Molecular Events in Recognition of Fungal Pathogens, Activation of Defense Response and Strategies for Plant Disease Management

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Abstract

Plants are compelled to withstand stresses of all kinds, be it biotic, abiotic or anthropogenic as a consequence of their immobility. A basic requirement for the proper functioning of even a simpler cellular system is communication between its components. The characteristics of the plant cell surface may influence the successive steps in infection process. Numerous signals are thought to be exchanged between the host-fungal partners during both compatible and incompatible interactions. Many of the signals produced during early stages of infection induce a hypersensitive reaction (HR) in the plant which is usually associated with the expression of chemical and molecular markers such as salicylic acid and synthesis of PR proteins some of which have glucanase and chitinase activities leading towards synthesis of phytoalexin for plant defences. Defense gene expression is to be a great extent regulated through the production of metabolites which act as signals. It is also the case that pathogens often generate metabolites which suppress plant defences and cause disease symptoms. Activation of inducible defence responses is likely to be based upon recognition of pathogen-associated molecular patterns, which bind to plant receptors. Significant progress in knowledge of association of beneficial microorganisms and their role on plant growth and disease management have been made. Successful biological control depends on skilful interference with the population dynamics of the biological control agent (BCA), the target parasite, the host crop and sometimes vectors and the indigenous microflora. Using immunological techniques it is now possible to obtain reliable and rapid measures of inoculum, which could be used directly within forecasting systems to quantify risk. Considerable advantages exist in the applicability of forecasts and in their uptake by end users if accurate estimates of inoculums could be integrated within more conventional weather based forecasts. Recent progress in our understanding of the biological interactions that occur in the rhizosphere and of the practical requirements for inoculant formulation and delivery should increase the technology's reliability in the field and facilitate its commercial development for plant disease management.

Key words: biological control, chemical and molecular markers, defense gene, immunological techniques

Mini Review

Sustainable Ecofriendly Disease Management Systems in Sugarcane Production under the Changing Climate

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Abstract

Sugarcane is an important commercial crop that usually gets affected by fungal diseases - red rot, smut and wilt; bacterial disease - ratoon stunting (RSD); phytoplasmal disease - grassy shoot and viral diseases - mosaic and yellow leaf disease (YL) in India. Vegetative propagation in the crop favours transmission of the pathogens through the planting materials and this favours buildup of epiphytotics. During the course of epiphytotics in the past, many popular varieties were eliminated from cultivation due to their high susceptibility to the diseases. The non-fungal diseases like grassy shoot, RSD, YL and mosaic seriously affect the crop productivity through varietal degeneration. Probably due to changes in environmental conditions, minor diseases like pokkah boeng and rust have assumed serious proportions and caused severe damage to the crop in the recent years. Detailed molecular characterization established that Fusarium sacchari is the causal agent of sugarcane wilt. PCR- based molecular diagnostic techniques have been developed to detect phytoplasmas and viruses infecting sugarcane, and these are being used routinely to diagnose viruses in sugarcane seedlings derived through tissue culture or meristem-tip culture. Meristem culture combined with molecular diagnosis has been standardized as a viable strategy to manage YL in the country thereby varietal degeneration is being addressed and thus it has become possible to prolong the commercial life of many elite varieties. In addition to host resistance, management of red rot through induced resistance and agro chemicals was attempted and promising results were obtained. Also a new strategy of rapid fungicide uptake in the setts was devised and by which extended protection of young crop from the fungal diseases is established. Heat therapy methods developed at SBI, Coimbatore and IISR, Lucknow are routinely adopted in most of the sugar mills in the country to produce disease-free planting materials through healthy seed nursery programmes. These processes ensure supply of disease-free planting materials and sustain sugarcane productivity in different regions. These new disease management strategies will improve productivity and sustain sugarcane cultivation in sugarcane.

