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ROOT ROT DISEASE OF COTTON AND ITS MANAGEMENT

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INTRODUCTION

The root rot caused by Rhizoctonia bataticola (Taub) Butler and Rhizoctonia solani Kuhn is one of the most seroius diseases of cotton particularly in the northern region of India where around 1.8 m. hectare area exists in the states of Punjab, Haryana, Rajasthan, western Uttar Pradesh and Jammu and Kashmir. The disease affects both, the hirsutum and arboreum cotton species being more serious on latter grown in the region. The disease first appears in June and becomes vigorous during July. In August, the attack slows down and almost ceases by the end of September. The damage due to root rot has not has not been assessed systematically. However, Vasudeva while studying root rot in Punjab province (undivided India) as early as in the year 1935 had put the average loss at about 2.5%. If calculations are carried out on this basis taking 12.5 quintal seed cotton as average yield per hectare of the region and Rs.1750 as the prevailing price of each quintal seed cotton, around Rs. 1000 m. is lost due to this important disease.

BACKGROUND INFORMATION

R.bataticola and R.solani are the sclerotial stages belonging to class Mycelia Sterilia of fungi. The sclerotia of R.bataticola are black, irregular in shape and have an average dimension of 105 ± 2 µ while those of R.solani are dark brown and irregular in shape and size. Highest number of sclerotia of R. bataticola usually occur at a depth of 15-30 cm whereas the number decreases at 35-45 cm depth. R. bataticola produces pycnidia and this stage is known as Macrophomina phaseolina (Maubl.) Ashby. The perfect stage of R.solani is Thanatephorus cucumeris (Frank) Donk which produces basidia and basidiospores. The thermal death points of R.bataticola and R.solani are 68 and 60^0 C respectively making them possible to survive even during hot summer of north India. The soil moisture of 15 and 20% and temperature of 39 and 35^0C respectively were reported as most suitable for infection. Variations in the isolates of both R.bataticola and R.solani have been reported. Both the pathogens have a very wide host range i.e. R.bataticola over 400 and R.solani more than 150.

No source of resistance against root rot pathogens are available. Seed or soil treatement with various chemicals like quintozene, carbendazine, thiabendazole, MEMC, thiram, captafol, chloroneb, benomyl, carboxin, thiophanate methyl, zinc sulphate and captan were reported effective in controlling root rot incidence. However, these reports are mostly restricted to pot studies conducted to control these patogens individually and only during seedling stage of plants. The disease appears in field 30-45 days after sowing and drenching the field with chemicals at that stage has not given desired results and is also not practical due to cost implications.

Sowing of cotton in first week of April or end of June instead of May was earlier recommended for root rot management. However, the harvesting of wheat in April delays cotton sowing whereas June sowing leads to yield reduction and subsequently boll opening problem in November due to low temperature. Intercrop of mothbean (Vigna aconitifolia) has also been shown to reduce disease incidence. Seed treatement (seed coating or pelleting) and soil application with antagonistic bacteria and fungi also contributed to better seedling emergence and disease reduction. It has been generally observed that practical solution to this complex problem is not available in farmers fields.

SYMPTOMS

Complete wilting of plants is the first visible symptom and every leaf from top to bottom droops down in such plants. The suddenness of wilting (Fig.1) is a characteristic feature of this disease. In the beginning a few plants here and there in the field show wilting which later get

converted into more or less circular diseased patches. The disease actually starts much early and its aboveground manifestation in the form of wilting is a very late symptom. The affected plants can easily be pulled out of the ground. The bark of roots is broken into shreds and gives yellowish appearance as compared to healthy plants.

RECENT ADVANCEMENTS CULTURAL/PATHOGENS VARIATIONS AND ANASTOMOSIS GROUPINGS

The isolates of R.solani collected from northern cotton growing area were categorized into four distinct groups i.e.A, B, C&D on the basis of cultural characteristics and pathogenicity. An isolate from each group was subjected to nuclear staining and anastomosis grouping (AG) studies. Isolates A, C & D were binucleate and the hyphae were comparatively thinner (diameter 3.6 to 8.3 µ) whereas isolate B did not anastomose with any of the Indian or Japanese tester isolates. An additional anastomosis type-I which indicates repulsion among isolates has been suggested. This type of reaction was observed between cotton B and Bv-7 (AG-K) / NKN-2-1 (AG-6 GV) isolates. Cross anastomosis studies further showed that A, C & D isolates belonged to different AGs. Anastomosis studies will help in better understanding of R.solani and its strains and ultimately in the management of root rot through breeding for disease resistance. Seven isolates of R. bataticola from the region differed in cultural characters including sclerotial size and number and also showed differences in pathogenicity on cotton seedlings.

