

Annual Progress Report: 2017-18

4. Agricultural Entomology

Contents

Executive summary.....	257
Detailed report	259
SM (E) 401: Pest survey, surveillance and seasonal incidence with different dates of sowing.....	259
401.1.1: Survey for insect pests of Finger millet	259
401.1.2: Survey for the incidence of shoot fly on small millets during kharif 2018.....	260
401.1.3: Seasonal incidence with different dates of sowing on incidence of insect pests on finger millet	261
401.1.4 Seasonal incidence with different dates of sowing on incidence of insect pests of little millet	263
401.1.5 Seasonal incidence with different dates of sowing on incidence of insect pests of Proso millet	264
401.1.6 Seasonal incidence with different dates of sowing on incidence of insect pests of Barnyard millet ..	264
401.1.7 Seasonal incidence with different dates of sowing on incidence of insect pests of foxtail millet.....	264
401.1.8 Seasonal incidence with different dates of sowing on incidence of insect pests of Kodomillet	264
401.1.9 Seasonal incidence with different dates of sowing on incidence of insect pests of Browntop millet ..	264
SM (E) 402: Multipest resistance screening trial (IVT, AVT I & II).....	265
402.1.1: Evaluation of finger millet IVT against insect pests (FMIVT).....	265
402.1.2 Evaluation of finger millet AVT against insect pests (FMAVT)	266
402.2 Evaluation of kodomillet Initial advanced varieties against shoot fly (KIAVT)	267
402.3 Evaluation of little millet Initial advanced varieties to shoot fly (LIAVT).....	267
402.4 Evaluation of proso millet initial and advanced varieties to shoot fly (PAVT).....	267
402.5 Evaluation of foxtail millet Initial and advanced varieties to shoot fly (FIAVT)	268
402.6 Evaluation of barnyard millet initial and advanced entries to shoot fly (BIAVT).....	268
402.7 Evaluation of browntop millet initial and advanced entries to shoot fly (BTIAVT).....	268
402.8 Evaluation of proso millet germplasm to shoot fly (PMG)	269
SM (E) 403: Management of shoot fly in small millets	269
403.1: Low cost management of shoot fly in little millet	269
403.2 : Low cost management of shoot fly in Proso millet.....	269
403.3: Low cost management of shoot fly in little millet three year pooled data.....	270
403.4 : Low cost management of shoot fly in Proso millet three year pooled data	270

4. Agricultural Entomology

Executive summary

Pest scenario in small millets: In finger millet, the grasshopper is a major biotic constraint followed by the Pink stem borer (*Sesamia inferens*), Aphids (leaf aphid and panicle aphid), *Myloccerus* weevil and ear head caterpillar, *Helicoverpa armigera* etc. During Kharif 2017, Bangalore centre scientists surveyed for outbreak of defoliators noticed in these places. Defoliators include armyworm, leaf folders and semiloopers in five districts were Chikkaballapur, Kolar, Bangalore rural, Bangalore urban and Tumkur districts. The per cent damage was ranged from 20 to 100 per cent. The Chikkaballapur district affected area was around **10,186 ha where as in Tumkur and Kolar district defoliator affected 35,150 and 4148 ha ragi fields in southern Karnataka, respectively.** The major defoliator is armyworm, *Mythimna separata* other include leaf folder *Cnaplocrosis* species and *Herpetogramma* sp., *Chrysodeixis chalcites*. The Berhampur centre surveyed for the insect pests of finger millet crop in the vegetative stage was found attacked by grasshopper, aphids, grey weevil. Leaf folder and stem borer infestation were also noticed in some of the farmer's field but not in the research station whereas in reproductive stage the prevalence of grass hopper, a panicle aphid was noticed.

Shoot fly was the major pest on other millets (viz., kodo, little, proso, foxtail, barnyard millet and brown top millet at five different centres. Survey was carried out during June and September month to know the incidence of shoot fly in millet growing areas. Field survey carried out at two agricultural research stations namely Arasikere and Tiptur. The deadheart caused by shoot fly ranges from 7.5 to 30 per cent noticed in barnyard and little millet, respectively. However, at ARS, Tiptur recorded the deadheart ranges from 2 to 22.8 per cent. Brown top millet affected by shoot fly at Hemdore (sira-taluk) 2-3 deadheart per m². (Ranchi (Jarkhand) found to be the hot spot for Kodo millet shoot fly. Among the centres', Ranchi and Bangalore recorded high per cent little millet shoot fly incidence. Ranchi Bangalore found to be the hot spot for prosomillet shoot fly. For the first time noticed the stem borer in Ranichauri on barnyard millet. This year introduced new crop i.e browntop millet, *Bracharia ramosa*, was only screened at PC unit, Bangalore.

