ABSTRACT BOOK

Brain storming session on

BLAST PROOFING IN AGRICULTURE

8th August 2018 | ICAR-IIWBR Karnal (An ISO-9001: 2015 certified institute)

Organized by

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ICAR-Indian Institute of Wheat and Barley Research, Karnal 132001 (Haryana), India

Editors

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Issued on the occasion of Brain storming session on "Blast Proofing in Agriculture" at ICAR-Indian Institute of Wheat and Barley Research, Karnal on 8th August 2018

Programme of brain storming session on "Blast Proofing in Agriculture" on 8th August 2018 at ICAR-IIWBR, Karnal

Time (h)	*Details of activity*
9.30-10.00	Registration & light breakfast
10.00-10.30	Inaugural session
10.05-10.10	Welcome and overview by -Dr. D.P. Singh, Organizing Secretary
10.10-10.15	About IPS and theme of session-Dr. Dinesh Singh, Convener
10.15-10.17	About INSOPP- Dr. Jaspal Kaur- Joint Secretary
10.17-10.25	Chairman's Remarks- Dr. Gyanendra Pratap Singh (Director, IIWBR and President, SAWBAR)
10.25-10.35	Remarks by Guest of honour- Dr. P.K. Chakarbarty (ADG, PP&B)
10.35-10.45	Remarks by Chief Guest - Dr. S. K. Malhotra (Agriculture Commissioner, DAC & FW)
10.45-10.50	Release of abstracts book (CD) & Vote of thanks by Dr. Sindhu Sareen

10.50-11.35 **Technical sessions I:** ***Pathogenic Variability and Epidemiology***
Chairman: Dr. S.M. Paul Khurana, Co-Chairman: Dr. M. Srinivas Prasad, **Rapporteur:** Dr. Ritu Bala

Speakers:

Epidemiology of wheat blast
Sunita Mahapatra

Cross infectivity of rice blast (*Magnaporthe oryzae*) pathogen, on economically important wheat and other cereal hosts under epiphytotic conditions
H. Rajashekara, K. K. Mishra, A. Pattanayak and Lakshmi Kant

Research progress in quest for rice blast management
M. K. Bag, M. K. Yadav, M. K. Kar, P.C. Rath and H. Pathak

(Tea Break: 11.35.-11.50)

11.50-12.35

Technical session II: ***Host resistance***
Chairman: Dr. S. K. Malhotra, Co-Chairman: Dr. V. C. Sinha
Rapporteur: Dr. Satyajit Hembram

Speakers:

Management of pearl millet blast through host plant resistance

Rajan Sharma

Deciphering the modifications in virulence genes of wheat blast pathogen (Magnaporthe *oryzae* Pathotype *Triticum* BdBar 16-1)

Alok Kumar Srivastva, Ruchi Srivastava and Anil K. Saxena

Induced mutagenesis for genetic enhancement of wheat blast resistance in India

Suman Bakshi, Sanjay J. Jambhulkar and V. P. Venugopalan

12.35-1.20 **Technical session III:** ***Integrated Disease Management***

Chairman: Dr. P. K. Chakrabarty Co-Chairman: Dr. D.P. Singh,

Rapporteur: Dr. Prashant K. Chauhan

Speakers:

Wheat Blast: current status and efforts to tame this challenge

Pawan K. Singh, Arun K. Joshi, Uttam Kumar, Ravi P. Singh

Distribution, Variability and Integrated Management of Pearl millet Blast Caused by *Pyricularia grisea* (Cooke) Sacc.

P. V. Patil, Roopadevi and Rajan Sharma

Integrated management of wheat blast

D. P. Singh, Sudheer Kumar, Prem Lal Kashyap and Gyanendra P. Singh

Brief presentation on new blasticide molecules

Tara Charan and M C Ranganatha

1.20-2.20	Lunch
2.20-5.00	**Discussion and Plenary session** **Chairman:** Dr. Gyanendra Pratap Singh **Rapporteur:** Dr. Prem Lal Kashyap
2.20-2.50	Recommendations (Co-chairman of respective technical sessions)
2.50-3.35	Open discussion
3.35-4.05	Tea
4.05-4.35	Final recommendations
4.35-4.50	Felicitation of organizing committee members by Chairman of the session
4.50-4.55	Vote of thanks by Dr. Sudheer Kumar

ORAL PRESENTATIONS

Theme I: Pathogenic Variability and Epidemiology

Abstract No. 1.