Keywords: diagnosis, disease resistance, heat therapy, meristem culture, pathogen variation, sugarcane

Mini Review

Integrated Disease Management: Need for Climate-resilient Technologies

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Abstract

Effect of climate change on agriculture or more precisely on insect pests and diseases of agricultural crops is multidimensional. Magnitude of this impact could vary with the type of species and their growth patterns. The elevated agricultural production could be off-set partly or by plant pathogens. It is, therefore, important to consider all the biotic components under the changing pattern of climate. Research world over on the effect of climate change on diseases of crops is inadequate. Several diseases have been noted to be showing higher levels of infestation on different field and horticultural crops in India, which have been discussed. The article also looks at different strategies to cope with effects of climate change on diseases of crops with a proposal for Integrated Decision Support System (IDSS) for Crop Protection Services that suggests the operational focus, research priorities and aspects of capacity building, apart from the thrust on climate-resilient technologies.

Key words: agriculture, climate change, impact, pathogens

Improving Efficacy of Fungicides with Integration of Plant Products and Resistance Inducers for the Management of Rice Blast

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Abstract

Experiments were conducted during 2008-2011 for the management of rice blast caused by Magnaporthe oryzae using fungicides plant products and resistance inducers. Based on the in vitro studies, promising fungicides isoprothiolane (1.5ml L⁻¹), carpropamide (1ml L⁻¹), carbendazim (1.5g L⁻¹), propiconazole (1ml L⁻¹) and tricyclazole (0.6g L⁻¹) were evaluated in integration with plant products- palmarosa oil and neemzal, and resistance inducers – salicylic acid and benzoic acid in a pot culture. Isoprothiolane and carpropamide singly and combinations of palmarosa oil + carbendazim, neemzal+ carbendazim, salicylic acid + carbendazim, showed enhanced efficacy in suppressing the disease. In the field trial, palmarosa oil + carbendazim had the highest B:C ratio of 2.69, which was exactly the same as in the case of Isoprothiolane. This was followed by neemzal + carbendazim, salicylic acid + carbendazim, and carpropamide and fungicidal check. The efficacy of carbendazim was improved by integrating it with palmarosa oil or neemzal or salicylic acid, which was as effective as isoprothiolane. The relationship between blast disease severity and weather factors during kharif 2010 indicated positive correlation between disease severity and maximum temperature, RH, rainfall, and rainy days, but negative correlation with minimum temperature. With an increase of one unit of maximum and minimum temperature, RH and rain fall, the percentage of disease index increased by 3.23, 2.29, 2.27 and 0.07, respectively. The judicious use of integrated treatments according to disease prediction system would be useful for reducing the losses caused by rice blast.

Key words: fungicide, plant products, resistance inducers, rice blast

Citation: Varma CKY, Santhakumari P and Mary CA. 2013. Improving efficacy of fungicides with integration of plant products and resistance inducers for the management of rice blast. J Mycol Pl Pathol 43(1): 37-43.

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Integration of Bioinformatics and Genomics Approaches Unveils Novel Aspects of \textit{Saccharomyces cerevisiae} Ste20 Kinases

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Abstract

Ste20 (Sterile 20) group kinases are the translational products of Ste20 gene, located on chromosome VIII of \textit{Saccharomyces cerevisiae}. The group is based on p21-activated kinases (PAK) and germinal center kinases (GCK). In \textit{S. cerevisiae}, members of Ste20 kinases have been reported to be essential for pheromone receptor mating pathways, hyphal tip extension and coordinated branch formation. These kinases may exhibit growth defects, characterized by cessation of cell elongation, hyper-branching, and altered cell-wall composition. During the present study, fragile sequences from Ste20 gene were analyzed using several bioinformatic tools, for identification of the factors promoting instability. We were successful in identifying several regions within the nucleotide sequence of Ste20 gene which may act as hot spots for genetic recombination evident in apoptosis regulation by MAPK pathway. The \textit{in-silico} results were validated experimentally.