Six different dates of sowing experiment were carried out at Bangalore and Berhampur to know the seasonal incidence of different insect pest of ragi. Insect pest of finger millet was recorded with weekly interval. There was low population of grasshopper and *Myloccerus* weevil was recorded at vegetative stage. Early stage higher leaf hopper population was observed, moderate level incidence of shoot aphid was observed at early stage of crop. Late sown crop affected with higher incidence of shoot aphid.

Different dates of sowing in small millets: The per cent deadheart caused by shoot fly was higher in July and August in particularly during early stage of the crop. Late sowing harbours the shoot fly incidence.

FMIVT: Total thirty initial and advanced entries were evaluated against insect pests of finger millet

Grasshopper and *Myloccerus* sp. Weevil: Across the locations and genotypes the per cent leaf affected by grass hopper ranged from 2.94 to 10.31 % with an average of 5.70 %. The mean leaf infestation was recorded lowest at Ranchi (0.20 %), Bangalore (0.67%) followed by Berhampur (6.85%) and highest at Berhampur (14.91 %). Across the locations and genotypes the per cent plant affected by grass hopper ranged from 8.17 to 21.98 % with an average of 0.61 % at Bangalore centre. However, Berhampur centre recorded low incidence of insect pests. The incidence of *Myloccerus* weevil population was recorded in Bangalore, Berhampur and Ranchi.

FMAVT:Total nine advanced entries were evaluated including four varieties with five checks against insect pests of finger millet. The incidence of insect pest population was recorded in Bangalore, and Berhampur under south zone whereas Ranchi and Ranichauri comes under North zone

South Zone: The incidence of *Myloccerus* weevil population was recorded in Bangalore and Berhampur. The lowest *Myloccerus* weevil/plant was recorded ranged from 0.10 to 0.23 with mean of 0.14. Very low incidence noticed in Bangalore. Number of leaf hopper observed on 30 plants were recorded and converted into percentage and it ranges from 15.66 to 24.09 with mean of 19.81. The incidence of grasshopper population was recorded in Bangalore and Berhampur. The lowest grasshopper/ 100 plant incidence was recorded at Bangalore. The grasshopper population ranged from 0.33 to 1.22 for 100 plants with mean 0.81 at Bangalore centre.

North zone (Ranchi and Ranichauri):Total 16 advanced entries were evaluated including 11 varieties with five checks against insect pests of finger millet. The lowest *Myloccerus* weevil/plant was recorded ranged from 1.0 to 2.0 with mean of 1.33. The per cent leaves affected by grasshopper ranged from 0.6 to 5.4 % at Ranchi centre.

KIAVT:Ten initial advanced entries of kodo millet were evaluated against shoot fly incidence. The entries KMV 541, KMV 547, TNAU 86 (Check), KMV 546, GPUK 3 (Check) and RK 390-25 (Check) recorded low deadhearts (<10 %) and rest of the entries were moderately suffered damage from shoot fly.

LIAVT:Total fifteen advanced entries were evaluated against little millet shoot fly incidence. The mean shoot fly infestation was recorded lowest at Dindori (4.66%), Berhampur (2.78%) followed by Bangalore (14.93% DH) and highest at Ranchi (10.09 % DH). The entries LMV 512, LMV 515, LMV 514, LMV 518, LMV 520, LMV 511, LMV 513, LMV 523, LMV 516, LMV 522 and LM524 recorded low deadhearts (<10 %) and rest of the entries were moderately suffered damage from shoot fly.

PIAVT:Total four initial advanced entries with five check varieties were evaluated against proso millet shoot fly incidence. Across the locations and genotypes the per cent shoot fly incidence ranged from 14.44 to 37.82 % DH with an average of 33.67 % deadhearts. The promising varieties tolerant to shoot fly are PMV 443, PMV 442 (20-30%).

