Plant Pathology Annual Progress Report: AICRP Small Millets *Kharif* 2020-21

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Executive summary

Survey and Surveillance: Survey and surveillance for small millets diseases in farmers field was conducted by six centers viz., Athiyandal, Jagdalpur, Mandya, Ranchi, Ranichauri and Vizianagaram for disease of finger millets; foxtail millet at Athiyandal and Nandyal; little millet and kodo millet at Athiyandal and barnyard millet at Ranichauri. Low to moderate incidence of blast was noticed at Athiyandal, Jagdalpur and Mandya; moderate to high incidence was recorded at Vizianagaram, Rnichauri and Ranchi. Other diseases viz., banded blight (0-9.26 PDI) at Jagdalpur; brown spot (0-3G) at Athiyandal; foot rot (0-8 %) at Mandya and severe incidence (5-8G) of cercospora leaf spot (CLS) was recorded at Ranichauri, Utharakhad.

In foxtail millet low to modeartae incidence of blast (1-5G); rust (1-5G) and brown spot (0-3G) was recoded at Athiyandal, Tamil Nadu. Severe incidence of leaf blast (5-7G on 109 scale) and rust (8-9G) was observed Nandyal, Andra Pradesh.Brown spot on little millet and kodo miilet and head smut on kodo millet was recorded at Athiyandal in Tamil Nadu.Low to moderate incidence of grain smut, head smut and banded sheath blight on local as well as improved varieties was observed at Ranichauri, Utharakhad

New reports of diseases: Blast on barnyard millet was observed for the first time in southern peninsular particularly in Karnataka at V C Farm mandya and Bengaluru. Pathogen causing blast on barnyard millet was isolated and pure culture was established by single spore isolation technique and pathogenicity was proved under controlled conditions. Pathogen was identified as *Pyricularia* Sp. based on cultural-morphological characters. Further, molecular characterization of the pathogens and species confirmation is under progress.

Finger Millet Initial Varietal Trial (FMIVT): A set of 23 test entries along with 4 checks *viz*.,VL 376, GPU 67, GPU 45, PR 202 and GE 4449 and Uduru mallige as resistant and susceptible checks for blast were evaluated for resistance to major diseases at eight centres. The leaf blast which is the most important disease of the crop was low at Jagdalpur, Rewa and Vizianagaram; Moderate to high at Athiyandal, Almora, Ranichauri and Mandya. Maximum (5.94G) mean incidence of leaf blast was recorded at Almora followed by Ranichauri (4.87G) and mandya (4.64G) on 1-9 scale. Severe finger blast (33.37%) was recorded at Athiyandal followed by Vizianagaram and Rewa. Similarly maximum neck blast was recorded at Vizianagarm followed by Athiyandal and Jagdalpur. Moderate to severe incidence of banded blight was observed at Jagadalpur, Rewa and Vizianagarm. Low to moderate incidence of foot rot was recorded at Jagadalpur, Mandya and Rewa and severe incidence of *Cercospora* leaf spot was noticed at Ranichauri center of Utharakhad district.

Among 23 test entries FMV 1187 (BR-IAR6) found resistant for leaf, neck as well as finger blast; FMV 1206 (VR 1130) found resistant for leaf as well as finger blast and FMV 1198 (OEB 610) resistant for neck and finger blast. The test entries viz., GE 4999 (C), FMV 1201(RAUF 25),FMV 1200 (OEB 633), FMV 1206 (VR1130), FMV 1198 (OEB 610), FMV 1204(IIMR- FM-3002), FMV 1202(IIMR-FM-3001), GPU 67 (C), and FMV 1191 (VL408) are found promising for banded blight. Entries VL 376(C), GE4449 (C), PR 202, FMV 1186(BR-IAR5), FMV 1190(VL 407), GPU 45(C), FMV 1205(IIMR- FM- 3003), FMV 1195(PR 1433), FMV 1187 (BR-IAR 6) and FMV 1201(RAUF 25)found promising for foot rot

Finger Millet Advanced Varietal Trial (FMAVT-SZ): Both early and medium maturity groups were screened for resistance to major diseases at five centres *viz.,* Athiandal, Bengaluru, Mandya, Jagdalpur and Vizianagaram. A set of 12 test entries along with blast resistant (GE 4449) and susceptible (Uduru mallige) checks were evaluated for major diseases of finger millet.

FMV 1162(VL 400) and FMV 1166(PR 1506) are found resistant for leaf, finger and neck blast. Entries viz., GE4449 (C), FMV 1137(WN- 591), FMV 1160(GPU 101), VL 376(C), FMV 1162 (VL 400), and FMV 1182(VR 1112) promising for banded blight .

Finger Millet Advanced Varietal Trial (FMAVT-NZ): A set of 13 entries of early and medium maturity groups with blast resistant (GE 4449) and susceptible (Uduru mallige) check were evaluated for resistance at three centres *viz.,*Almora, Ranichauri and Ranchi in north zone. FMV 1141(KMR 650), found promising for leaf and neck blast and FMV 1166(PR 1506) for neck and finger blast. Entries viz., FMV 1155(IIMR-FM-8011-17), FMV 1160(GPU 101), FMV 1141(KMR 650), FMV 1165(PR 1643), FMV 1143(OEB 604) and FMV 1137(WN-591) were promising for CLS at Ranichauri.

Foxtail millet Initial and Advanced Varietal Trial (FIAVT): Among 18 entries evaluated at 5 centers for major diseases. Entries viz., SiA 3282(C), FXV 645(IIMRFxM-7), FXV 615(SiA 3159), FXV 626(SiA 4200), FXV 625(SiA 3303) and FXV 638(CRSFxM-1) were found promising for blast resistance (< 4G on 1-9 scale). FXV 645(IIMRFxM-7), FXV 615(SiA 3159), FXV 626(SiA 4200) and SiA 3282, DHFt 109-3 were found promising for rust

Little millet Advanced Varietal Trial (LIAVT): Twenty one entries evaluated along with RLM 208-Resistant check for Banded blight and RLM 223-Susceptible check grain smut at 6 centers. LMV 533(IIMR-LM-8400-17), LMV 554(TNPsu 227), LMV 559(VS 13), LMV 539 (VS 25), RLM 223(C), LMV 540 (GPUL 8) and JK 8(C) were found resistant for leaf blight. Entries viz., RLM 208 (C), LMV 546(IIMR-R 18-5004), LMV 550(VS 6), JK 8(C), LMV 552(LMNDL -4), LMV 533(IIMR-LM-8400-17), LMV 555(TNPsu 231) and LMV 559(VS 13).All the tested entries shown highly resistant to resistant reaction for brown spot

Kodo millet Initial and Advanced Varietal Trial (KIAVT): Among twenty entries evaluated at 7 centers Entries RK 390-25 (C), KMV 562(RPS 1009), KMV 558(TNPsc 313), KMV 571(IIMR-KM-2)KMV 566(KMNDL-5) and KMV 560(DK 159) were found promising for head smut resistance. RK 390-25 (C), KMV 559(DK 151), TNAU 86, KMV 568(TNPsc 308) and KMV 560(DK 159) were found promising for banded blight.

Barnyard millet Initial and Advanced Varietal Trial (BIAVT): Among 22 entries evaluated entries viz., PRB 903(C), BVM 595(IIMR-VM-2-17), BVM 612(IIMR-BM-8-1920), BVM 597(TNEF 317), BVM 591(TNEf 307) and BVM 614(VMBC 336 were found promising for grain smut resistance. BVM 600(VMBC 333), BVM 612(IIMR-BM-8-1920), BVM 610(TNEf 319), BVM 613(VMBC 335) and PRB 903(C) were promising for banded/sheath blight.

Proso millet Initial and Advanced Varietal Trial (PIAVT): Out of twenty three entries TNPm230(C), PMV 446(PMNDL-1), PMV 468(PNMDL-4), PMV 452(PMNDL-2), PMV 463(TNPm 280) and PMV 462(TNPm 275) were found promising for leaf blight. TNPm230(C), PMV 459(GPUP 32), PMV 458(GPUP 30), TNAU 202, PMV 457(IIMR 163), PMV 467(DHPM 81-3) and PMV 452(PMNDL-2)were found promising for banded blight.

Browntop millet Initial Varietal Trial (BTIVT): Fifteen entries were tested for their reaction to major diseases. None of the entries found resistant for leaf blight. However entries BTV 5(KMBT-1), BTV 20(GPBT 9), BTV 23(TNBr 012) and BTV 9(GPUBT 5) accounted comparatively less disease grade. Entries viz., GPUBT 6, BTV 23(TNBr 012), BTV 25(VBT 007) and BTV 1(GPUBT 1) were found promising for banded blight and GPUBT 6, BTV 23(TNBr 012) and BTV 3(GPUBT 3) were found promising for rust.

National screening nursery (NSN): Identification of resistant source to major diseases of a millets is essential for breeding for disease resistance. With this background selected entries of all six millets were screened at different locations of disease hot spots to know their reaction to major diseases. In NSN finger millet 20 entries were evaluated of which NSNFM-28(KMR 630), NSNFM-30 (KMR 655), were resistant for neck and finger blast with minimum disease incidence and NSNFM-33 (VL 410) is found resistant for leaf and finger blast. In NSN

foxtail millet NSNFoxM-6 (TNSi 416) found promising for leaf blast and brown spot resistance. SiA 3282 (C), NSNFoxM-11(TNSi 421), NSNFoxM-12(TNSi 422) NSNFoxM-20(SiA 2755), NSNFoxM-18(GS 2137) and NSNFoxM-4(SiA 1827) were found promising for rust. Out of 13 entries evaluated in NSN little millet entries NSNLM-16 (RLM 368), NSNLM-17(RLM 396), NSNLM-14(RLM 217), NSNLM-15(RLM 224), NSNLM-7(TNPSu 221) and RLM 208 (C) were found promising for leaf blight. RLM 208 (C), NSNLM-6(TNPSu 220), NSNLM-13(RLM 204), NSNLM-12(BL 29) and NSNLM-5(TNPSu 219) were found promising for banded blight. Out of 15 entries evaluated in Kodo Millet, NSNKM-5(GPLM 254), NSNKM-17(TNPsc 176), RK390 25 (C), NSNKM-5(GPLM 254) and NSNKM-13(RPS 1007)were found promising for head smut. Out of 13 entries evaluated in NSN barnyard millet NSNBM 28 (VL 257), NSNBM 19(LRB-24) NSNBM 29(VB-19-15), NSNBM 20(LRB-29) and NSNBM 18(LRB-17) were found promising for grain smut. In NSN proso millet entries NSNPM-2(TNPm-311), NSNPM-6(TNPm-315), NSNPM-7(TNPm-316) and NSNPM-8(TNPm-317) were found promising for leaf blight and TNPm230 (C), NSNPM-1(TNPm-310), NSNPM-2 (TNPm-311) and NSNPM-6(TNPm-315) were found promising for banded blight

Management of Finger millet blast with bio-agents and new molecules of fungicides: Seed treatment with *P. flourescence* @10g/kg + spraying with Tricyclazole + Mancozeb 62% WP combi product 1st spray at the time of flowering, 2nd spray 10-15 days later @0.5g/L was found effective for management of blast and it also accounted maximum grain yield (2349 Kg/ha.) and fodder yield (6004Kg/ha). Pooled analysis (2019 and 2020) also revealed that seed treatment with *P. flourescence* @10g/kg + spraying with Tricyclazole + Mancozeb 62% WP (T_3) was found effective in management of blast disease compared to other treatments as evidenced by minimum incidence of leaf (3.64G), finger (13.94%) and neck blast (10.41%) with maximum grain and fodder yield. Further, it also accounted maximum BCR of 3.4 rupees as against 1.29 in untreated control.

Avoidable yield loss assessment: Avoidable yield loss assessment due to blast in finger millet, rust in foxtail millet and banded blight in finger millet and other small millets was initiated. A graded level of disease intensity was created by manipulating the artificial inoculation on popular local disease susceptible variety. Preliminary studies indicated that yield loss was increased with increasing disease severity.

Detailed report

Coordinated trails on seven millets *viz.,* finger millet, foxtail millet, kodo millet, little millet, barnyard millet proso millet and browntop millet were conducted at 9 AICRP centres located in seven different states and two voluntary centre one at VPKAS, Almora (Uttatakhand) and Rewa (Madya Pradesh) during the *Kharif* 2020, all centres could implement the cent percent programme as per technical plan.