Key words: bioinformatics, genetics, \textit{Saccharomyces cerevisiae}, Ste20-kinases

Search for Agriculturally Important Microorganisms from Terai-Dooars Regions of North Bengal, Analysis of their Diversity and Application for Plant Growth Promotion and Disease Management

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Abstract

Studies on microbial diversity and their importance as bioprotector and biofertilizer may signify the economically agricultural based regions. Microorganisms were isolated from soil sample of forest, riverine beds and rhizosphere of different crops using various selective medium and isolation soil plating technique. Microbial population determined in soils ranged between $5 \times 10^5$ and $15 \times 10^5$cfu in case of fungi and $10^{10}$cfu and $30 \times 10^5$cfu in case of bacteria. Isolates were characterized for H₂S production, phosphate solubilization, starch hydrolysis, casein hydrolysis, chitin degrading, siderophore production, catalase production, protease production, urease production, cellulase production and indole production. On the basis of these positive activities of phosphate solubilizing fungi (Aspergillus niger, A. melleus, A. clavatus), phosphate solubilizing bacteria (Bacillus pumilus) and phosphate solubilizing actinomycetes (Streptomyces griseous) were evaluated for the growth promotion of Glycine max, Vigna radiata and Cicer arietinum. In vitro tests of potential biocontrol agents (Trichoderma) showed significant inhibition against different fungal pathogens. Application of potential BCA isolates of Trichoderma harzianum singly and jointly suppressed sclerotial blight incidence of Vigna radiata and Phaseolus vulgaris in greenhouse and field conditions by enhancing key defense enzymes like chitinase, β 1-3 glucanase, and peroxidase, which were confirmed by immunological assays. The diversity of selective potential isolates of PSF and BCA were analysed using RAPD-PCR.

Key words: agriculturally important microorganisms, biological control, disease management, diversity, PGPR

Citation: Dey PL, Chakraborty BN and Saha A. 2013. Search for agriculturally important microorganisms from Terai-Dooars regions of North Bengal, analysis of their diversity and application for plant growth promotion and disease management. J Mycol Pl Pathol 43(1): 51-62.

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Molecular Detection of Citrus Greening Disease of North Eastern Region of India

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Abstract

The citrus dieback complex is caused by the combination of many serious diseases. One of those diseases is the Citrus Greening disease (CGD) (syn. Huanglongbing), caused by a fastidious phloem limited, uncultivable gram negative bacterium known as Candidatus liberibacter spp. The forms of Candidatus liberibacter were reported to occur in citrus known as Candidatus liberibacter asiaticus, C. liberibacter africanus and C. liberibacter americanus. The disease is primarily spread by two species of psyllid insects, the Asian citrus psyllid, Diaphorina citri and the African citrus psyllid, Trioza erytreae. Molecular detection of CDG from four important citrus producing states of the North Eastern region of India - Assam, Arunachal Pradesh, Meghalaya and Nagaland comprising of 10 districts in two major commercial citrus species of the region, namely, Khasi mandarin (Citrus reticulata) and Assam lemon (Citrus limon) were carried out using polymerase chain reaction (PCR) and real time PCR assays. CGD specific PCR primer pair CGD A2 and J5 yielded 703 bp PCR products in all the representative samples from four North eastern states of India. Samples were further assayed by means of multiplex and individual real time PCR using taqman primers and probes against all the four forms of Candidatus liberibacter spp. and against specific primers of Cl asiaticus, Cl africanus and Cl americanus as evident from the multiplex real time PCR. Results revealed that all the CGD samples from four different states of North eastern states were positive to Cl asiaticus. However, samples from Assam, Meghalaya and Nagaland were positive to Cl africanus only. No samples were found to be positive against Cl americanus. The results thus suggested that the samples from Assam, Meghalaya and Nagaland were dual infected by Cl asiaticus and Cl africanus.