EPIDEMIOLOGICAL STUDIES

Mapping of root rot disease in an artificially created sick field by plotting mortality due to root rot of individual plants at weekly interval during three years revealed patterns in the progress of disease vis-a-vis weather factors. On careful examination of root rot progress in different varieties showed that the disease progress was slow in the beginning followed by sharp rise for certain period depending on weather parameters. Later on the disease progress depending on weather parameters. Later on the disease progress reached a plateau (Fig.2). The disease progressed faster in arboreum cottons than hirsutums. Among hirsutum varieties-LH 900, LH 886 and F 505 showed relatively slow progress of root rot during three seasons (1991-93) whereas varieties Bikaneri Narma, H 777 and Zhurar (underscript variety) showed faster progress. In order to study the effect of soil temperature and soil moisture on the incidence and progress of root rot, data was recorded for four years i.e; 1992, 1993, 1995 & 1996. Soil temperature recorded at 20 cm depth ranged between 28 to 43^0C and the soil moisture during the crop season varied from 3.0 to 21.9%. The incidence of root rot ranged from 31.7 to 69.1% during the four years period. It was further noted that when the soil temperature was higher, the soil moisture was generally lower. However, no clear cut relationship between soil temperature and moisture vis-à-vis incidence of root rot could be discerned as was evident from the fact that the incidence of root rot showed an increase at times when there was increase or decrease of soil moisture. These variations are probably due to the fact that the two causal organisms involved in root rot have different biology and one of them becomes active at a particular condition favourable for its infection. This was further confirmed by making isolations where it was noted that infections due to R. solani was prevalent when moisture was higher and temperature lower while it was the other way round in R. bataticola. It was also observed that incidence of root rot was maximum ie.,69.1% in 1993 when the moisture ranged between 3.8 to 13.4% and soil temperature varied from 29.7 to 36.9^0 C.

SCREENING OF FUNGICIDES FOR PATHOGENS AND BIOCONTROL AGENTS

Twelve fungicides (carbendazim, carboxin, MEMC, captafol, mancozeb, copper oxychloride, captan, thiophanate-M, sulphur, dodine, kitazin and celest) were tested against both

the pathogens, R.solani and R.bataticola at four concentrations (50, 100, 500 & 1000 ppm) using poisoned food inhibition techinique. Carbendazim, MEMC and thiophanate-M were highly toxic to both the root rot pathogens showing complete inhibition at 50 ppm. In addition to this, mancozeb, captan and celest showed complete inhibition of R.solani at 50 ppm. Captan at 100 ppm and celest and mancozeb at 1000 ppm showed complete inhibition of R.bataticola also (Table 1).

Table 1: Promising fungicides (in vitro) for the control of root rot pathogens.

Fungicide	Conc. (ppm)	R.solani (% inhibition)	Conc. (ppm)	R.bataticola (% inhibition)
Carbendazim	50	100	50	100
MEMC	50	100	50	100
Mancozeb	50	100	1000	100
Captan	50	100	100	100
Thiophanate M	50	100	50	100
Celest	50	100	1000	100
Kitazin	1000	100	500	58.1
Carboxin	1000	100	1000	54.3

These fungicides were also tested against biocontrol cultures i.e. Trichoderma harzianum, T.viride and Gliocladium virens with a view to identifying biogents-friendly chemicals and integrating them for the management of root rot of cotton (Fig.3). The study revealed that carbendazium, MEMC and thiophanate M proved toxic to biocontrol cultures also. Other fungicides however, reacted differently to bioagents. For instance, captafol and mancozeb when used upto 100 ppm did not inhibit any of the biocontrol cultures tested whereas these fungicides were highly toxic to R.solani at this concentration. Similarly captafol at 500 and 1000 ppm did not inhibit T. viride but was toxic to R. bataticola. Further it was noted that captan at 100 ppm was not toxic to G.virens but showed 75% and 100% inhibition of R.solani and R.bataticola respectively. Kitazin at 50 ppm did not inhibit T.harzianum and G.virens whereas R.solani and R.bataticola were inhibited to the extent of 43% and 65% respectively at this concentration. This shows a distinct possibility of integrating lower concentration of fungicides alongwith biocontrol agents for the management of root rot of cotton.

VARIETAL AND GERMPLASM SCREENING

Varieties and germplasm lines were screened in root rot sick field at the regional station farm. Eighteen cotton varieties popularly grown in northern region were grown in sick field using randomized block design n three replications during 1991-93 seasons. The results revealed that G.arboreum varieties were more susceptible (43.9 – 63.1 % disease incidence).Among arboreum varieties minimum incidence was noted in G-1 (43.9%) followed by LD 327 (52%) and RG-8 (61.2%). Maximum seed cotton yield was recorded in G-1 followed by G-27 and DS-1. In case of hirsutum varieties, LH 900 showed minimum disease incidence (19.1%) followed by varieties LH 886 (28.1%) and F 505 (30.7%) with maximum in DS 1 (Fig. 4) Seed cotton yield was also maximum in variety LH 900 followed by LH 886.