1. Survey and surveillance for the important of diseases of finger millet and other small millets

1.1. Survey and surveillance for the incidence of diseases of finger millet

Survey and surveillance for diseases is essential to monitor occurrence of different diseases vis-à-vis the extent to which it occurs. It also provides information on new disease/s noticed alongside the location and varieties affected for planning the breeding and management strategies.

Athiyandal: Low to moderate incidence of leaf blast (1-6G), finger blast (0-23%) , neck blast (0-12%), brown spot and grain mould disease were noticed in surveyed areas on local as well as improved varieties (Table 1.1)

Jagdalpur: Maximum incidence (34.60%) of finger blast was recorded on local variety. Moderate to low incidence of leaf and neck blast was observed in the finger millet local varieties in surveyed area. Banded blight incidence was observed in the range of 0-9.26 per cent on local varieties (Table 1.2).

Mandya: Low to moderate finger (0-35%) and neck blast (0-20%) incidence was noticed on local as well as improved varieties of finger millet. Maximum (8%) foot rot incidence was recorded at VC Farm, Mandya on KMR 301 variety (Table 1.4).

Ranchi: Moderate to high blast incidence was noticed, maximum incidence of leaf, finger and neck blast was observed on local varieties compared to improved varieties *viz*., A 404 and BBM- 10 of finger millet (Table 1.3). Leaf blast (1-7G); finger blast (6.5-38.7%) and neck blast (0-32.8%) was observed in the surveyed area.

Ranichauri: In local as well as improved varieties low to moderate incidence of leaf blast, finger blast and neck blast was noticed. However, incidence varied with date of sowing. Moderate to high incidence (4-8G) of *Cercospora* leaf blast was recorded in local as well as improved varieties with mean incidence of 6.27G (Table 1.5)

Vizianagaram: Surveyed areas of Vizianagaram district revealed that moderate to high incidence of leaf (1.3-6.7G) neck (9-20%) and finger blast (11.3-24.7%) occurred in the VR 847 variety of finger millet (Table 1.6).

1.2: Survey and surveillance for the incidence of diseases of other small millets

Survey was conducted for the incidence of diseases in foxtail millet (Athiyandal and Nandyal); little millet and kodo millet (Athiyandal) and barnyard millet (Ranichauri)

Athiyandal: Low to moderate incidence of leaf blast, rust and brown spot were noticed in surveyed areas on local varieties in foxtail millet (Table 1.7) and brown spot (1-3G) on little millet (Table 1.9). Head smut (0-5%) on kodo millet (Table 1.10)

Nandyal: Moderate to high incidence of leaf blast and brown spot in surveyed areas of Nandyal and 5- 10.3 per cent incidence of downy mildew was observed.

Ranichauri: Low to moderate incidence of grain smut, head smut and sheath blight was recorded in local as well as improved varieties in surveyed areas (Table 11.1).

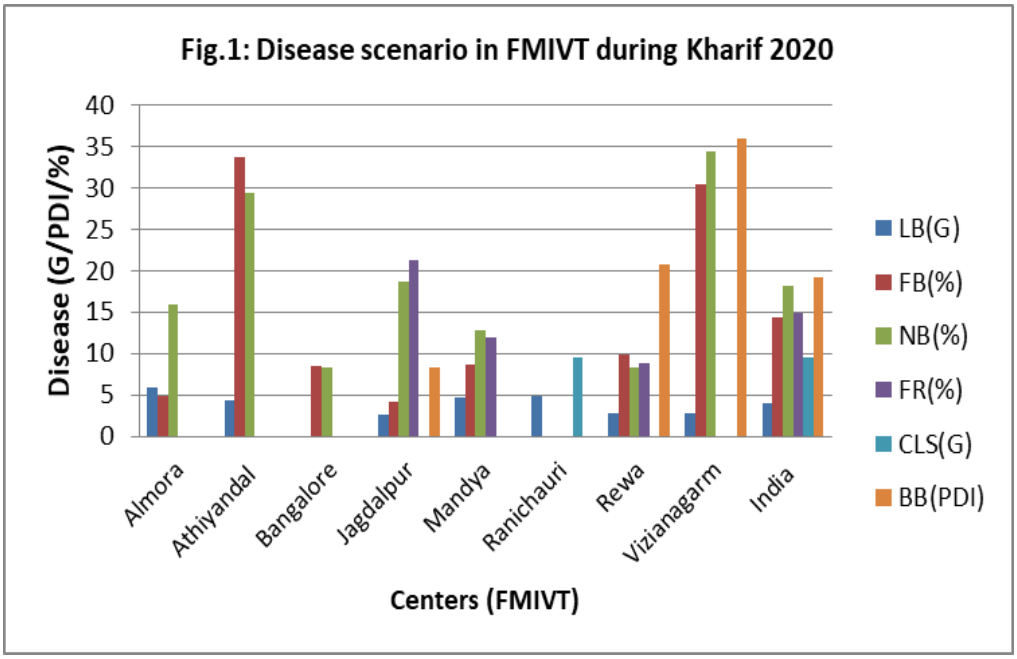
2. Evaluation of Coordinated breeding materials for diseases

2.1: Evaluation of IVT entries of finger millet

A set of 23 test entries along with 4 checks *viz*.,VL 376, GPU 67, GPU 45, PR 202 and GE 4449 and Uduru mallige as resistant and susceptible checks for blast were evaluated for resistance to major diseases at eight centres. The leaf blast which is the most important disease of the crop was low at Jagdalpur, Rewa and Vizianagaram; Moderate to high at Athiyandal, Almora, Ranichauri and Mandya. Maximum (5.94G) mean incidence of leaf blast was recorded at Almora followed by Ranichauri (4.87G) and mandya (4.64G) on 1-9 scale. (Table 2.1 and Fig. 1). Severe finger blast (33.37%) was recorded at Athiyandal followed by Vizianagaram and Rewa. Similarly maximum neck blast was recorded at Vizianagarm followed by Athiyandal and Jagdalpur. Moderate to severe incidence of banded blight was observed at Jagadalpur, Rewa and Vizianagarm. Low to moderate incidence of foot rot was recorded at Jagadalpur, Mandya and Rewa and severe incidence of *Cercospora* leaf spot was noticed at Ranichauri center of Utharakhad district (Table 2.2, 2.3, 2.4, 2.5 and Fig. 1)

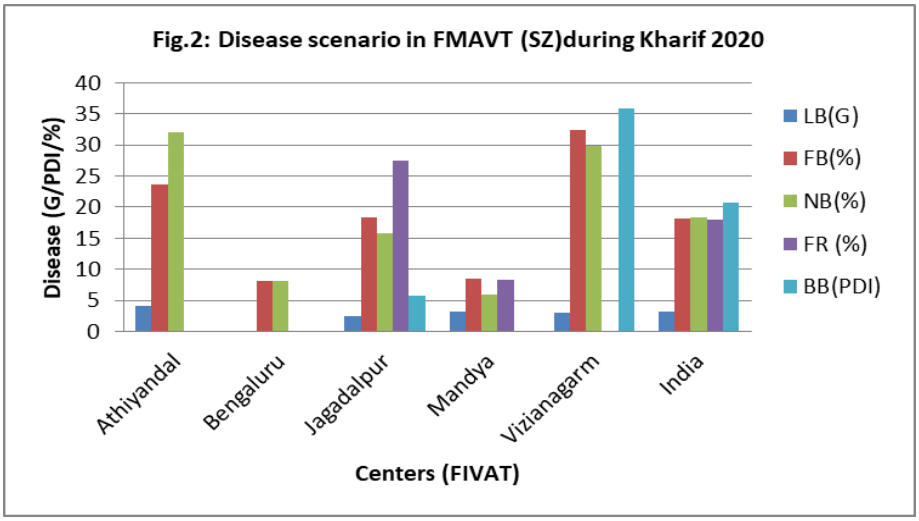
Among 23 test entries FMV 1187 (BR-IAR6) found resistant for leaf, neck as well as finger blast; FMV 1206 (VR 1130) found resistant for leaf as well as finger blast and FMV 1198 (OEB 610) resistant for neck and finger blast.

The test entries viz., GE 4999 (C), FMV 1201(RAUF 25),FMV 1200 (OEB 633), FMV 1206 (VR1130), FMV 1198 (OEB 610), FMV 1204(IIMR- FM-3002), FMV 1202(IIMR-FM-3001), GPU 67 (C), and FMV 1191 (VL408) are found promising for banded blight. Entries VL 376(C), GE4449 (C), PR 202, FMV 1186(BR-IAR5), FMV 1190(VL 407), GPU 45(C), FMV 1205(IIMR- FM- 3003), FMV 1195(PR 1433), FMV 1187 (BR-IAR 6) and FMV 1201(RAUF 25) found promising for foot rot. Promising entries identified against important diseases (Table I).



2.2: Evaluation of AVT (SZ) entries of finger millet

Both early and medium maturity groups were screened for resistance to major diseases at five centres *viz.,* Athiandal, Bengaluru, Mandya, Jagdalpur and Vizianagaram. A set of 12 test entries along with blast resistant (GE 4449) and susceptible (Uduru mallige) checks were evaluated for major diseases of finger millet. FMV 1162(VL 400) and FMV 1166(PR 1506) are found resistant for leaf, finger and neck blast. Entries viz., GE4449 (C), FMV 1137(WN- 591), FMV 1160(GPU 101), VL 376(C), FMV 1162 (VL 400), and FMV 1182(VR 1112) promising for banded blight (Table 3.1, 3.2, 3.3) and the disease severity at various centers was presented in Fig 2). Promising entries identified against important diseases in south zone (Table I).



2.3: Evaluation of AVT (NZ) entries of finger millet

A set of 13 entries of early and medium maturity groups with blast resistant (GE 4449) and susceptible (Uduru mallige) check were evaluated for resistance at three centres *viz.,*Almora, Ranichauri and Ranchi in north zone. FMV 1141(KMR 650), found promising for leaf and neck blast and FMV 1166(PR 1506) for neck and finger blast. Entries viz., FMV 1155(IIMR-FM-8011-17), FMV 1160(GPU 101), FMV 1141(KMR 650), FMV 1165(PR 1643), FMV 1143(OEB 604) and FMV 1137(WN-591) were promising for CLS at Ranichauri (Table 4.1 and 4.2) and the disease severity at Almora, Ranchi and Ranichauri centers was presented in Fig 3 and Promising entries identified against important diseases(Table I)

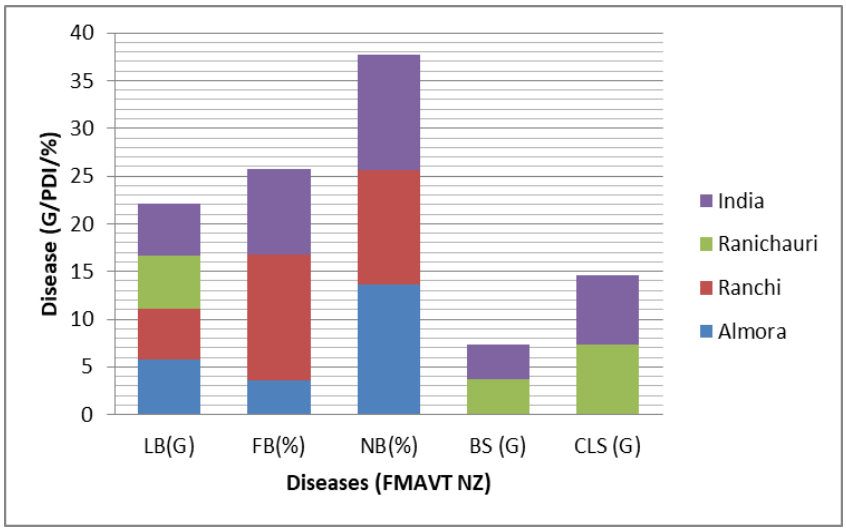


Fig.3: Disease scenario in Finger millet AVT (NZ) during Kharif 2020

2.4: Evaluation of Foxtail millet Initial and Advanced Varietal Trial (FIAVT)

Among 18 entries evaluated at 5 centers for major diseases. Entries viz., SiA 3282(C), FXV 645(IIMRFxM-7), FXV 615(SiA 3159), FXV 626(SiA 4200), FXV 625(SiA 3303) and FXV 638(CRSFxM-1) were found promising for blast resistance (< 4G on 1-9 scale). FXV 645(IIMRFxM-7), FXV 615(SiA 3159), FXV 626(SiA 4200) and SiA

3282, DHFt 109-3 were found promising for rust (Table 5.1 & 5.2). Promising entries identified against important diseases are presented in Table I. The disease severity of various diseases varied from center to center (Fig 4.)