Epidemiology of wheat blast

Sunita Mahapatra
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Wheat blast caused by *Magnaporthe oryzae* pathotype *Triticum* (MoT) is a serious threat to Southeast Asia in coming years. It has been reported from Bangladesh in 2016. Researchers have predicted that the global climate change along with hot humid weather during the crop growing phase in Indo-Gangetic plains would be vulnerable for wheat blast. Wheat blast may cause severe losses in warm- humid climatic conditions that prevail in Bangladesh and also in neighbouring countries like India, Nepal and Pakistan. Wheat blast pathogen (MOT) is a seed borne pathogen. It attacks all the above ground parts by airborne conidia and may cause up to 100% crop losses. Brazil from where wheat blast was first reported in 1985, had developed a weather based infection model which stated how spike wetness hours and temperature may favour for disease development. On that basis US also develop a weather based model which showed 25% of US weather conditions are conducive for wheat blast outbreak, in spite of MoT is not present in USA. The pattern of temperature and rainfall (during January to April) during last last five years in North-eastern states of India has been analysed to predict if it will favour wheat blast epidemic. It may helps to reveal initial or basic information about epidemiology of wheat blast only on the basis of emperial data. It is predicted that the rainfall and temperature pattern of the border districts of West Bengal to Bangladesh may favour for wheat blast development. It is suggested that detailed studies may be carried out to understand the pest risk analysis of wheat blast in entire Indo-Gangetic plains zone, for evolving forewarning system to manage the threat of wheat blast in India effectively.

Abstract No. 2.

Cross infectivity of rice blast (*Magnaporthe oryzae*) pathogen, on economically important wheat and other cereal hosts under epiphytotic conditions

H. Rajashekara, K. K. Mishra, A. Pattanayak and Lakshmi Kant
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Rice blast caused by *Magnaporthe oryzae* pathotype *Oryza* (Ana. *Pyricularia oryzae*) is one of the most serious diseases and dominant factor limiting yield potential in rice worldwide including India. The rice blast pathogen attacks a wide range of grasses and also infects small grains. However, there is no information on infectivity and host range of rice blast pathogen on other economically important cereals in India. ICAR-VPKAS, Almora is known as hotspot for rice blast worldwide and rice, wheat, finger millet and other cereals are grown here as well as in hills of NWZ. It may be possible that in future the rice blast pathogen MoO) may infect the wheat and other cereal crops as these crops are grown on substantial areas. With this background, experiments were conducted under controlled climatic conditions to test the infectivity of rice blast fungus on other cereal hosts. Seedlings of wheat (Agra local, VL Gehun 907, VL Gehun 829 and VL Gehun 892) barley (VL Jau-118), finger millet (VL Mandua 352, VL Mandua 324, VL Ragi 149 and Udar mallige) and rice (Tetep, Bala and VLK-39) at two to three leaf stages were inoculated with rice blast isolate (LB-VLD-209). Typical blast symptoms were observed on inoculated leaves of wheat, barley, and rice within 5-7 days after inoculation and subsequently lesions coalesced all along the leaf, however, finger millet genotype seedlings were free from infection. Pathogen was re-isolated from the infected leaves of barley and wheat and re-inoculation on same set of healthy seedlings of these hosts produced the same symptoms satisfying Koch's postulate. Thus, there may be a possibility of infection of rice blast to other cereals especially wheat under such environmental conditions. However finger millet genotypes could not show blast symptoms.

Abstract No. 3.

Research progress in quest for rice blast management

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Rice blast disease caused by the fungus *Magnaporthe oryzae* pathotype *Oryza* (anamorph: *Pyricularia oryzae*) is one of the most destructive disease causing huge losses to rice yield and thereby posing a great threat to world food security. The disease was first reported from India in 1913 and also the first epidemic due to rice blast was occurred in Tanjore delta in 1919. It is usually rated as number one pathogen among the world's top ten threatening fungal pathogens of crops. The yield losses due to blast may be up to 75% or more. During the initial period of research major importance was given on identification of the pathogen, its epidemiology and adoption of chemical management and selection of resistant rice varieties. Still the occurrences of new races of the pathogen have resulted in frequent breakdown of resistance. The utilization of many blast resistance genes in land races was also done. Later dramatic changes were observed in development of rice blast resistant varieties with the advancement of biotechnological tools.

