which could be transferred from infected strain to healthy one. Damping off of Japanese radish could be suppressed by adding living diseased mycelim of *R. solani* to soil (Homma *et al.*, 1981). Certain avirulent or weakly virulent strains were found to harbour a DNA plasmid (Hashiba *et al.*, 1984). Exact role of ds RNA mycovirus-like agent or DNA plasmid in fungi is not understood.

Tolerance of the antagonists to fungicide occurs either due to genetic (mutation, chromosome breakage, mitotic recombination) or nongenetic causes. *Trichoderma* spp. tolerant of MBC fungicides could be obtained by induced mutagenesis with UV light (Papavizas, 1982). Possibility to develop more aggrassive strains of antagonists by radiation are to be explored.

Induced resistance

Resistance can be induced in a host against a pathogen by inoculating mildly or avirulent strain of the same pathogen or a related species. Acquired resistane in rice plant against sheath blight has been reported by using avirulent strains of *R. solani* (Kalaiselvi *et al.* 1986; Waheeta *et al.*, 1987). Resistance in rice plant against blast, brown spot, sheath rot, tungro virus and also sheath blight could also be induced by using different organic or inorganic chemicals or micronutrients at low concentrations nontoxic to the pathogen. Cyclohexamide, ferric chloride, sodium selenite (Sarkar and Sinha, 1989), micronutrients (Kannaiyan and Prasad, 1979) and calcium (Roy, 1992) are reported to induce resistance in rice against sheath blight at 1 ppm which are toxic above 100 ppm producing similar type or lesions suggesting these to be phytoalexin elicitors (Manibhushanrao *et al.*, 1981 1990; Ramalingam; 1986; Waheeta *et al.*, 1987). Zuber and Manibhushanrao (1979) observed that germinating seeds of ricecv.IR20 heavily infected by *R. solani* produced a phytoalexin-like substance which inhibited growth of *R. solani*.

Among nonconventional chemicals tested by Bhattacharyya and Roy (1995), sodium selenite, zinc sulphate, litium sulphate, calcium nitrate and sodium flouride have induced resistance against sheath blight. Some changes in chemical composition of plants as well as enzyme activities ahve been noticed which in the susceptible cv. IR 50 tended to approach near the resistant cv. Tetep (Bhattacharyya, 1995). In general, total soluble sugars, starch, N,P,K, Ca and Mg were more in resistant cv., and application of zinc sulphate and sodium selenite on the inoculated susceptible plants increased their concentrations but not to the extent of resistant cv. Similarly, total phenols, polyphenol oxidase, peroxidase and phenylalanine ammonia lyase were also more in resistant cv. which increased in the inoculated and treated plants but the increase in the susceptible cv. was not to the extent of resistant cv. Chlorophyll content was also more in the resistant cv. but inoculation with the pathogen reduced the contents both in resistant and susceptible cv., the chemicals could not bring any appreciable change in this pattern.

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