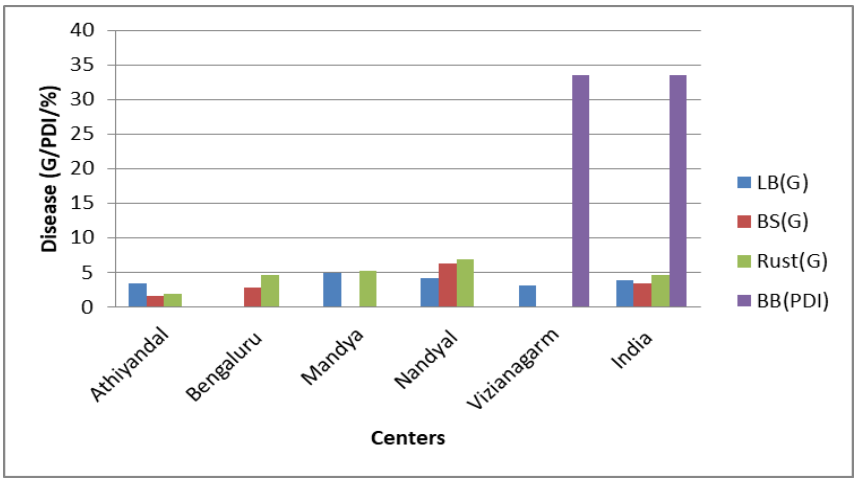


Fig.4: Disease scenario in Foxtail millet (FIAVT) during Kharif 2020

2.5: Evaluation of Little millet Initial Varietal Trial (LIAVT)

Twenty one entries evaluated along with RLM 208-Resistant check for Banded blight and RLM 223-Susceptible check grain smut at 6 centers. LMV 533(IIMR-LM-8400-17), LMV 554(TNPsu 227), LMV 559(VS 13), LMV 539 (VS 25), RLM 223(C), LMV 540 (GPUL 8) and JK 8(C) were found resistant for leaf blight. Entries viz., RLM 208 (C), LMV 546(IIMR-R 18-5004), LMV 550(VS 6), JK 8(C), LMV 552(LMNDL -4), LMV 533(IIMR-LM-8400-17), LMV 555(TNPsu 231) and LMV 559(VS 13). All the tested entries shown highly resistant to resistant reaction for brown spot (Table 6.1 & 6.2)..

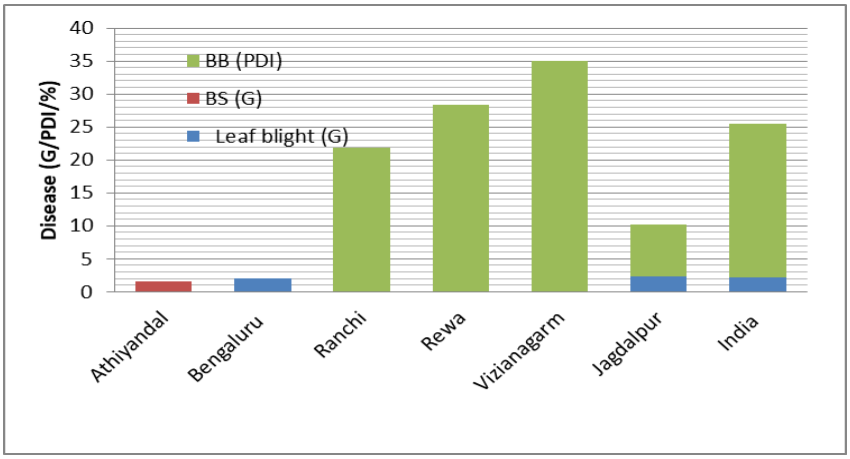


Fig.5: Disease scenario in Little millet (LIAVT) during Kharif 2020

Promising entries against important disease were presented in Table II and the brown spot at Athiyandal and leaf blight at Bengalore and Jagadalpur and different levels of banded blight incidence was recoded at Jagdalpur, Ranchi, Rewa and Vizianagaram (Fig 5)

2.6: Evaluation of Kodo millet Initial and Advanced Varietal Trial (KIAVT)

Among twenty entries evaluated at 7 centers Entries RK 390-25 (C), KMV 562(RPS 1009), KMV 558(TNPsc 313), KMV 571(IIMR-KM-2)KMV 566(KMNDL-5) and KMV 560(DK 159) were found promising for head smut resistance. RK 390-25 (C), KMV 559(DK 151), TNAU 86, KMV 568(TNPsc 308) and KMV 560(DK 159) were found promising for banded blight.

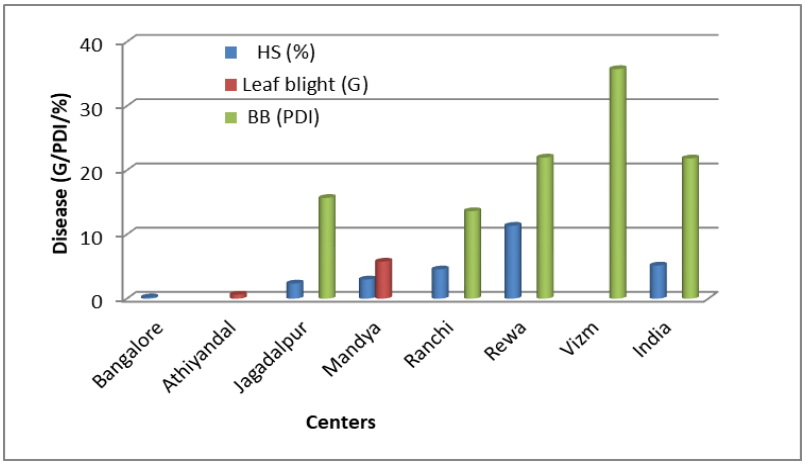


Fig.6: Disease scenario in Kodo millet (KIAVT) during Kharif 2020

Promising entries against important disease were presented in Table II and the disease scenario of various diseases varied and is depicted in Fig 6.

2.7: Evaluation of Barnyard millet Initial and Advanced Varietal Trial (BIAVT)

Among 22 entries evaluated at various locations entries *viz*., PRB 903(C), BVM 595(IIMR-VM-2-17), BVM 612(IIMR-BM-8-1920), BVM 597(TNEF 317), BVM 591(TNEf 307) and BVM 614(VMBC 336 were found promising for grain smut resistance. BVM 600(VMBC 333), BVM 612(IIMR-BM-8-1920), BVM 610(TNEf 319), BVM 613(VMBC 335) and PRB 903(C) were promising for banded/sheath blight.

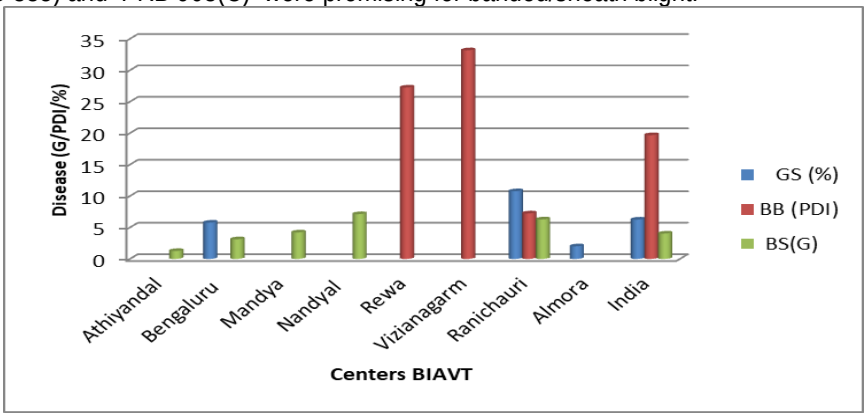


Fig.7: Disease scenario in Barnyard millet (BIAVT) during Kharif 2020

BVM 603(ACM 15-343), BVM 602(ACM-15-353), BVM 610(TNEf 319), PRB 903(C), BVM 613(VMBC 335) and BVM 595(IIMR-VM-2-17) were found promising for leaf blight resistance (Table 8.1, 8.2 and Table II).

2.8: Evaluation of Proso millet Initial and Advanced Varietal Trial (PIAVT)

Proso millet Initial and Advanced Varietal Trial (PIAVT): Out of twenty three entries TNPm230(C), PMV 446(PMNDL-1), PMV 468(PNMDL-4), PMV 452(PMNDL-2), PMV 463(TNPm 280) and PMV 462(TNPm 275)

were found promising for leaf blight. TNPm230(C), PMV 459(GPUP 32), PMV 458(GPUP 30), TNAU 202, PMV 457(IIMR 163), PMV 467(DHPM 81-3) and PMV 452(PMNDL-2)were found promising for banded blight and All entries tested shown highly resistant to resistant reaction at Athiyandal (Table 9.1 and 9.2). Promising entries were identified against major diseases (Table II).

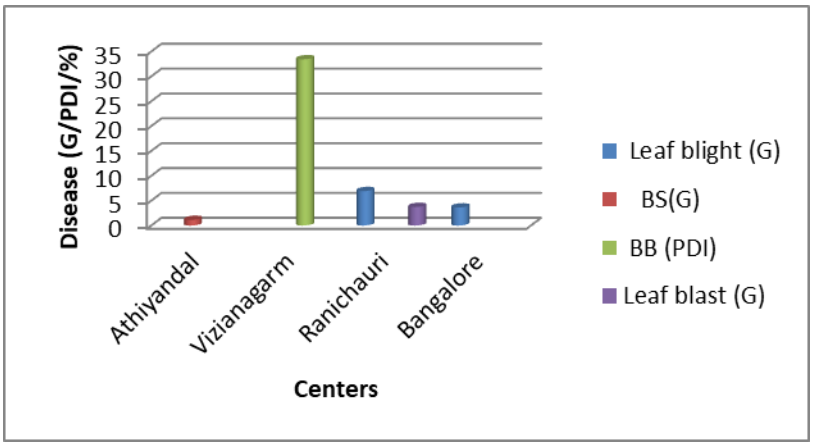


Fig.8: Disease scenario in Proso millet (KIAVT) during Kharif 2020

2.9: Evaluation of Browntop millet Initial Varietal Trial (BTIVT)

Fifteen entries were tested for their reaction to major diseases. None of the entries found resistant for leaf blight. However entries BTV 5(KMBT-1), BTV 20(GPBT 9), BTV 23(TNBr 012) and BTV 9(GPUBT 5) accounted comparatively less disease grade. Entries viz., GPUBT 6, BTV 23(TNBr 012), BTV 25(VBT 007) and BTV 1(GPUBT 1) were found promising for banded blight and GPUBT 6, BTV 23 (TNBr 012) and BTV 3(GPUBT 3) were found promising for rust (Table 10.1 and 10.2)

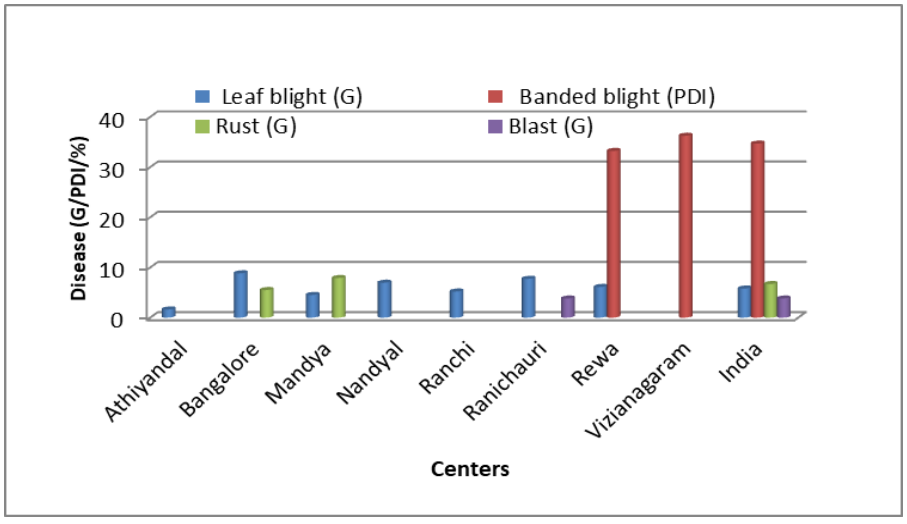


Fig.9: Disease scenario in Browntop millet (BTIVT) during *Kharif* 2020

3. Evaluation of National Screening Nursery (NSN)

National screening nursery (NSN): Identification of resistant source to major diseases of a crop is essential to generate information on lines showing multiple disease resistance. In this background selected entries of finger millet, kodo millet, little millet, foxtail millet, barnyard millet and proso millet were screened at different locations

for reaction to major diseases to identify resistant sources with multiple disease resistance for use as donors in developing improved varieties

3.1: Evaluation of NSN finger millet entries

NSN finger millet 20 entries were evaluated at eight locations *viz.*, Athiyandal, Almora, Bengaluru, Mandya, Jagadalpur, Ranchi, Ranichauri and Vizianagaram. NSNFM-28(KMR 630), NSNFM-30 (KMR 655), were resistant for neck and finger blast with minimum disease incidence and NSNFM-33 (VL 410) is found resistant for leaf and finger blast. Entries viz., NSNFM-23(UURM-2014-1), GE 4999 (C), NSNFM-33 (VL 410) and NSNFM-17 (VR 1149) were found promising for foot rot resistance. Similarly NSNFM-33 (VL 410), NSNFM-16 (VR 1148), NSNFM-22 (VRBMF 1819), NSNFM-23 (UURM-2014-1) and NSNFM-31 (VL 384) were found promising for CLS resistance (Table 11.1, 11.2, 11.3 and 11.4). Promising entries were identified for major disease (Table I). The severity of diseases varied significantly among the locations (Fig.10).