At NRRI, a detailed study was taken to understand the pathogen population and variability to develop appropriate location, area and ecology specific blast resistant rice varieties. Studies on mating type variability were conducted that 63 isolates of *M. oryzae* were collected. Out of these,16 (25%) were MAT1-1 while 35 (56 %) were MAT1-2 mating type. MAT1-2 isolates predominated in Jharkhand and Assam while MAT1-1 is more predominant in the isolates of Odisha. Both MAT1-1 and MAT1-2 were equally distributed in the isolates of Meghalaya and Tripura. In another study, forty six isolates of *M. oryzae* were collected from various ecosystems of coastal Odisha, and the mating type analysis showed that MAT1-1 mating type was dominating in all the ecosystems and whereas MAT1- 2 was present in uplands and irrigated conditions. Both mating types were found in the same field in irrigated ecosystem. Recently, 20 isolates of *M. oryzae* were collected from Chhattisgarh and categorized into groups based on colony colour and texture. Out of 20 isolates, five were highly virulent, 8 were moderately virulent while, 7 were mild in nature. In phylogenetic analysis, overall two major groups were formed. The Chhattisgarh (CG-2 and CG-43) blast isolates along with

Indian isolate were in one group whereas isolates from Brazil, Kenya, Japan and China were in a separate group.

Seed dressing with tricyclazole followed by need based spraying of ediphenphos was found promising in managing blast (both leaf and neck blast) in upland rice. Isoprothiolene and tricyc1azole were most effective in controlling the blast disease in nursery. In rice, strobilurin fungicide trifloxystrobin plus tebuconazole gave effective results against blast disease. Application of metaminostrobin 20% SC + hexaconazole 5% SC was effective against leaf and neck blast.

Among several management strategies, use of host plant resistance (HPR) is most effective. Some prospective donor for resistance were identified on screening of 14000 germplasm including landraces and wild rice. One recent study to find out the status of twelve major blast resistance genes and their diversity among 80 National Rice Research Institute released rice varieties. Linked molecular markers for genes Pib, Piz, Piz-t, Pik, Pik-p, Pikm, Pik-h, Pita/Pita-2, Pi2, Pi9, Pi1 and Pi5 were used in this study. Among 80 varieties used, 19 were resistant, 21 were moderately resistant and 40 were susceptible to the pathogen. The blast resistance genes in the different varieties varied from 4 to 12 and the frequencies of the resistance genes ranged from 0 to100% (Yadav et al. 2017). In another recent studies, marker assisted backcross breeding strategy was applied for pyramiding blast resistance genes (Pi2 and Pi9), into Vandana and Kalinga III through the crosses (Kalinga III/C101A51 (Pi-2(t))//KalingaIII/O. minute der. WHD IS 75-127(Pi-9(t)) and Vandana/C101A51//Vandana /O. minuta. WHD IS 75-127). Many lines in the background of Vandana and Kalinga III were developed. Among the promising lines, CR 2619-2, CR 2619-5, CR 2619-6, CR 2619-7, CR 2619-8 and CR 2619-9 are in the background of Vandana while CR 2620-1, CR 2620-2, CR 2620-3 and CR 2620-4 are in Kalinga III background. The promising lines were tested in Disease Screening Nursery (DSN) under AICRIP for multi-location trials.

At present, research on development of multiple stress tolerant varieties is going on. Like, improvement of elite varieties Pooja and Naveen for bacterial blight and blast are under process and popular drought tolerant donor N22 was targeted for introgression of blast resistance gene Pi9 for higher grain yield under drought. Therefore, N22 was hybridized with CRMAS2620-1 for Pi9 and Way Rarem for qDTY12.1. The homozygous plants would be phenotype for resistance and grain yield under stress.