FIAVT:Thirteen initial advanced entries of foxtail millet were evaluated against shoot fly incidence. The entries FXV 610, FXV 602, FXV 612, FXV 601 FXV 604, FXV 603 and FXV 613 recorded low deadhearts (<10 %) at 28 DASE and rest of the entries were moderately suffered damage from shoot fly.

BIAVT:Total eight varieties including six initial advanced entries with two check varieties were evaluated against barnyard millet shoot fly incidence. The entries viz., BMV 582 and BMV 583 recorded low deadhearts (<10 %).

BTIAVT:Total 28 varieties were evaluated against browntop millet shoot fly incidence. Deadhearts caused due to shoot fly was recorded 21 DASE at Bengaluru. The range was from 1.0 to 6.00% DH with an average of 2.0 % deadhearts. All the tested entries found less than 10 per cent dead heart.

Proso millet germplasm screening: Total 22 varieties were evaluated against proso millet shoot fly incidence. Deadhearts caused due to shoot fly was recorded at peak stage in Bangalore. The Bengaluru centre recorded per cent dead heart ranged from 1.0 to 5.33 % DH with an average of 2.81% deadhearts. All the tested entries found less than 10 per cent dead heart.

Management of shoot fly in small millets

Little millet :All India average deadheart recorded lower in treatment sprayed with 1500 ppm azadirachtin at 15 DAS and NSKE 5 % at 15 DAS also significantly different from control followed by treatment spraying of 1500 ppm azadirachtin at 25 DAS.

Proso millet: Low per cent incidence of shoot fly /deadheart recorded at 1500ppm azadirachtin at 15 DAS (25.0 %) and spraying of 1500ppm azadirachtin at 25 DAS (26.27 %).

Technology Recommendations for Package of practice

Little millet three year pooled data revealed that spraying of 1500ppm azadirachtin at 15 DAS reduced the incidence of shoot fly (6.4 %) followed by spraying of 5 % NSKE 15 DAS (7.54 %). However, Control plot recorded higher dead heart 17.06 per cent

Proso millet three year pooled revealed that per cent dead heart noticed in 20 and 30 days after seedling emergence was very low in treatment sprayed with 1500 ppm azadirachtin at 15 DAS followed by early sowing before the normal sowing. The highest yield in treatment spraying of 1500ppm azadirachtin and spraying of NSKE at 5 % 15 DAS treatment recorded 4.09 and 3.80 quintal per hectare, respectively.

Detailed report

Introduction: A total of 167 entries were evaluated against insect pests reaction from 10 trials (FMIVT, FMAVT, BAVT, FAVT, KAVT, LAVT PAVT, BTIVT and Proso millet germplasm), two trials on low cost management of little millet and proso millet shoot fly. All the entries were evaluated under natural conditions.

SM (E) 401: Pest survey, surveillance and seasonal incidence with different dates of sowing

401.1.1: Survey for insect pests of Finger millet

In most of the parts, there were late but scanty and scattered rains received during *Kharif* crop were established very well during seedling stage. The grass hopper is a major biotic constraint followed by the Pink stem borer (*Sesamia inferens*), Aphids (leaf aphid and panicle aphid), *Myllocer* weevil and ear head caterpillar, *Helicoverpa armigera* etc.

- a. **Bangalore:** During Kharif 2017, five districts were surveyed for outbreak of defoliators noticed in these places. Defoliators include armyworm, leaf folders and semiloopers in Chikkaballapur, kolar, Bangalore rural, Bangalore urban and Tumkur districts. In Kolar district Chikkaballapur and Srinivaspura taluks, Bangalore rural include Devanahalli, Doddaballapur and Nelamangala, Tumkur district include Kunigal, Gubbi and Tumkur taluks, Bangalore urban include Hosakote taluks surveyed for defoliators on finger millet. The per cent damage was ranged from 20 to 100 per cent. The Chikkaballapur district affected area was around 10,186 ha where as in Tumkur and Kolar district defoliator affected 35,150 and 4148 ha ragi fields in southern karnatak, respectively. The major defoliator is armyworm, *Mythimna separata* other include leaf folder *Cnaplocrosis* species and *Herpetogramma* sp., *Chrysodeixis chalcites*. (Table 4.1.1).
- b. **Berhampur:** The finger millet crops grown during the *kharif* season of 2017 in the farmers' field of different locations of Ganjam district as well as the research station were surveyed for the presence of various kinds of insect pests. The crop in the vegetative stage was found attacked by grasshopper, aphids, grey weevil. Leaf folder and stem borer infestation were also noticed in some of the farmer's field but not in the research station whereas in reproductive stage the prevalence of grass hopper, a panicle aphid was noticed. Predatory ladybird beetles (*Coccinella transversalis* and *C. sexmaculata*) and black ant were found associated with the aphid pest. Predatory spiders are found throughout the crop growth stage. (Table 4.1.2)