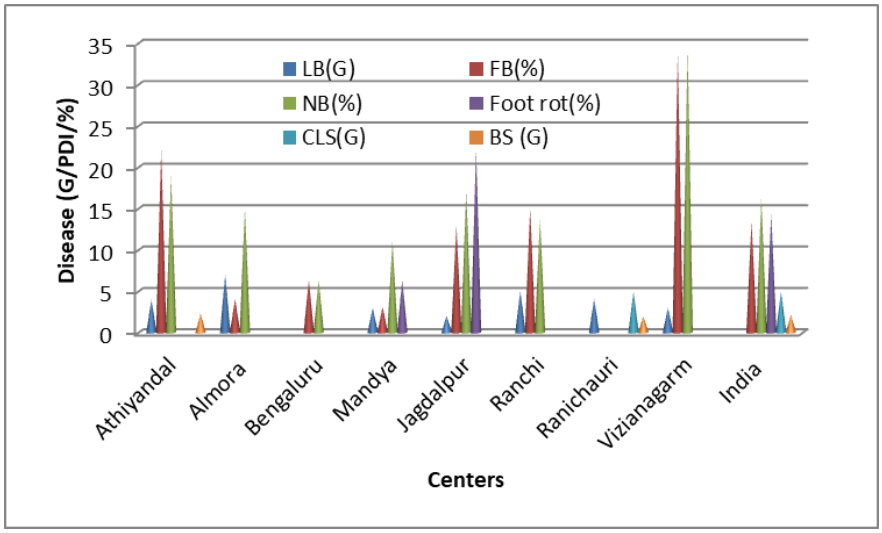


Fig.10: Disease scenario in Finger millet (NSN FM) during *Kharif* 2020

3.2: Evaluation of NSN Foxtail millet entries

Fourteen entries along with SiA 3282-Resistant check for Downy mildew and SiA 326-Susceptible check for blast, downy mildew, brown spot and rust were evaluated at 5 centers. Among tested entries NSNFoxM-6 (TNSi 416) found promising for leaf blast and brown spot resistance. SiA 3282 (C), NSNFoxM-11(TNSi 421), NSNFoxM-12(TNSi 422) NSNFoxM-20(SiA 2755), NSNFoxM-18(GS 2137) and NSNFoxM-4(SiA 1827) were found promising for rust (Table 12.1 and 12.2). The disease scenario varied among the different locations (Fig.11).

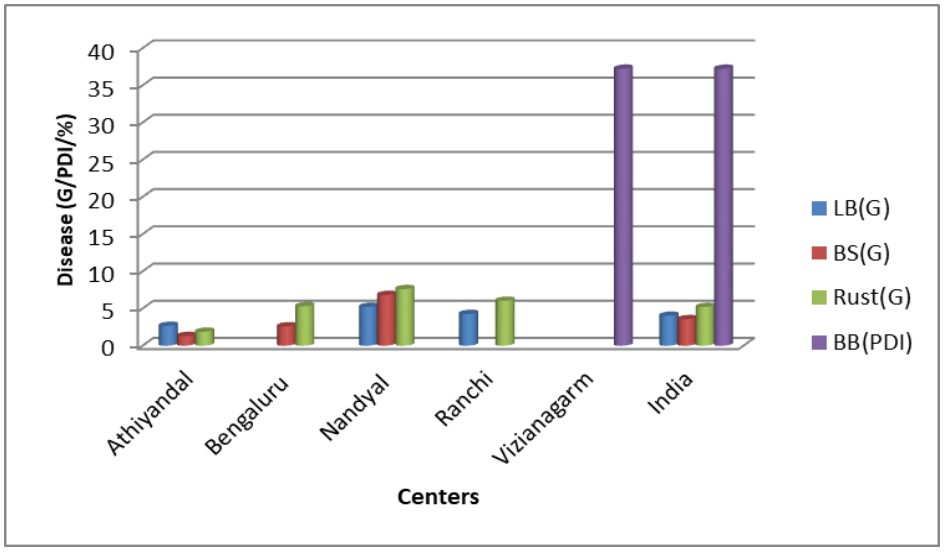


Fig.10: Disease scenario in Foxtail millet (NSN FM) during *Kharif* 2020

3.3: Evaluation of NSN Little millet entries

Out of 13 entries evaluated in NSN little millet entries NSNLM-16 (RLM 368), NSNLM-17(RLM 396), NSNLM-14(RLM 217), NSNLM-15(RLM 224), NSNLM-7(TNPSu 221) and RLM 208 (C) were found promising for leaf blight. RLM 208 (C), NSNLM-6(TNPSu 220), NSNLM-13(RLM 204), NSNLM-12(BL 29) and NSNLM-5(TNPSu 219) were found promising for banded blight. Banded blight and little millet are rise and found to be important emerging diseases (Fig.11). All entries shown highly resistant to resistant reaction for brown spot disease (Table 13.1)

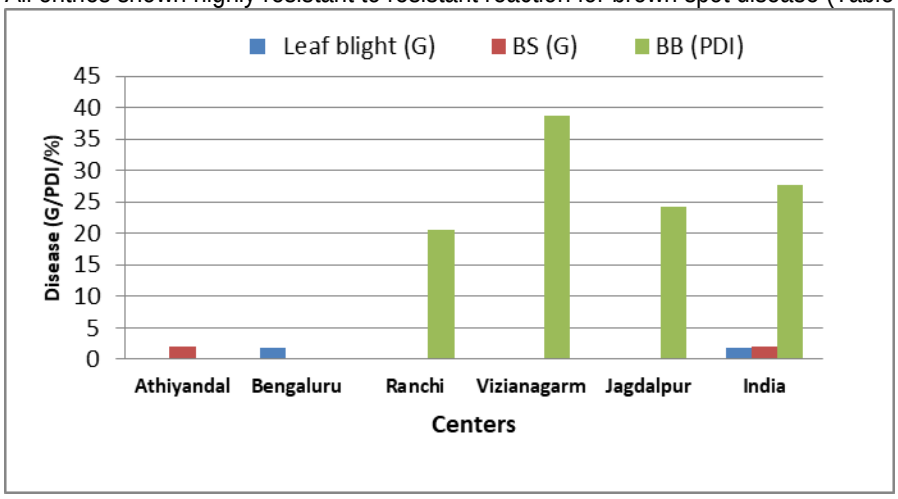


Fig. 11.Disease scenario in NSN Little millet during *Kharif* 2020

3.4: Evaluation of NSN Kodo millet entries

Out of 15 entries evaluated in Kodo Millet, NSNKM-5(GPLM 254), NSNKM-17(TNPsc 176), RK390 25 (C), NSNKM-5(GPLM 254) and NSNKM-13(RPS 1007)were found promising for head smut. RK390 25 (C), NSNKM-8(GPLM 316), NSNKM-12(RPS 1005), NSNKM-16(RPS 1011), NSNKM-14(RPS 1008) were found promising for banded blight (Table II and Table 14.1)

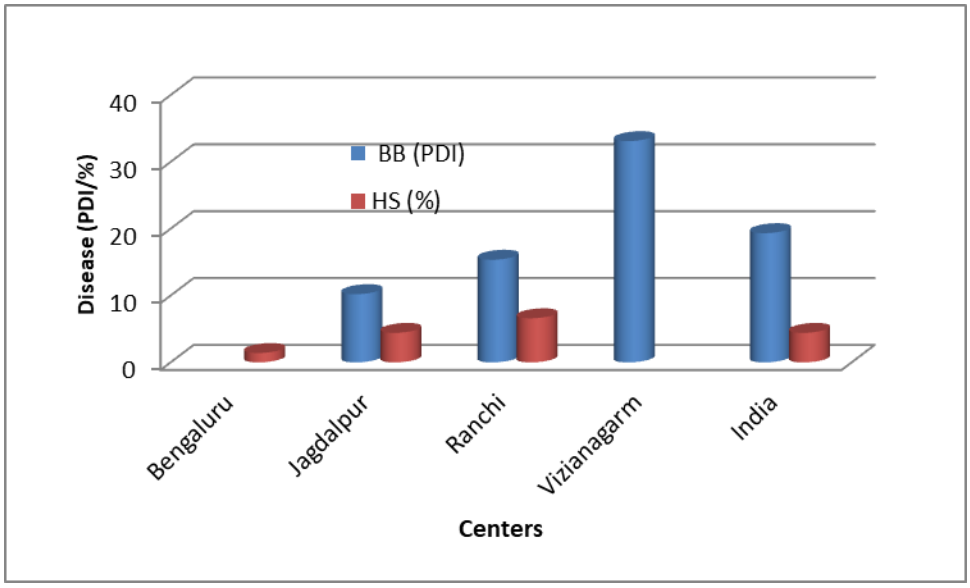


Fig.12: Disease scenario in NSN Kodo millet during *Kharif* 2020

3.5: Evaluation of NSN Barnyard millet entries

Out of 13 entries evaluated in NSN barnyard millet NSNBM 28 (VL 257), NSNBM 19(LRB-24) NSNBM 29(VB-19-15), NSNBM 20(LRB-29) and NSNBM 18(LRB-17) were found promising for grain smut. BVM 600(VMBC 333), BVM 612(IIMR-BM-8-1920), BVM 610(TNEf 319), BVM 613(VMBC 335), and PRB 903(C) found promising for banded sheath blight. Entries viz., BVM 603(ACM 15-343), BVM 602(ACM-15-353), BVM 610(TNEf 319), PRB 903(C), BVM 613(VMBC 335) and BVM 595(IIMR-VM-2-17) found promising for leaf blight (Table 15.1 and 15.2)

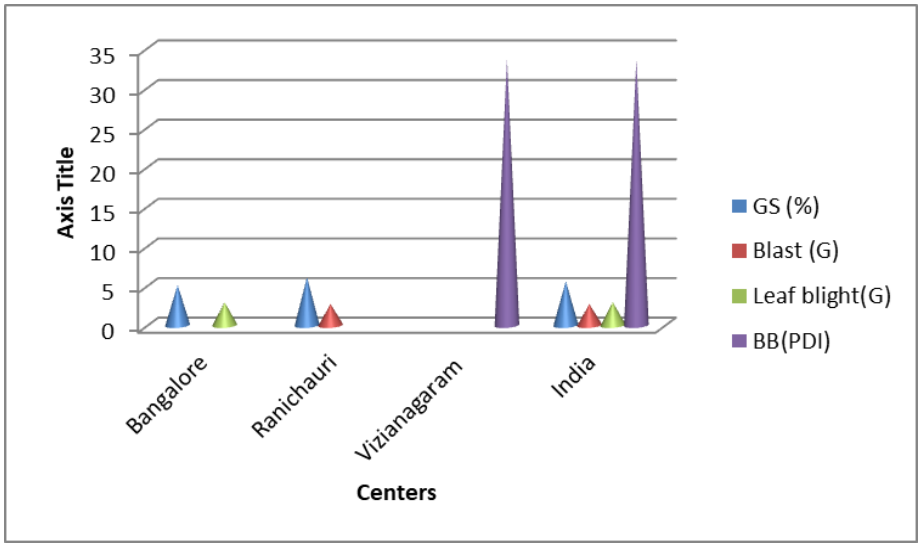


Fig.13. Disease scenario in NSN Barnyard millet during Kharif 2020

3.6: Evaluation of NSN Proso millet entries

In NSN proso millet entries NSNPM-2(TNPm-311), NSNPM-6(TNPm-315), NSNPM-7(TNPm-316) and NSNPM-8(TNPm-317) were found promising for leaf blight and TNPm230 (C), NSNPM-1(TNPm-310), NSNPM-2 (TNPm-

311) and NSNPM-6(TNPm-315) were found promising for banded blight. All entries tested shown highly resistant to resistant reaction for brown spot disease.