Forty G.hirsutum lines along with H 777 as check were screened against root rot during 1993-95. Line B-1371 (11.2%) showed relatively lower root rot incidence as compared to 45% in check variety H777 (Table 2). These lines also showed higher seed cotton yield of 6.50, 6.71, 5.42 and 7.78 Q/ha. respectively as compared to 4.29 Q/ha of variety H777. The GOT (%) of lines FS 128 (36.4) and B 1371 (35.4) was superior to H 777 (34.6). These lines also showed better 2.5% span length (mm) (B 1371:26.7, FS 128:25.6, Arkansas green: 25.5 and A 72-62:23.7

as compared to H 777: 22.1). The micronaire value (g tex/g) of lines B 1371 (4.5), FS 128 (4.4) and Arkansas green (4.4) was superior to check (4.9). These lines can be used in root rot endemic areas because of their tolerance and also as donors in hybridization programme for developing root rot tolerant varieties.

BIOLOGICAL CONTROL APPROACHES

A. Nutritional requirement of biocontrol agents

Nitrogen source was essential for the spore germination of Trichoderma and Gliocladium species. T.viride showed poor sporulation when raised on different carbon sources (glucose, sucrose, fructose and maltose). G.virens exhibited excellent sporulation on all carbon sources except maltose whereas sucrose and glucose supported excellent sporulation by T.koningii and T.harzianum. Fructose was the best carbon source for the growth of T.viride and G.virens. However, T.koningii and T.harzianum grew best on maltose and glucose respectively. Culture filtrate of G.virens grown on maltose showed 57% inhibition of R.solani and that grown on sucrose showed 66% inhibition of R.bataticola.

Sporulation of T.viride was poor on all the nitrogen sources (potassium nitrate, ammonium chloride, alanine, and glycine).Organic nitrogen sources were good for the sporulation of other bioagents. Potassium nitrate was best for the growth of T.viride. T.koningii and G.virens whereas glycine as nitrogen source proved best for T.harzianum.

Culture filtrates of T.viride grown on alanine and glycine showed 38.6 and 25 percent inhibition of R.solani. In case of G.virens the inhibition ranged from 22 to 54.7% depending on the nitrogen sources used. T.koningii when grown on alanine and ammonium chloride showed around 35% inhibition of R.solani whereas T.harzianum culture filtrates showed 21 and 42% inhibition when grown on alanine and potassium nitrate respectively (Fig.5).G.virens when grown on different carbon sources, the inhibition of R.bataticola was to the extent of 30 to 65% (Fig.6). When the culture filtrates were tested against R.bataticola the inhibition of 100 and 77% was noted only when G.virens was raised on alanine and glycine respectively (Fig 7).

B. Role of biocontrol agents in root rot management

Nine isolates of Trichoderma and Gliocladium were tested (in-vitro) in dual culture against R.solani and R.bataticola. Two isolates of T.harzianum and one each of T.viride and G.virens showed promise against R.solani. Similarly an isolate of G.virens proved effective against R.bataticola. Application of a combination of T.harzianum., T.viride and G.virens (@ 0.33% of each culture w/w, total bioagents added @ 1.0%) in pot culturestudies was effective in reducing the root rot of cotton in arboreum variety DS-1. When this experiment was conducted under field conditions with three soil applications of bioagents (@0.2% on the basis of all the three soil applications of bioagents) combined together i.e. @ 400 g/sqm during 1991 & 1992, a combination of T.harzianum., T.viride and G.virens alongwith carbendazim seed treatment reduced root rot reduction and yield improvement when T.harzianum was used. Reduction in seedling mortality by using T.viride was also noticed. Improvement in germination by coating the seeds with bioagents seemed to be an added advantage (Fig.8).

FUTURE OPTIONS

Considerable advancement has taken place for the management of soil borne diseases particularly in the last decade. The literature on the management of soil borne diseases by using biocontrol means is enormous. Development of understanding of factors responsible for establishment of biocontrol organism in the plants rhizosphere has been quite impressive. Researches on the development of efficient strains, rapid screening techniques, selective

isolation media, and mass multiplication and delivery system have greatly helped in making the biological control a near reality. There appears to be great potential in the large scale use of antibiotics and enzymes for the management of soil borne diseases. These antibiotics and enzymes can be produced by genetically trailored fungi and bacteria. Search for the development of new fungicides is likely to continue and a chemical which controls the root diseases after its spray on leaves will be of much interest to plant pathologists. Development of resistant varieties is a continuous process, however, the role of genetic engineering needs to be enhanced in addition to ongoing conventional plant breeding programme. Integration of various components of plant disease management such as fungicides, bioagents, organic amendments and resistant varieties in one way or the other hold promise as future strategy in the management of root rot of cotton.

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