Key words: Assam lemon, citrus greening disease, Khasi mandarin, PCR, Real time PCR

Comparative Morphology and Taxonomy of the Genus *Chaetomium* Kunze and its Species

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Abstract

Forty-nine isolates of *Chaetomium* species deposited in Indian Type Culture Collection (ITCC) and Herbarium Cryptogamae Indiae Orientalis (HCIO) in the Division of Plant Pathology, Indian Agricultural Research Institute, New Delhi were reexamined for taxonomic revision. Based on the observations of morphological characters, 12 valid species of the genus *Chaetomium* were described and the taxonomic keys with illustrations for their identification have been provided.

Keywords: *Chaetomium*, morphology, taxonomic characterization, terminal hairs

Pathogenic and Genetic Variability in *Rhizoctonia solani* Isolates Infecting Chickpea

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Abstract

Eight isolates of *Rhizoctonia solani* Kühn, the incitant of wet root rot of chickpea collected from Haryana, Rajasthan and Delhi, were assessed for pathogenicity and genetic variability using RAPD markers. Pathogenicity of these isolates varied both in sterilized and unsterilized soils when tested on chickpea variety C-235. Isolates differed in their RAPD banding pattern. The similarity value of RAPD profiles ranged from 0.12 (Hanumangarh - Karnal) to 0.79 (Delhi - Gurgaon and Hisar - Karnal) with an average of 0.34± 0.1 among the isolates. Ten random primers were used to fingerprint the individual isolates. The cluster analysis using un-weighted pair group method with arithmetic average distinguished *R. solani* isolates into different fingerprint groups.

Key words: Chickpea, RAPD markers, *Rhizoctonia solani*, variation

Cultural, Morphological and Pathogenic Variability in Isolates of *Fusarium udum* causing Wilt of Pigeonpea

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Abstract

Variability among 15 isolates of *Fusarium udum*, the pigeonpea wilt pathogen, collected from different locations of Bihar was studied in respect of cultural and morphological characters, and pathogenicity. The colony diameter ranged from 42.3 to 70.3 mm 8d after incubation at 27 ± 2°C. The colony color varied from white to pink, and back of the plate showed light to dark yellow to brown pigmentation. The dry mycelium weight ranged from 98.3 to 201.3 mg, while number of spores ranged from 0.8 to 3.6 million ml⁻¹ on potato dextrose broth medium after 15 d at 27 ± 2°C. The size of macro conidia and micro conidia ranged from 15.4 - 35.0 × 2.0 - 8.2 μm and 4.1 - 16.5 × 2.0 - 6.1 μm, respectively. Wilt incidence ranged from 14.3 to 61.9% on the susceptible cultivar Bahar. Isolates which produced abundant sporulation were highly virulent, while moderately virulent isolates were poor sporulators.

Key words: Cultural-morphological-pathogenic diversity, *Fusarium udum*, pigeonpea, wilt

Citation: Kumar Sanjeev and Upadhyay JP. 2013. Cultural, morphological and pathogenic variability in isolates of *Fusarium udum* causing wilt of pigeonpea. *J Mycol Pl Pathol* 43(1): 76-79.
Cultural, Morphological and Pathogenic Variability in *Alternaria burnsii* causing Blight of Cumin

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Abstract

The present investigation was undertaken to study the cultural, morphological and pathogenic variability in five isolates of *Alternaria burnsii* causal agent of cumin blight during 2011-2012. The isolates were procured from four major cumin growing districts, Jalore, Udaipur, Bikaner and Jodhpur of Rajasthan. These exhibited considerable variations in cultural and morphological characteristics. Pathogenic variability with inoculation on pot-grown plants of cumin and black cumin resulted in 24.2 to 65.4 and 26.2 to 68.6 PDI, respectively. The isolates also exhibited significant variations in symptoms and latent period. Based on the disease severity, the five isolates were distinguished into pathogenic groups, where isolate from Jalore district was found most virulent and predominant by causing the typical blight symptoms with shortest latent period and highest disease severity.