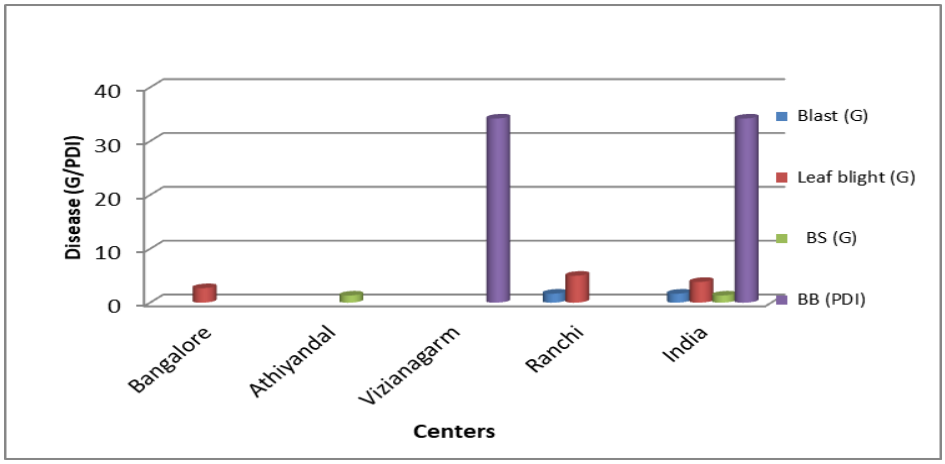


Fig.14. Disease scenario in NSN Proso millet during *Kharif* 2020

4. *Management of finger millet blast*

Blast caused by *Pyricularia grisea* is one of most destructive disease and widely distributed in almost all finger millet growing regions of the world. Its prevalent wherever finger millet is grown and is one of the major disease causing recurring yield losses in all states. Bengaluru and Mandya from Karnataka, Jagdalpur from Chatishgarh, Ranchi (Jarkhand), Ranichauri (Uttarakhand) and Vizianagaram (Andra Pradesh) were identified as host spots for blast disease among the all India coordinated centers of small millets. Therefore it was necessitated for managing the disease with bio-agents and new molecules of fungicides to find out effective management practices. The trials are implemented in seven small millets coordinating centers in six states and results are as follows.

4.1. Management of Finger millet blast with bio-agents and new molecules of fungicides:

Seed treatment with *P. flourescence* @10g/kg + spraying with Tricyclazole + Mancozeb 62% WP (T_3) combi product 1st spray at the time of flowering, 2nd spray 10-15 days later @0.5g/L was found effective for management of blast by accounting minimum incidence of leaf (3.33G), finger (11.02) and neck blast (10.41%) and it also accounted maximum grain yield (2349 Kg/ha.) and fodder yield (6004Kg/ha) as against 1192 Kg/ha and 3991 Kg/ha grain and fodder yield respectively in untreated control (Table 17.1,17.2, 17.3, 17.4 and 17.5). Pooled analysis also revealed that seed treatment with *P. flourescence* @10g/kg + spraying with Tricyclazole + Mancozeb 62% WP (T_3) was found effective in management of blast disease compared to other treatments as evidenced by minimum incidence of leaf (3.64G), finger (13.94%) and neck blast (10.41%) with maximum grain and fodder yield (Table 17.6, Fig.15 and 16). Further, it also accounted maximum BCR of 3.4 rupees as against 1.29 in untreated control (Table 17.6)

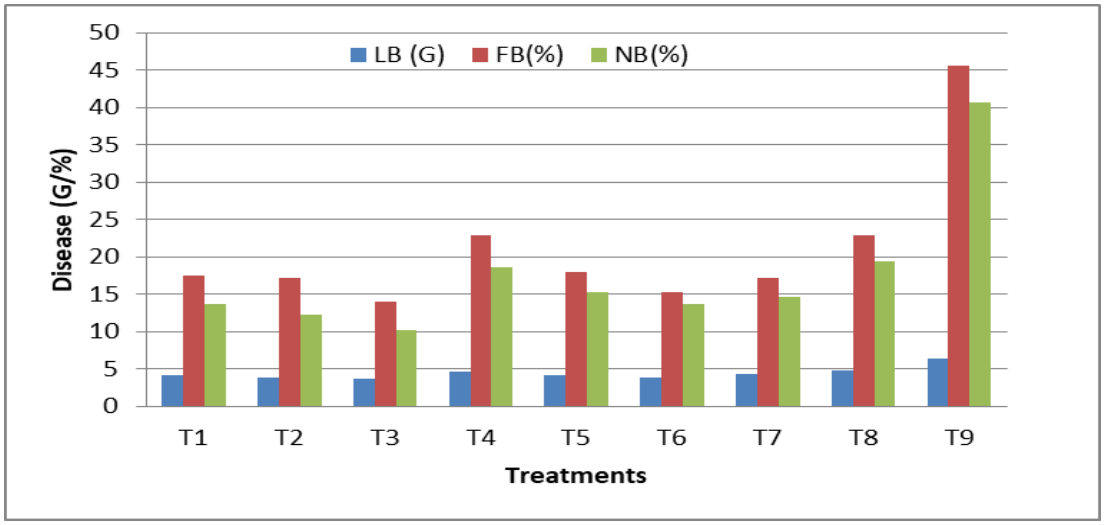


Fig.15. Efficacy bio-agents and new molecules of fungicides on Finger millet (Mean of 2 years)

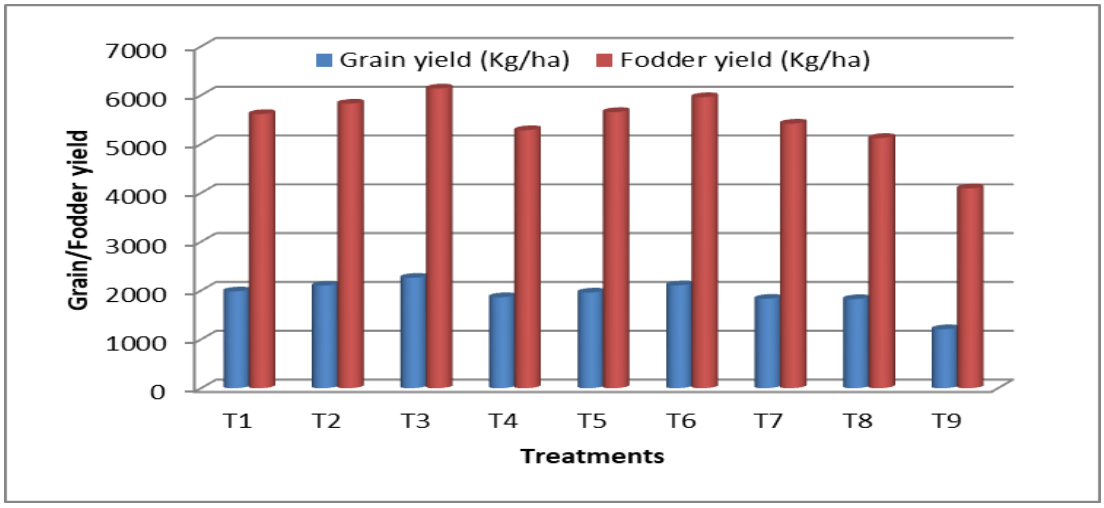


Fig.16. Efficacy bio-agents and new molecules of fungicides on Finger millet-Grain yield and fodder yield (Mean of 2 years)

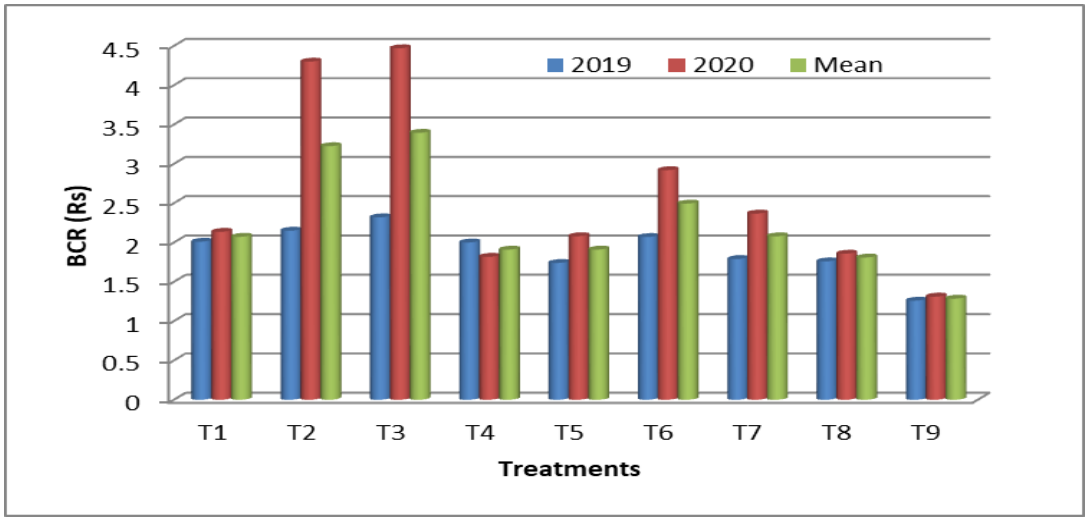


Fig.17. Efficacy bio-agents and new molecules of fungicides on Finger millet-BCR (Mean of 2 years)

Treatment details

T_1	Tebuconozole 50% + Triflixystrobin 25 WG (Nativo)	1st spray at the time of flowering, 2nd spray 10-15 days later @0.40g/L
T_2	Tricyclazole 75% WP (Beam)	1st spray at the time of flowering, 2nd spray 10-15 days later @0.60g/L
T_3	Tricyclazole + Mancozeb 62% WP (Merger)	1st T spray at the time of flowering, 2nd spray 10-15 days later @0.5g/L
T_4	Isoprothiolane 40% EC (fuji one)	1st spray at the time of flowering, 2nd spray 10-15 days later @ 1ml/L
T_5	Azoxystrobin + Difenconazole (Amister top)	1st spray at the time of flowering, 2nd spray 10-15 days later @ 1ml/L
T_6	Propiconazole (Tilt)	1st spray at the time of flowering, 2nd spray 10-15 days later @ 1ml/L
T_7	Carbendazim+ Mancozeb (Saaf)	1st spray at the time of flowering, 2nd spray 10-15 days later @2g/L
T_8	Carbendazim 50% WP(Bavistin)	1st spray at the time of flowering, 2nd spray 10-15 days later @1g/L
T_9	Control	Water spray

Note: For all the treatments seed treatment with *Pseudomonas flourescence* @10g/kg

5. Avoidable yield loss assessment

5.1. Avoidable yield loss assessment due to blast in finger millet

Avoidable yield loss assessment experiment was conducted to evaluate the effect of different levels of blast disease on finger millet yield loss. A graded level of disease intensity was created by manipulating the artificial inoculation and artificial inoculation was done at maximum tillering and during flowering stage on popular local disease susceptible variety. A total area of 250 sq m (200 sq m for the inoculated treatments and 50 sq m for the uninoculated treatment) was used for the experiment. The 200 sq m area marked for inoculation was further divided into 4 blocks of 50 sq m each to create graded level of disease. For blast trial, Block I was sprayed with blast spores ($1X10^5$/ml) 4 time at an interval of 2 days (2 sprays at tillering and 2 sprays at flowering stage); Block II was sprayed with blast spores ($1X10^5$/ml) twice one each at tillering & flowering stage and Block III was sprayed once with blast spores during maximum tillering stage and Block IV No spray and no protection (natural infection) to create different level of disease. Disease data was recorded following the SES scale as mentioned in

SOP of small millets. Yield data was recorded at 5 spots each one sq mt area in each of the four blocks and in control treatment.