Theme II: Host Resistance

Abstract No. 1

Management of pearl millet blast through host plant resistance

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Pearl millet blast, caused by *Pyricularia grisea* (Cooke) Sacc. (teleomorph – *Magnaporthe grisea* (Hebert) Barr.), has emerged as a serious disease of pearl millet hybrids in India. Although blast was considered a minor disease of pearl millet, the disease incidence has increased alarmingly during the recent years. Host plant resistance is the economical and viable disease management strategy to control pearl millet blast; however, resistance in the commercial hybrids being grown in India is not available as no efforts were made in the past to breed for blast resistance. Information on the pathogenic variation in the pathogen populations is essential for the management of a disease through host plant resistance. Therefore, efforts were made to study pathogenic variation in *M. grisea* and identify resistance sources to different pathotypes of the pathogen. To begin with, pathogenic variation was studied among 25 *M. grisea* isolates collected from four major pearl millet growing states in India (Rajasthan, Haryana, Maharashtra and Uttar Pradesh) on ten pearl millet genotypes to select pathotype-isolates for use in greenhouse screening to identify sources of blast resistance. For the identification of resistance sources, a pearl millet mini core comprising 238 germplasm accessions was evaluated under greenhouse conditions against selected five *M. grisea* pathotype-isolates (Pg118, Pg119, Pg56, Pg53 and Pg45). Three accessions (IP 7846, IP 11036 and IP 21187) exhibited resistance to four of the five pathotypes. Efforts were also made to screen 305 accessions of *Pennisetum violaceum* (wild relative of pearl millet) against these five pathotypes. Based on mean blast score, 17 accessions (IP 21525, -21531, -21536, -21540, -21594, -21610, - 21640, -21706, -21711, -21716, -21719, -21720, -21721, -21724, -21987, -21988 and -22160) were found resistant to all the five pathotypes and 24 accessions were resistant to any of the four pathotypes. However, resistance sources need to be stabilizedby repeated selfing and screening before using them in breeding programs. The differential set was further refined and ten pearl millet genotypes- ICMB 93333-P1, ICMB 95444, ICMB 97222-P1, ICMB 01333, ICMB 02444,ICMR 06444, 863 B-P2, ICMR 06222, ICMR 11003 and IP21187-P1 have been selected as host differentials to

assess pathogenic variation in *M. grisea*. Using this differential set, virulence diversity was studied among 65 isolates of *M. grisea* collected from different pearl millet growing areas of Rajasthan, Uttar Pradesh, Maharashtra, Haryana and Gujarat states. Based on the virulence/avirulence on differentials, the isolates were clustered in different pathogenic groups. Five isolates- Pg 138/Pg174, Pg 186, Pg 204, Pg 232 and Pg 118 representing geographical and pathogenic diversity have been selected for the greenhouse screening of breeding material for blast resistance. IP 21187-P1which is included in the differential set was found to have resistance to most of the pathotypes and is now being used as a blast resistance donor in the pearl millet breeding program at ICRISAT. In addition to IP 21187-P1, ICMB 97222-P1, ICMR 06444 and ICMR 11003 are the other resistance donors having resistance to any two of the selected five pathotypes. Mini core accessions (238) are now being screened against new pathotype-isolates (Pg 138, Pg 204 and Pg 186) for the identification of resistance sources. None of the mini core accession was completely resistant to highly virulent pathotype-isolate Pg 138; however, some resistant plants were observed in some accessions and they were transplanted for selfing and further screening. Similarly, resistant plants from seven accessions against Pg 186 and from 10 accessions against Pg 204 were transplanted for selfing and screening for 2-3 generations to develop blast resistant genetic stocks for use in blast resistance breeding programs.

Abstract No. 2

Decephering the modifications in virulence genes of wheat blast pathogen (Magnaporthe *oryzae* Pathotype *Triticum* BdBar 16-1)