Key words: *Alternaria burnsii*, cumin, leaf blight, variability

Evaluation of Fungicides and Biological Control Agents for Integrated Management of Spot Blotch of Wheat

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Abstract

Spot blotch, incited by Bipolaris sorokiniana, is an important disease of wheat occurring throughout the world. Field trials were conducted during 2007-09 using chemical fungicides, biocontrol agents and their combinations to develop an effective integrated management method for spot blotch disease in wheat, particularly in Jammu region of India. In field trials conducted during 2007-08, fungicide propiconazole and tebuconazole (0.1% each) as pre- and post-inoculation sprays were most effective in controlling the disease in the range of 82-87%. A combination of foliar application of carbendazin + mancozeb (0.1%) + foliar application of Trichoderma viride (1× 10^7 spores ml^-1) reduced the disease by 80.4% and increased the yield by 20.3%, which were significantly superior to other treatments and control.

Key words: Bipolaris sorokiniana, integrated disease management, spot blotch, wheat

Evaluation of Mycoherbicide *Gibbago trianthemae* on Horse Purslane (*Trianthema portulacastrum*)

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**Abstract**

The culture of a local isolate of *Gibbago trianthemae* (ITCC 6407) was evaluated as mycoherbicide of *Trianthema portulacastrum* (horse purslane/carpet weed). Based on variations in colony growth, rate of sporulation and pathogenicity, 45 single-spore cultures were grouped into nine types, and among these, the isolate Gt-02 was found to be the most pathogenic on *T. portulacastrum*. Gt-02 could infect *T. portulacastrum* plants of all ages from 7- to 20-d after sowing, though the most susceptible age was 7 d after sowing. The disease severity increased with increased inoculum density and was maximum (100%) in plants inoculated with $1 \times 10^8$ conidia ml$^{-1}$. Thirteen different formulations consisting of Gt-02 spores, different inert carriers, oils and Tween-20, were evaluated for their effect on disease development on pot-grown plants of *T. portulacastrum* in a greenhouse. The Maximum per cent disease index (PDI) and the lowest fresh and dry weight were observed with Gt-02 spores + kaoline + paraffin oil + water (wow formulation), followed by Gt-02 spores+ bentonite + paraffine oil + water formulation. In a microplot testing during two years, wow formulation of Gt-02 resulted in maximum PDI, plant mortality and significantly lower fresh and dry plant weight compared to uninoculated control.

**Key words:** Carpet weed, *Gibbago trianthemae*, mycoherbicide, *Trianthema portulacastrum*

**Citation:** Khatik SK, Mathur K and Rathore SS. 2013. Evaluation of mycoherbicide *Gibbago trianthemae* on horse purslane (*Trianthamea portulacastrum*). *J Mycol Pl Pathol* 43(1) : 88-94.
Evaluation of *Bacillus megaterium* strain NBAII 63 against Bacterial Wilt of Brinjal (*Solanum melongena*)

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**Abstract**

Bioefficacy of talc-based formulation of *Bacillus megaterium* strain NBAII 63 was evaluated through different methods of applications in the field trials for suppression of bacterial wilt in brinjal (*Solanum melongena*) incited by *Ralstonia solanacearum* and plant growth promotion. The efficacy of the talc formulation of the antagonist was evaluated as seed treatment ((4g kg⁻¹), soil application (2.5kg ha⁻¹), seedling root dip (10g L⁻¹) and foliar spray(10g L⁻¹) individually as well as in different combinations. The lowest wilt incidence (17.3 %) was recorded when all the four treatments were combined and this was significantly superior over control where 55.1% of wilt incidence was observed. Reduction in wilt incidence up to 68.6% under field conditions were recorded in the combined application. Highest rhizosphere population of antagonistic bacteria $76.5 \times 10^8$ cfu g⁻¹ was also recorded at 40 d after transplanting when the antagonist was applied as a combination of seed treatment, seedling root dip, soil application and foliar spray.