The trial was conducted at 3 locations *viz*., bangalore, mandya and vizianagarm. Graded level of leaf blast (2-8G); finger blast (6- 58 %) and neck blast (5-58 %) was observed in differentially inoculated plots accordingly. The incidence of leaf blast with 8G on 1-9 scale and neck and finger blast with 58 % resulted in 66 percent yield loss and yield loss increased with increase in severity of disease. Under natural infection with 5G leaf blast; 23 % finger blast and 21% neck blast accounted for 25.46 % reduction in yield (Table 18.1 and 18.2)

5.2. Avoidable yield loss assessment due to rust in foxtail millet

The trial was conducted to evaluate the effect of different levels of rust disease on foxtail millet yield loss. A graded level of disease intensity was created by manipulating the artificial inoculation on popular local disease susceptible variety. Artificial inoculation of rust spore was essentially done by spraying conidial suspension for rust at 30-35 days after sowing. Trial was laid out as described above (5.1). For rust trial, Block I was sprayed with rust spores ($1X10^5$/ml) thrice at an interval of 2 days during panicle initiation stage ; Block II was sprayed with rust spores ($1X10^5$/ml) twice at an interval of 2 days and Block III was sprayed once with rust spores ($1X10^5$/ml) during panicle initiation stage and Block IV No spray and no protection to create different level of disease. Disease data was recorded following the SES scale as mentioned in SOP of small millets. Yield data was recorded at 5 spots each one sq mt area in each of the four blocks and in control treatment.

The trial was conducted at 3 locations *viz*., athiyandal, bangalore and nandyal. Rated level of rust (1-9G) was recorded at Bangalore in differentially inoculated plots accordingly. However, the disease pressure was low in athiyandal and nandiyal. The yield loss varied from 19 to 27 per cent and yield loss increased with increase in severity of disease (Table 19.1)

5.3. Avoidable yield loss assessment due to banded blight in finger millet and other small millets

The trial was conducted to evaluate the effect of different levels banded blight disease on small millet yield by artificial inoculation of pathogen. A graded level of disease intensity was by manipulating the artificial inoculation of pathogen. Artificial inoculation was done at maximum tillering stage in finger millet and 30-35 days after inoculation in other millets on disease susceptible variety. A total area of 250 sq m (200 sq m for the inoculated treatments and 50 sq m for the uninoculated treatment) was used for the experiment. The 200 sq m area marked for inoculation was further divided into 4 blocks of 50 sq m each to create graded level of disease. For sheath blight in Block I all the plants was inoculated (soil inoculation); in Block II alternate plants was inoculated and in Block III, one in each three plants was inoculated and Block IV No inoculation and no protection (natural infection) to create different level of disease intensity. . Disease data was recorded following the SES scale as mentioned in SOP of small millets. Yield data was recorded at 5 spots each one sq mt area in each of the four blocks and in control treatment.

5.3.1. Avoidable yield loss assessment due to banded blight in Finger millet

The trial was conducted only at viziangaram and graded level of banded blight (2-8.2G) was recorded at in differentially inoculated plots accordingly. The yield loss varied from 37.40 per cent to 61.30 per cent and yield loss increased with increase in severity of disease (Table 20.1)

5.3.2. Avoidable yield loss assessment due to banded blight in Foxtail millet and other small millets

Avoidable yield loss assessment due to banded blight in Foxtail millet and other small millets viz., little millet, kodo millet, barnyard millet, proso millet and browntop millet was conducted only at viziangaram .

In foxtail millet graded level of banded blight (1.8 – 7.6 G) was recorded at in differentially inoculated plots accordingly. The yield loss varied from 31.4 per cent to 58.8 per cent and yield loss increased with increase in severity of disease (Table 20.2). In little millet, the disease incidence ranged from 2.6 -8.6 G on 1-9 scale in differentially inoculated plots and yield loss varied from 39.8 – 63 percent (Table 20.3). In kodo millet 2-8.6 G of banded blight was recorded and yield loss was increased with increase in disease severity (Table 20.4). In barnyard millet banded blight incidence ranged from 2.6 – 8.6 G with 52.7 – 67.2 per cent yield loss. Proso millet accounted 2.4 -8.6 G with 50-97.6 per cent yield loss. Similarly, in browntop millet 1.8 – 8.4 G disease incidence was observed with 36.8 – 64.6 per cent yield loss and yield loss increased with increase in severity of disease (Table 20.5. 20.6 and 20.7).

Table I. Promising entries with less disease incidence in finger millet and foxtail millet

Trial	Leaf blast(G)	Neck blast (%)	Finger blast(%)	Banded blight (PDI)	Foot rot (%)	CLS(G)
FMIVT	GE4449 (C), FMV 1187 (BR-IAR6) FMV 1206 (VR 1130) GPU 67 (C), FMV 1190 (VL 407), GPU 45 (C), FMV1204 (IIMR-FM-3002), FMV 1198 (OEB 610), FMV 1205 (IIMR-FM-3003)	FVV 1184 (GPU 103), GE4449 (C), FMV 1194 (PR 1731), FMV 1198(OEB 610), FMV 1189 (KMR 702), FMV 1197 (TNEc 1326), FMV 1193 (PPR 1096), FMV 1190(VL 407), FMV 1187 (BR-IAR6), FMV 1204 (IIMR-FM-3002)	FMV 1194 (PR 1731), FMV 1189 (KMR 702), GE 4999 (C), FMV 1185 (GPU 104), FMV 1206 (VR 1130) FMV 1187 (BR-IAR 6) FMV 1205 (IIMR- FM-3003), FMV 1200 (OEB 633), FMV 1191 (VL 408)	GE 4999 (C), FMV 1201(RAUF 25), FMV 1200 (OEB 633), FMV 1206 (VR1130), FMV 1198 (OEB 610), FMV 1204(IIMR- FM-3002), FMV 1202(IIMR-FM-3001), GPU 67 (C), FMV 1191 (VL408)	VL 376(C), GE4449 (C), PR 202, FMV 1186(BR-IAR5), FMV 1190(VL 407), GPU 45(C), FMV 1205(IIMR- FM- 3003), FMV 1195(PR 1433), FMV 1187 (BR-IAR 6), FMV 1201(RAUF 25)	FMV 1187 (BR-IAR 6), FMV 1189(KMR 702), FMV 1185(GPU 104), GPU 67(C), GPU 45(C), PR 202(C), FMV 1205(IIMR- FM- 3003), FVV 1184(GPU 103), FMV 1206(VR 1130), FMV 1197(TNEc 1326), FMV 1203(IIMR- FM -3126), FMV 1198(OEB 610)
FMAVT (SZ)	FMV 1162(VL 400), GPU 45, VL 376(C), GE4449 (C), PR 202, FMV 1160(GPU 101), FMV 1166(PR 1506)	GE4449 (C),FMV 1137(WN-591), FMV 1162(VL 400), FMV 1137(WN- 591), FMV 1182(VR 1112), FMV 1166(PR 1506)	GE 4999 (C), FMV 1166(PR 1506), GPU 67 (C), FMV 1162(VL 400), VL 376(C), PR 202 (C)	GE4449 (C), FMV 1137(WN- 591), FMV 1160(GPU 101), VL 376(C), FMV 1162 (VL 400), FMV 1182(VR 1112)	GE4449 (C), FMV 1147(BR-14-27), FMV 1160(GPU 101), VL 376(C), FMV 1162(VL 400), FMV 1182(VR1112)	--
FMAVT (NZ)	GE4449 (C), FMV 1141(KMR 650), GPU 45 (C), FMV 1155(IIMR-FM-8011-17), VL 376(C), FMV 1182(VR 1112)	FMV 1143(OEB 604), FMV 1166(PR 1506), FMV 1137(WN-591), FMV 1160(GPU 101), FMV 1141(KMR 650)	FMV 1143(OEB 604), FMV 1141(KMR 650) FMV 1162(VL 400), FMV 1137(WN-591), FMV 1166(PR 1506)	--	--	FMV 1155(IIMR-FM-8011-17), FMV 1160(GPU 101),FMV 1141(KMR 650), FMV 1165(PR 1643), FMV 1143(OEB 604), FMV 1137(WN-591)
NSNFM	NSNFM-15 (VR 1146), NSNFM-16 (VR 1148), NSNFM-26 (KMR 203) NSNFM-31 (VL 384) NSNFM-33 (VL 410), GE 4999 (C)	NSNFM-27 (KMR 340), NSNFM-28 (KMR 630) NSNFM-30 (KMR-655), GE 4999 (C)	NSNFM-28(KMR 630), NSNFM-30 (KMR 655), NSNFM-33 (VL 410) GE 4999 (C)	GE 4999 (C), NSNFM-22 (VRBMF 1819) NSNFM-23 (UURM-2014-1) NSNFM-20(VHC 4087), NSNFM (UURM2014-2)	NSNFM-23(UURM-2014-1), GE 4999 (C), NSNFM-33 (VL 410), NSNFM-17 (VR 1149)	NSNFM-33 (VL 410) NSNFM-16 (VR 1148), NSNFM-22 (VRBMF 1819) NSNFM-23 (UURM-2014-1) and NSNFM-31 (VL 384)

Foxtail millet

TRIAL	Leaf blast	Brown spot	Rust
FIAVT	SiA 3282(C), FXV 645(IIMRFxM-7), FXV 615(SiA 3159), FXV 626(SiA 4200), FXV 625(SiA 3303), FXV 638(CRSFxM-1)	FXV 639(CRSFxM-2), FXV 645(IIMRFxM-7), FXV 643(TNSi -380), FXV 615(SiA 3159), FXV 644(IIMR-FxM-6)	FXV 645(IIMRFxM-7), FXV 615(SiA 3159), FXV 626(SiA 4200), SiA 3282, DHFt 109-3
NSNFoxM	SiA 3282(C), NSNFoxM-6(TNSi 416), NSNFoxM-4(SiA 1827), NSNFoxM-16(GS 702), NSNFoxM-8(TNSi 418)NSNFoxM-12(TNSi 422)	NSNFoxM-6(TNSi 416), NSNFoxM -1(SiA 2566), NSNFoxM-3(SiA 2667), NSNFoxM-11(TNSi 421), NSNFoxM-12(TNSi 422)	SiA 3282 (C), NSNFoxM-11(TNSi 421), NSNFoxM-12(TNSi 422) NSNFoxM-20(SiA 2755), NSNFoxM-18(GS 2137), NSNFoxM-4(SiA 1827)

Note: Under lined entries shown multiple disease resistance

Table II. Promising entries with less disease incidence in small millets

Little millet			
TRIAL	Leaf blight	Brown spot	Banded blight
LIAVT	LMV 533(IIMR-LM-8400-17), LMV 554(TNPsu 227), LMV 559(VS 13), LMV 539 (VS 25), RLM 223(C), LMV 540 (GPUL 8), JK 8(C)	All entries shown highly resistant to resistant reaction	RLM 208 (C), LMV 546(IIMR-R 18-5004), LMV 550(VS 6), JK 8(C), LMV 552(LMNDL -4), LMV 533(IIMR-LM-8400-17), LMV 555(TNPsu 231), LMV 559(VS 13)
NSNLM	NSNLM-16 (RLM 368), NSNLM-17(RLM 396), NSNLM-14(RLM 217), NSNLM-15(RLM 224), NSNLM-7(TNPSu 221), RLM 208 (C)	All entries shown highly resistant to resistant reaction	RLM 208 (C), NSNLM-6(TNPSu 220), NSNLM-13(RLM 204), NSNLM-12(BL 29), NSNLM-5(TNPSu 219)