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Wheat blast is the most scary and uncontrollable wheat disease, caused by *Magnaporthe oryzae* Pathotype *Triticum* and is composed ofa range of host-specific pathotypes that are specific for affecting rice, wheat (*Triticum* pathotype - *MoT*), ryegrass and other graminaceous hosts. *M. oryzae* is a disastrous pathogen of rice globallyand the leading ideal organism for explaining the molecular basis of fungal disease. The pathogen *M. oryza* BdBar 16-1 (MoT pathotype) causing wheat blast in Bangladesh was isolated from wheat spikes, and its genome has been sequenced (LXON0000000).In this study, the genome of BdBar 16-1 was compared with reference strain of *M. oryzae* (70-15; AACU00000000) for modifications in few virulence/pathogenic genes. It was found that the number of predicted genes in genome of BdBar 16-1 is approximately double as compared to *M.* oryzae 70-15. A total of 3700 Genes were taken for annotation, pathway analysis and modelling, and when both the genomes were compared with Database of Fungal Virulence Factor (DFVF), a few genes*viz: PUF, Peptidase_M48, ER_lumen_recept, CUE (*coupling of ubiquitin to ER degradation*)* and *MFS_1* (Major facilitator superfamily) could be located in genome of BdBar 16-1,which were absent in reference genome of *M. oryzae* 70-15. In addition, the BdBar 16-1 genome codes for a huge and various sets of secreted protein. It also contains an enlarged family of GPCRs (G-protein-coupled receptors), various sets of genes involved in secondary metabolism and virulence. Cutinase catalyzes the hydrolysis of cutin, allows fungi to penetrate through the cuticular barrier into the host/ wheat plant during the initial stage of the blast infection and trehalase belongs to the glycosyl hydrolase 37 family, which plays an important role in pathogenicity, specifically in proliferation of invasive hyphae in blast disease, during sporulation, plant infection and in response to hyperosmotic stress, genes were identified. BdBar also possesses MAPK (mitogen-activated protein Kinase) cascades that regulate appressorium development, penetration peg formation and adaptation to hyper-osmotic stress *Ras* (GTPases protein) Signal transduction cascade; regulating fungal development and virulence. Knowledge of the genes and the signal transduction cascade responsible for the fungal development, virulence and production

of secondary metabolites, will help to elucidate the virulence mechanisms functional in the pathogen and to design or develop a novel techniques/drugs against blast disease which are not previously described.

Abstract No. 3

Induced mutagenesis for genetic enhancement of wheat blast resistance in India

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Wheat blast, caused by *Magnaporthe oryzae* pathotype *Triticum* (MoT) although not yet present in India but is a serious threat to wheat production in India. India ranks second in wheat production on global map and meets domestic consumption. Biotic stresses are one of the constraints in wheat production challenging the food security. The blast pathogen (MoT) is fast spreading and can cause yield losses in wheat crop up to 100%. The existing wheat germplasm is not generated and tested properly for resistance to wheat blast. This is an ideal situation where mutation breeding programme can only pave the way to achieve the target of resistance. Mutation breeding has been successfully applied to isolate resistant mutation for deadly stem rust race *Ug99*. At BARC, mutation breeding programme has been initiated for strengthening the germplasm for improvement of wide range of characters including morphological, physiological, biochemical and biotic and abiotic stress tolerance. Unraveling the success achieved in the past for deadly disease like stem rust race *Ug99*, targeted mutation breeding program for creating resistance in wheat plant to blast provides a good an opportunity to tackle the deadly fast evolving pathogen, MoT.

Abstract No. 4

Wheat Blast: current status and efforts to tame this challenge

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A lot has been said and written about appearance of wheat blast in Bangladesh since February 2016 when it was reported in about 15% of the wheat acreage in that country. In contrast to the ~7,000-year history of rice blast, wheat blast emerged as a serious problem just over 32years ago when it was first reported in Brazil's Parana province in 1985 to further spread to Bolivia, Paraguay and Argentina.

Blast causing pathogen *Pyricularia* spp. is pathogenic to more than 50 graminaceous hosts including major staple crops like rice and wheat and other crops such as finger millet, pearl millet and foxtail millet. The wide host range of this fungus speaks of the dynamic genetic-pathotypic variability emanating from variability generating reproductive system of the fungus. Separate fungal populations cause the ancient diseases on rice (*M. oryzae Oryza* pathotype, MoO), foxtail millet (*Setaria* pathotype, MoS) and finger millet (*Eleusine* pathotype, MoE), as well as the recently emerged disease on wheat (*Triticum* pathotype, MoT). The livelihoods of millions of smallholder farmers around the world depend on each of these crops and other minor cereals that are also limited by blast disease.