**Key words:** *Bacillus megaterium*, bioefficacy, *Ralstonia solanacearum*, *Solanum melongena*, talc-formulation

**Citation:** Sivakumar G and Rangeshwaran R. 2013. Evaluation of *Bacillus megaterium* strain NBAII 63 against bacterial wilt of brinjal (*Solanum melongena*). *J Mycol Pl Pathol* 43(1): 95-98.
Efficacy of Seed Treatment, Seedling Dip and Foliar Sprays for the Management of Fruit Rots of Brinjal (*Solanum melongena*)

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Abstract

Systemic and non systemic fungicides were used as seed treatment, seedling dip and foliar sprays alone and in combination to control fruit rot of brinjal (*Solanum melongena*) caused by a fungal complex - involving species of *Alternaria, Fusarium, Colletotrichum, Phytophthora* and *Phomopsis*. The experiments were conducted at experimental farm of CSKHPKV, Palampur and at farmer's field at Kangra. The systemic fungicide Bavistin (carbendazim 50WP) @ 0.25%) as seed treatment and seedling dip, followed by spray of non-systemic fungicides viz., Indofil M45 (mancozeb), Ridomil MZ (metalaxyl 8%+ mancozeb 64%) and Polyram (metiram 70%) each @ 0.25%) gave 62.4, 62.0 and 56.7% disease control, respectively. Integration of seed treatment, seedling dip with Captan and foliar spray of mancozeb, Ridomil MZ and seedling dip with Captan and foliar sprays with mancozeb and Ridomil MZ were at par in their effectiveness against fruit rots of brinjal.

**Key words:** brinjal, foliar sprays, fruit rots, seed treatment, seedling dip

**Citation:** Kumar S and Kumar P. 2013. Efficacy of seed treatment, seedling dip and foliar sprays for the management of fruit rots of brinjal (*Solanum melongena*). *J Mycol Pl Pathol* 43 (1): 99-101.
Efficacy of *Trichoderma* strains against *Fusarium oxysporum* f. sp. *ciceri*, the Incitant of Wilt Disease in Chickpea

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Abstract

Thirty isolates of *Trichoderma* belonging to three species - *T. harzianum*, *T. viride* and *T. virens* collected from diverse agro-ecological habitat were evaluated against *Fusarium oxysporum* f.sp. *ciceri* (*Foc*) Kanpur isolate to test their antagonistic potential in chickpea. Of the 30 isolates of *Trichoderma*, isolates IPT 2, 4, 6, 8, 10, 16, 17, 22, 25, 28 and 29 were found promising in reducing mycelial growth and conidia production of *Foc* in dual cultures. Non-volatile compounds of the culture filtrate of *Trichoderma* isolates (IPT 5, 7, 11, 13, 14, 15, 16, 17, 19, 25 and 31) were highly detrimental to growth and sporulation of *Foc* (85.7 - 100% inhibition). Similarly, volatile metabolites produced by *Trichoderma* isolates (IPT 2, 6, 9, 11, 16, 20, 24, 28 and 31) reduced growth by 25.0-65.3% and conidia production by 25.0-87.5% of *Foc* were highly effective. In seed inoculated plants, there was a significant decrease in wilt incidence caused by *Foc*. Both in dry and wet seed treatments *Trichoderma* isolates IPT 2, 4, 6, 8, 11, 19, and 31 effectively reduced the wilt incidence by 23.0 to 53.5% compared to control, but without any significant difference among the two methods of seed treatment.

Key words: Biocontrol, chickpea, *Fusarium oxysporum* f. sp. *ciceri*, *Trichoderma*, wilt

Short Communication

Combined Effect of Fungal Bio-agents and Plant Extracts against Reniform Nematode, *Rotylenchulus reniformis* on Soybean

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**Key words:** Fungal bio-control agents, *Rotylenchulus reniformis*, plant extracts, combined effect, reniform nematode, soybean