Kodo millet		
TRIAL	Head smut	Banded blight
KIAVT	RK 390-25 (C), KMV 562(RPS 1009), KMV 558(TNPsc 313), KMV 571(IIMR-KM-2)KMV 566(KMNDL-5), KMV 560(DK 159)	RK 390-25 (C), KMV 559(DK 151), TNAU 86, KMV 568(TNPsc 308), KMV 560(DK 159)
NSNKM	NSNKM-5(GPLM 254), NSNKM-17(TNPsc 176), RK390 25 (C), NSNKM-5(GPLM 254), NSNKM-13(RPS 1007)	RK390 25 (C), NSNKM-8(GPLM 316), NSNKM-12(RPS 1005), NSNKM-16(RPS 1011), NSNKM-14(RPS 1008)

Barnyard millet				
TRIAL	Grain smut	Banded/sheath blight	Brown spot/leaf blight	Leaf blast
BIAVT	PRB 903(C), BVM 595(IIMR-VM-2-17), BVM 612(IIMR-BM-8-1920), BVM 597(TNEF 317), BVM 591(TNEf 307), BVM 614(VMBC 336)	BVM 600(VMBC 333), BVM 612(IIMR-BM-8-1920), BVM 610(TNEf 319), BVM 613(VMBC 335), PRB 903(C),	BVM 603(ACM 15-343), BVM 602(ACM-15-353), BVM 610(TNEf 319), PRB 903(C), BVM 613(VMBC 335), BVM 595(IIMR-VM-2-17)	All entries shown highly resistant to resistant reaction
NSNBM	NSNBM 28 (VL 257), NSNBM 19(LRB-24) NSNBM 29(VB-19-15), NSNBM 20(LRB-29), NSNBM 18(LRB-17)	PRB 903(C), NSNBM 14(LRB-13), NSNBM 15(LRB-14), NSNBM 24(VB-19-5), NSNBM 25(VB-19-6)	NSNBM 24(VB-19-5), NSNBM 26(VB-19-7), NSNBM 18(LRB-17), NSNBM 19 (LRB-24)	

Proso millet			
TRIAL	Leaf blight	Brown spot	Banded blight
PIAVT	TNPm230(C), PMV 446(PMNDL-1), PMV 468(PNMDL-4), PMV 452(PMNDL-2), PMV 463(TNPm 280), PMV 462(TNPm 275)	All entries shown highly resistant to resistant reaction	TNPm230(C), PMV 459(GPUP 32), PMV 458(GPUP 30), TNAU 202, PMV 457(IIMR 163), PMV 467(DHPM 81-3), PMV 452(PMNDL-2)
NSNPM	NSNPM-2(TNPm-311), NSNPM-6(TNPm-315), NSNPM-7(TNPm-316), NSNPM-8(TNPm-317)	All entries shown highly resistant to resistant reaction	TNPm230 (C), NSNPM-1(TNPm-310), NSNPM-2 (TNPm-311), NSNPM-6(TNPm-315)

Browntop millet				
TRIAL	Leaf blight (G)	Banded blight (PDI)	Leaf blast (G)	Rust (G)
BTIVT	BTV 5(KMBT-1), BTV 20(GPBT 9), BTV 23(TNBr 012), BTV 9(GPUBT 5)	GPUBT 6, BTV 23(TNBr 012), BTV 25(VBT 007), BTV 1(GPUBT 1)	BTV 6(HBr-2), BTV 5(KMBT-1), BTV 23(TNBr 012), BTV 20(GPBT 9)	GPUBT 6, BTV 23(TNBr 012), BTV 3(GPUBT 3)

Note: Under lined entries shown multiple disease resistance

6. Evaluvation of small millets Germplasms

6.1. Evaluation of Finger millet Germplasms for major diseases

Finger millet 24 lines/ germplasm which are found totally free form blast were selected from 580 accessions during 2018 were reexamined for their reaction to blast. at ICAR-AICRP on Small millets, Project coordinating unit, Bengaluru during Kharif 2020 with plot size of 2 rows of 3 m length with 2 replications along with blast resistant (GE 4449) and susceptible (Udurumallige) checks. All the tested entries were shown highly resistant to resistant reaction to the blast (Leaf/finger and neck blast) with 1-3 G on 1-9 scale. Hence, it is decided to test the resistance stability of these lines at high disease pressure under diverse climatic conditions in order to identify stable resistance source for resistance breeding programme. The details of entries is as follows GE 4994, GE 5879, GE 5771, GE 5825, GE 4879, GE 5126, GE 5800, GE 5000, GE 5155, GE 5772, GE 4911, GE 4796, GE 4866, GE 4997, GE 5812, GE 4861, GE 4722, GE 5112, GE 4837, GE 4907, GE 4998, GE 5816, GE 5103 and GE 6024.

6.2. Evaluation of foxtail millet Germplasms (PC Unit, Bengaluru) for blast diseases

Foxtail millet 99 germplasm were evaluated for blast diseases at ICAR-AICRP on Small millets, Project coordinating unit, Bengaluru during Kharif 2020 with plot size of two rows of 3 m length with 2 replications. These lines were selected from 300 lines shown highly resistant to resistant reaction for blast and rust during 2018 and 2019. Out of 99 lines 15 were found promising for the both blast and rust resistance. Therefore, it is decided to test the resistance stability of these lines at high disease pressure under diverse climatic conditions in order to identify stable resistance source for blast and rust resistance breeding programme. The details of entries are as follows ISe 914, ISe 1655, ISe 1629, ISe 1685, ISe 1704, ISe 1736, ISe 1745, ISe 1664, ISe 1177, GS 2239, GS 432, GS, 2235 and GS 2092.

7. Epidemiological studies of foxtail millet blast and rust (Nandyal)

Correlation with epidemiological parameters with the occurrence of foliar disease/s is useful in planning sowing time and suggesting the farmers for taking need based sprays for crop protection. In this context severity of Foxtail millet diseases in relation to weather parameters was studied from 2018-19 at Nandyal, Andra Pradesh.

In this study, susceptible variety Prasad was taken up in 8 different dates of sowings since June 2nd FN to October first FN 2020 at forth night intervals in RBD design. Plot size is 15 rows of 3m length and all recommended practices were followed. September and October first FN crop was damaged due to heavy and continuous rains received during these months. Hence data is being presented for the June 2d FN crop to August 2nd FN crop. Blast and Brown spot diseases were noticed. Downy mildew was noticed but very negligible. Blast is initiated at early seedling stage that too in lower leaves only and reoccurred at around 50 days after sowing. Blast ranged from grade 3 to grade 7.6 and Brown spot ranged from grade 3 to grade 7

Occurrence of blast and brown spot in different sowing windows

Period of crop sown	Blast ranges (Grade)		Brown spot ranges (Grade)	
	Lowest	*Highest*	*Lowest*	*Highest*
June 2nd FN	3	5	--	--
July F FN	3.5	5.1	--	--

Period of crop sown	Blast ranges (Grade)		Brown spot ranges (Grade)	
July 2nd FN	3	6.1	5	8
August F FN	3.5	7.6	4	8
August 2nd FN	3.6	5.7	3	7

During the crop growth period of foxtail millet total rainfall of 1092.7 mm was received in 43rainy days. Maximum temperature ranged from 25^{0}C to 36^{0}C. Minimum temperature ranged from 22.2^{0}c to 26.8^{0}c. Relative humidity ranged from 65% to 98% in morning, 49% to 96% in evening and sunshine hours ranged from 0 to 10.8 hours/day.

Correlation Studies:

Blast- Blast is positively correlated to more rainfall, morning relative humidity, and less sunshine hours.
Brown spot: Brown spot is positively correlated to les Sun shine hours high Rainfall, and evening Relative humidity.

8. Publications & Recognitions

i. Research papers in national and international Journals

Anuradha, N and Patro, T.S.S.K.2020. Estimates of variability, heritability and genetic advance in foxtail millet. *Journal of Pharmacognosy and Phytochemistry.* 9 (1):1614-1616

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ii. Papers in seminars/conferences

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Palanna, K.B., H.R. Raveendra., T.S. S.K. Patro., M. Rajesh. and Prahlad netam., 2020, Evaluation and identification of resistant source for blast and other diseases of finger millet across the geographical locations in southern states of India, *107th Indian Science Congress* held at UAS, Bengaluru.

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Annapoorna, G.S., Raghavendra, M.P., Raveendra, H.R. and Bharath, M., Effect of cultural media, pH, nitrogen source and carbon source on sclerotium rolfsii sacc. Mycelial growth causing foot rot disease of finger millet International E – Conference on Multidisciplinary approaches for plant disease management in achieving sustainability in agriculture", 6-9th October 2020.Pp-2

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iii. Books

Patro, TSSK, Eden Georgia, K.,Palanna, K. B., Ganiger, P., Praveen, B., Jain, AK, Rawat, Laxmi, Ekka, Savita, Saralamma, S., Rajesh, M., Raveendra, HR, Yadav, SC, Das, IK, Anuradha, N., Sandhya Rani, Y., Triveni, U., Jamuna, P., Prabhakar and Tonapi, VA (2020). ***Compendium on Diseases and Pests of Small Millets.*** AICRP on Small Millets, Acharya N.G.Ranga Agricultural University, ARS, Vizianagaram (AP).pp 1-44. (ISBN No. 978-93-90028-07-8)

iii. Books chapters

Jain, A. K. , Chourasia, Ruchi and Joshi, R. P. (2020). Rational approaches for the management of partial root parasite (*Striga asiatica* Kuntze) in kodo millet. In *Advances in Agriculture for doubling of farmers income.* (Eds.) Shampi Jain and Verma, Neeraj. Empyreal Publishing House. pp 43-47. ISBN; 978-81-946373-1-8

Nagaraja, A., Chethana, B. S. and Jain, AK (2020). Biotic Stresses and their Management. In *Millets and Pseudocereals: Genetic Resources and Breeding Advancement* (Eds.) Mohar Singh and Salej Sood. Woodhead Publishing Series in Food Science, Technology and Nutrition, U.K.. pp 119-142. (ISBN No. 978-0-12-820089-6)

Laxmi Rawat and T S Bisht (2021). Minor Millets: Profile and Ethnobotanical Scenario. In: Millets and Millet Technology (Eds. Kumar, A., Tripathi, M.K., Joshi, D.C., Kumar Goyal, V) Springer Nature. Chapter 03 (In Print).

Laxmi Rawat and T S Bisht (2020). Plant Disease Management in Organic Farming System: Strategies and Challenges. *In:* Emerging trends in plant pathology (Eds. K P Singh et al). Springer Nature. Chapter 27 (Published).

iv. Technical bulletins/Book Chapter/Pomphlets

Saralamma *et al*., 2021. DIAGNOSTIC BULLETIN for identification of pest of jowar (jonna) is published during 2020-21.

Laxmi Rawat (2021). Mota Anaz: Vartman Paripekshya Me Mahatwa. (VCSG UUHF/COF/PP/2020-21/Booklet- MotaAnaz-01). VCSG Uttarakhand University of Horticulture and Forestry, Bharsar. Pp 56

9. International/National Awards:

1. Dr.TSSK Patro.

i. Excellence in Innovation Award-2020 at National Conference on Recent Scientific Advances in Agricultural and Environmental Sciences organized by Dr. Vasantharaj David Foundation on 5th December, 2020 at Chennai, Tamil Nadu
ii. Received Best Performing AICRP Centre for the period of 2017-20 among 33 stations during Annual Group Meeting of AICRP on Sorghum & Small Millets at ICAR-IIMR, Hyderabad on 28-29th May, 2020.
iii. Received Best Performing AICRP-Integrated Farming Systems TSP-Centre for the period of 2017-20 Annual Group Meeting of AICRP on IFS at ICAR-IIFS, Modipuram.
iv. Received Best Agricultural Research Station Award under category B-2020 from ANGRAU on 20 & 21 of January, 2021 at RARS, Tirupathi during REAC meeting

2. Dr. Laxmi Rawat

i. Best Scientist Award (2020). *In* International Women's Day on 08.03.2021, Organized by KVK, Ranichauri, Veer Chandra Singh Garhwali Uttarakhand University of Horticulture and Forestry, Bharsar.
ii. Best Participant Award (Certificate of Achievement). *In* Two Days Workshop on "Publication Ethics and Journal Selection" organized by Vigyan Varta E-Magazine-An International E- Magazine for Science Enthusiasts which was held on 26-27 February, 2021.
iii. Most Impactful Article Award of June 2020. Vigyan Varta E-Magazine-An International E- Magazine for Science Enthusiasts.