It is established that the pathogen causing wheat blast in Bangladesh is genetically similar to the South American isolates and has not evolved from rice blast pathogen or variants (www.wheatblast.org). Wheat blast was found in Bangladesh in each of the last three years, 2016, 2017, and 2018. The year 2018 was one of the coolest years in the last 50 years. This indicates that MoT can survive and adjust to even harsh conditions, and is now an established disease in Bangladesh.

The MoT invasion can be seed borne as well as air borne. So there is high probability of its spread out of Bangladesh. There are studies supporting its spread to the correspondingly-vulnerable areas in South Asia which can be up to 7 million ha. Even a minor yield loss of 5-10% will be significant amounting to losses of hundreds of millions of dollars.

There has been an intense search for sources of resistance to wheat blast. Cultivars such as BR18, IPR85, CD113, have shown some resistance over years in many locations of Latin America. Promising new lines from CIMMYT include, Reedling#1, Roelfs F2007, Sup152/Baj#1, Misr3, Motacú, Urubó and Cupesi-CIAT. Some of these lines adapt well in Indian conditions and can be targeted for direct release. Using BSL-3 containment inoculations in the US and field tests in South America, the 2NS/2AS translocation from *Aegilops ventricosa* possessing rust resistance genes *Yr17*/*Lr37*/*Sr38* was verified to confer good resistance. However, recently 2NS/2AS based resistance is breaking down.

To strengthen breeding for wheat blast resistance, Precision Phenotyping Platforms (PPP) were established in Okinawa and Quirusillas in Bolivia and Jessore in Bangladesh. Elite germplasm from CIMMYT, India, Bangladesh and Nepal were evaluated at the PPP. Several elite germplasm with 2NS translocation showed promising response compared to fewer non-2NS sources. Of the non-2NS wheat lines, those showing consistent good resistance were, Super 152, Quaiu #1, Vorobey, Tepoca T89 and Francolin #1. This exhibited the heavy reliance on 2NS resistance and an urgent need to identify non-2NS resistance in bread wheat to avoid the fast appearance of 2NS-virulent MoT isolates.

A good development has been that the blast resistant line BAW 1260 (Kachu/Solala) possessing the 2NS, was released in Bangladesh as BARI Gom 33 in 2017. This variety showed competitive yields and about 30 percent higher grain zinc content. Seed multiplication in Mexico and BWMRI, Bangladesh is underway to accelerate the availability to farmers. This line is presently being tested in India and can be a potential variety. Many such efforts are required to address this problem.

Given the gravity of the challenge posed by wheat blast, it makes a strong case for wheat breeding strategy in South Asia. Seeing past record of wheat breeding in India and South Asia and theirs strong collaboration with global programs such as that of CIMMYT, it is hoped that this challenge will also be met in coming years if serious efforts are applied.

Abstract No. 1

Distribution, Variability and Integrated Management of Pearl millet Blast Caused by *Pyricularia grisea* (Cooke) Sacc.

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Pearl millet is a nutrient-rich food source for human as well as a forage/fodder crop for livestock. It is the only cereal crop that is capable of producing a reliable yield under the marginal soil and environmental conditions. However, it encounters number of diseases which attack the crop during its growth, cause low yield and thus economic loss. Among several diseases that affect pearl millet blast also called as leaf spot caused by *Pyricularia grisea* (Cooke) Sacc. has been emerging as a serious disease affecting both forage and grain production in major pearl millet growing states of India.

Both field and laboratory experiments were conducted during 2015 and 2016 to ascertain the losses, distribution of the disease, variability in pathogen and integrated management of pearl millet blast. Overall the blast was distributed in all the four districts (Bagalkote, Koppal, Bellary and Vijayapura) of northern Karnataka. Highest blast severity of 18.75% was recorded in Koppal district and lowest was in Vijayapura district (9.30%).

Assessment of loss due to blast by doing artificial inoculation in 15 pearl millet genotypes (Penna seeds 4959, Laxmi 234, Vikas nugenes, Super 80, Gangakaveri, Mahalaxmi hybrid, Panchganga 510, 86 M 35, MRB 2232, Kaveriboss 65, GHB 558, 86 M 64, ICMV 221, ICTP 8203 and 86 M 88) revealed highest per cent loss in grain yield of 44.03% and fodder yield of 49.63% in ICTP 8203 and it was least in Kaveri boss 65 which has recorded 15.30% grain yield loss and fodder yield loss of 14.49%.

Twenty one isolates of *P. grisea* collected from ten different pearl millet growing states of India showed variability with respect to morphological and cultural characters and pathogenic ability. Variation in colony colour was ranged from white to black, margin varied from irregular to regular, mycelial growth from flat to raised, variation in growth rate, number of septa in conidia remained same (two septa)in all isolates, slow to excellent sporulation (10 to 60 spores/ microscopic field under 100 X) with pyriform shaped conidia.

On the basis of pathogenicity/ virulence (avirulent/virulent), the 21 isolates were grouped into five different pathotypes. Pathotype group 1 and 2 includes each of

eight isolates, Bag*Pg*1, Bal*Pg*3, Arb*Pg*8, Bkn*Pg*13, Egl*Pg*14, Kal*Pg*15, Ptc*Pg*18 and Ndh*Pg*19 and Kop*Pg*2, Vij*Pg*4, Dhu*Pg*6, Pune*Pg*7, Nsk*Pg*9, Bld*Pg*10, Jpr*Pg*11 and Dnt*Pg*16, respectively and the remaining isolates represented pathotype 3 (Yad*Pg*5), 4 (Lud*Pg*20 and Ant*Pg*17) and 5 (Jdr*Pg*12 and *GwaPg*21). Yad*Pg*5, Lud*Pg*20 and Ant*Pg*17 pathotypes were found most virulent.

Mancozeb @ 0.1% (100%), Carbendazim 12% + Mancozeb 63 % @ 0.05% (100%), agroneem @ 0.25% (74.1%), consortium of two bioagents *T. harzianum* + *B. subtilis* recorded maximum inhibition of mycelial growth and panchagavya @ 5% inhibited 75.0 % spore germination. In Integrated disease management, two sprays of Carbendazim 12% + Mancozeb 63% @ 0.1% effectively reduced the severity of blast (PDI 18.83) and increased grain yield (30.75 q ha^{-1}) with highest C: B ratio (1:3.9).

241 pearl millet mini core from ICRISAT, Hyderabad and 426 inbreed lines of Regional Agricultural Research Station, Vijayapura screened under polyhouse revealed that none of the genotypes showed immune or resistant reaction to blast. However, 79 genotypes of mini core and 16 inbreed lines depicted moderately susceptible reaction and remaining was found susceptible to highly susceptible.

Abstract No. 2.

Integrated management of wheat blast

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Wheat blast has reached to Bangladesh in 2016 and posing threat to wheat cultivation in neigbhouring countries sharing borders with Bangladesh. In India strategies are formulated jointly by DAC&FW, ICAR SAUs and state agriculture departments during 2016-17 and 17-18 crop seasons to prevent the entry of wheat blast from Bangladesh and other South American countries where wheat blast occurs. Regular survey and surveillance programmes are conducted with competent teams of scientists along Indo-Bangladesh borders in West Bengal, Assam and along West Bengal borders in the states of Jharkhand and Bihar. Vigil on disease is also kept in other states. Trap plot nurseries are planted at strategic locations in West Bengal. Strict quarantine measures are in place to restrict import of wheat seeds from Bangladesh and other countries where wheat blast is reported. As a precautionary measure, 'no wheat zone' up to five km distance from Bangladesh borders in India is maintained and 'wheat holiday' is declared in two major wheat growing districts, Nadia and Murshidabad in West Bengal. The BSF is trained to intercept any unauthorized wheat seed movement across the borders from Bangladesh. An adhoc IPM is formulated for use under any emergency situation. A set of 140 Indian wheat varieties and entries in advanced yield trials was screened against wheat blast in Bangladesh and USA and at least six entries were found quite resistant. HD 2967 high yielding variety of wheat meant for Northeastern and western plains zones was found resistant. Awareness among seed growers, farmers and agriculture department officers is created through trainings and use of digital media. Anticipatory breeding programme for blast resistance is initiated.

List of Participants in Brain Storming session at IIWBR Karnal held on 8th August 2018

1. Dr. S. K. Malhotra,
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