3.Dr. A. K. Jain, Prof.(Pl. Path.), College of Agriculture, Rewa (M.P.)

i. Has been awarded with Best Paper Award in 5th AGRIVISION-2021 National Convention on *Krishi Evam Atamnirbhar Bharat* organized by Vidyarthi Kalyan Nyas, Bhopal at National Agricultural Science Complex, ICAR, New Delhi on March 6-7, 2021

4. Palanna, K.B

i. P R Verma Student Award-2020 for research paper entitled "*Characterisation, Host range and Virulence analysis of Bipolaris setariae causing Browntop millet leaf blight in India*" presented by G V Ramesh and KB Palanna, UAS, GKVK, Bangalore at the 41st ISMPP Annual Conference and National e-Symposium during January 28-30 , 2021

5. Dr.M.Rajesh, Asst. Professor (Plant Pathology)

i. Received "Best Paper Award 2019" in 5th National Conference on Agricultural Scientific Tamil organized at TNAU, Coimbatore during 9 and 10th October 2020.

10. Seminars/Conferences/Trainings organized:

S.N	Seminars/Conferences	Scientist involved
	1. Millet nutri poshakmaah at KVK, Yaganti palli on 17-09-20,	Dr.Saralamma, ARS, Nandyal, AP
	• INSOPP-National e Conference on Recent Trends in Plant Pathology on 4th May 2021	Dr.TSSK Patro, ARS, Vizianagarm, AP

Annexure I: Details of collaborator

Centre	Collaborator, Address
Athiyandal	Dr. M. Rajesh, Asst. Professor (Plant Pathology), Centre of Excellence, TNAU, Athiyandal - 606 603 , Tiruvannamalai District (TN)
Bengaluru	Dr. K.B. Palanna, Jr. Pathologist, Project Coordinating Unit (Small Millets), ICAR, GKVK, Bengaluru- 560 065
Jagdalpur	Dr. Prahlad Netam, Jr. Pathologist, Zonal Agril. Research Station, Kumharwand Farm, Jagdalpur – 494 005, Chhattisgarh
Ranchi	Dr. (Mrs). Savita Ekka, Jr. Pathologist, Birsa Agricultural University, Kanke-Ranchi 843 006, Jharkhand
Mandya	Dr. H. R. Raveendra, Jr. Pathologist, Zonal Agril. Research Station, V.C. Farm, Mandya- 571 405 (Karnataka)
Nandyal	Dr. S. Saralamma, Pathologist & Officer In-charge, AICRP on Small Millets, RARS, Nandyal – 518 503 (AP)
Ranichauri	Dr. Laxmi Rawat, Jr. Pathologist & Officer In-charge, Uttarakhand University of Hort. & Forestry, Hill Campus, Ranichauri – 249 199, Uttarakhand
Rewa*	AICRP on Small Millets, College of Agriculture, Rewa- 486 001 (MP)
Vizianagaram	Dr. T. Samuel S.K. Patro, SeniorScientist (Pl. Path) & Officer In-charge, Agricultural Research Station, Gajularega, Vizianagaram – 531 001(AP)
Almora*	Dr. H. Rajashekar, Pathologist, ICAR- Vivekananda Parvatiya Krishi Anusandhana Sanstha, Almora -263 601, Uttarakhand
IIMR, Hyderabad	Dr. I.K Das, Principal Scientist (Pathology), ICAR-Indian Institute of Millets Research, Rajendranagar, Hyderabad-500030. Telangana

Annexure II: Diseases and causal organisms

Crop	Disease	Causal organism
Finger millet	Blast	*Pyricularia grisea*
	Brown spot	*Helminthosporium nodulosum*
	Banded blight	*Rhizoctonia solani*
	Smut	*Melanopsichium eleusinis*
	Downy mildew	*Sclerophthora macrospora*
	Wilt or Foot rot	*Sclerotium rolfsii*
	Rust	*Puccinia substriata*
Foxtail millet	Blast	*Pyricularia setariae*
	Rust	*Uromyces setariae italic*

	Smut	*Ustilago crameri*
	Downy mildew	*Sclerospora graminicola*
	Udbatta	*Ephelis sp*
Kodo millet	Head smut	*Sorosporium paspali*
	Rust	*Puccinia substriata*
	Udbatta	*Ephelis* sp
Little millet	Rust	*Uromyces linearis*
Barnyard millet	Head smut	*Ustilago crus-galli*
	Kernel smut	*Ustilago paradoxa*
Proso millet	Head smut	*Phacelothecadestruens*

Annexure III: Disease resistant and susceptible checks

Crop	Checks	Blast	Rust	Banded blight	Grain smut	Head smut	Downy mildew
Finger millet	GE 4449	R	-	-	-	-	-
	Uduru Malige	S	-	-	-	-	-
Foxtail millet	SiA 3282	-	-	-	-	-	R
	SiA 326	S	S	-	-	-	S
Kodo millet	RK 390-25	-	-	R	-	R	-
	JK 76	-	-	S	-	S	-
Little millet	RLM 208	-	-	R	-	-	-
	RLM 223	-	-	-	S	-	-
Barnyard millet	PRB 903	-	-	R	R	-	-
	LDR 1	-	-	S	S	-	-

Note: R= resistance, S= susceptible

Annexure IV: Grades for estimation of diseases

Leaf blast rating (1-9 scale)

Score	Description	Disease Reaction
1	Small, brown, pinhead size specks without sporulating centre	Highly Resistant (HR)
2	Small (1-2 mm) roundish to elongated, necrotic grey spots with a distinct brown margin covering up to 5% leaf area	Resistant (R)
3	Typical blast lesions (≥3 mm) with sporulating center, covering 6-10 % of the leaf area	Resistant (R)
4	Blast lesions covering 11-20% leaf area	Moderately Resistant (MR)
5	Blast lesions covering 21-30% leaf area	Moderately Resistant (MR)
6	Blast lesions covering 31-40% leaf area	Susceptible (S)
7	Blast lesions covering 41-50% leaf area	Susceptible (S)
8	Blast lesions covering 51-75% leaf area	Highly Susceptible (HS)
9	Blast lesions covering >75% leaf area & plant dead	Highly Susceptible (HS)

Neck blast rating scale (1-9 scale)

Score	Description	Disease Reaction
1	<1% plants infected with neck blast	Highly Resistant (HR)
2	1-5% plants infected with neck blast	Resistant (R)
3	6-10% plants infected with neck blast	Resistant (R)
4	11-20% plants infected with neck blast	Moderately Resistant (MR)
5	21-30% plants infected with neck blast	Moderately Resistant (MR)
6	31-40% plants infected with neck blast	Susceptible (S)
7	41-50% plants infected with neck blast	Susceptible (S)
8	51-75% plants infected with neck blast	Highly Susceptible (HS)
9	>75% plants infected with neck blast	Highly Susceptible (HS)

Finger blast rating scale (1-9 scale)

Score	Description	Disease Reaction
1	<1% fingers infected with finger blast	Highly Resistant (HR)
2	1-5% fingers infected with finger blast	Resistant (R)
3	6-10% fingers infected with finger blast	Resistant (R)
4	11-20% fingers infected with finger blast	Moderately Resistant (MR)
5	21-30% fingers infected with finger blast	Moderately Resistant (MR)
6	31-40% fingers infected with finger blast	Susceptible (S)
7	41-50% fingers infected with finger blast	Susceptible (S)
8	51-75% fingers infected with finger blast	Highly Susceptible (HS)
9	>75% fingers infected with finger blast	Highly Susceptible (HS)

Disease rating scale for brown spot/ leaf blight/ *Cercospora* leaf spot (1-9 scale)

Score	Description	Disease Reaction
1	<1% leaf area affected	Highly Resistant (HR)
2	1-5% leaf area affected	Resistant (R)
3	6-10 % leaf area affected	Resistant (R)
4	11-20% leaf area affected	Moderately Resistant (MR)
5	21-30% leaf area affected	Moderately Resistant (MR)
6	31-40% leaf area affected	Susceptible (S)
7	41-50% leaf area affected	Susceptible (S)
8	51-75% leaf area affected	Highly Susceptible (HS)
9	>75% leaf area affected	Highly Susceptible (HS)

Banded blight rating scale (1-9 scale)

Grade	Description	Disease Reaction
1	<1% of plant area covered by lesion	Highly Resistant (HR)
2	1-5% of plant area covered by lesion	Resistant (R)
3	6-10% of plant area covered by lesion	Resistant (R)
4	11-20% of plant area covered by lesion	Moderately Resistant (MR)
5	21-30% of plant area covered by lesion	Moderately Resistant (MR)
6	31-40% of plant area covered by lesion	Susceptible (S)
7	41-50% of plant area covered by lesion	Susceptible (S)
8	51-75% of plant area covered by lesion	Highly Susceptible (HS)
9	>75% covered by lesion & plant dead	Highly Susceptible (HS)

Foot rot rating scale (1-9 scale)

Grade	Description	Disease Reaction
1	<1% Disease Incidence	Highly Resistant (HR)
2	1-5% Disease Incidence	Resistant (R)
3	6-10% Disease Incidence	Resistant (R)
4	11-20% Disease Incidence	Moderately Resistant (MR)
5	21-30% Disease Incidence	Moderately Resistant (MR)
6	31-40% Disease Incidence	Susceptible (S)
7	41-50% Disease Incidence	Susceptible (S)
8	51-75% Disease Incidence	Highly Susceptible (HS)
9	>75% Disease Incidence	Highly Susceptible (HS)

Rust disease rating scale (1-9 scale)

Grade	Description	Disease Reaction
1	Pinhead flecks with no sporulation	Highly Resistant (HR)
2	Small scattered erumpent pustules with little sporulation covering up to 5% leaf area	Resistant (R)
3	Small scattered erumpent pustules with little sporulation covering up 6-10% leaf area	Resistant (R)
4	Many erumpent pustules with numerous spores covering 11-20% leaf area	Moderately Resistant (MR)
5	Coalescing pustules covering 21-30% leaf area	Moderately Resistant (MR)
6	Coalescing pustules covering 31-40% lea area	Susceptible (S)
7	Coalescing pustules covering 41-50% leaf area	Susceptible (S)
8	Coalescing pustules covering 51-75% leaf area	Highly Susceptible (HS)
9	Coalescing pustules covering >75% leaf area	Highly Susceptible (HS)

Grain smut rating scale (1-9 scale)

Grade	Description	Disease Reaction
1	<1% grains in a panicle affected	Highly Resistant (HR)
2	1-5% grains in a panicle affected	Resistant (R)
3	6-10% grains in a panicle affected	Resistant (R)
4	11-20% grains in a panicle affected	Moderately Resistant (MR)
5	21-30% grains in a panicle affected	Moderately Resistant (MR)
6	31-40% grains in a panicle affected	Susceptible (S)
7	41-50% grains in a panicle affected	Susceptible (S)
8	51-75% grains in a panicle affected	Highly Susceptible (HS)
9	>75% grains in a panicle affected	Highly Susceptible (HS)

Head smut rating scale (1-9 scale)

Grade	Description	Disease Reaction
1	< 1% Head smut incidence	Highly Resistant (HR)
2	1-5% Head smut incidence	Resistant (R)
3	6-10% Head smut incidence	Resistant (R)
4	11-20% Head smut incidence	Moderately Resistant (MR)
5	21-30% Head smut incidence	Moderately Resistant (MR)
6	31-40% Head smut incidence	Susceptible (S)
7	41-50% Head smut incidence	Susceptible (S)
8	51-75% Head smut incidence	Highly Susceptible (HS)
9	>75% Head smut incidence	Highly Susceptible (HS)

Downy mildew rating scale (1-9 scale)

Grade	Description	Disease Reaction
1	<1% plants with systemic infection	Highly Resistant (HR)
2	1-5% plants with systemic infection	Resistant (R)
3	6-10% plants with systemic infection	Resistant (R)
4	11-20% plants with systemic infection	Moderately Resistant (MR)
5	21-30% plants with systemic infection	Moderately Resistant (MR)
6	31-40% plants with systemic infection	Susceptible (S)
7	41-50% plants with systemic infection	Susceptible (S)
8	51-75% plants with systemic infection	Highly Susceptible (HS)
9	>75% plants with systemic infection	Highly Susceptible (HS)