401.1.2: Survey for the incidence of shoot fly on small millets during kharif 2018

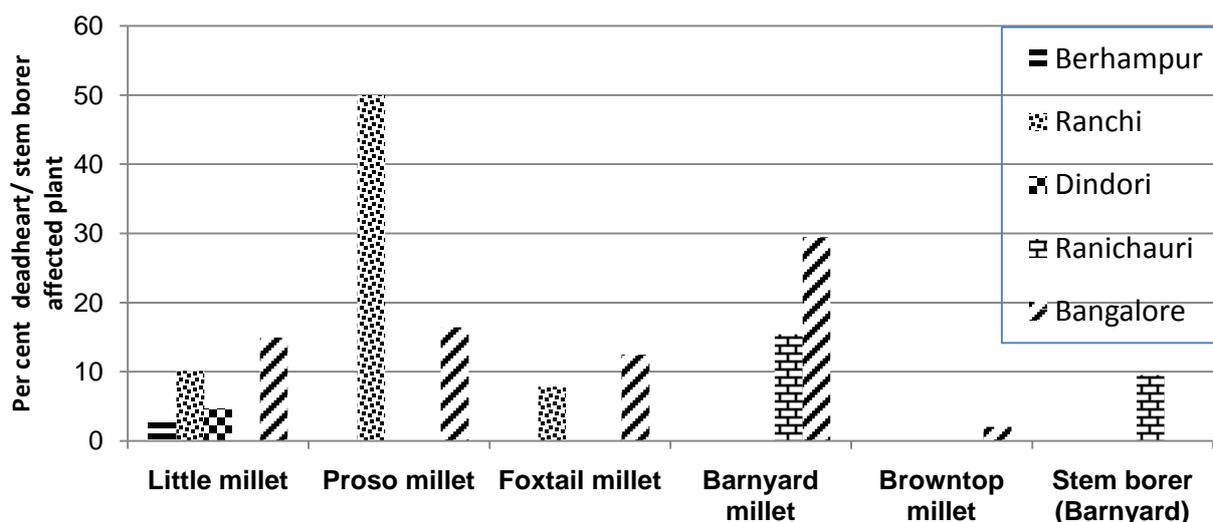
Survey was carried out during June and September month to know the incidence of shoot fly in millet growing areas. Field survey carried out at two agricultural research stations namely Arasikere and Tiptur. The deadheart caused by shoot fly ranges from 7.5 to 30 per cent noticed in barnyard and little millet, respectively. However, at ARS, Tiptur recorded the deadheart ranges from 2 to 22.8 per cent. Brown top millet affected by shoot fly at Hemdore (sira-taluk) 2-3 deadheart per m².(Table 4.1.3)

Summary of pest situation in finger millet growing states during Kharif2017

S. No.	State	Per plants affected by Grashopper	<i>Mylocerus</i> weevil/plant	Stem borer (%)	Aphid (%)	Remarks
1	Odisha	6.85 to 11.27	0 to 0.1	-	-	Major pests such as grasshopper and <i>Mylocerus</i> noticed in all centres
2	Jharkhand	0.20 to 17.87	0.60 to 10.40	-	-	
3	Bangalore	0.7 to 2.33	0.33 to 1.33	-	-	

Per cent shoot fly incidence on different small millets

S. No.	Crop	Odisha	Jharkhand	Madhya Pradesh	Ranichauri	Bangalore	Remarks
1	Kodomillet	-	18.09	1.5	-	9.01	Ranchi(Jarkhand) found to be the hot spot for shoot fly
2	Little millet	2.78	10.09	4.66	-	14.93	Among the centres', Ranchi and Bangalore recorded high shoot fly incidence.
3	Proso millet	-	50.0	-	-	16.42	Ranchi Bangalore found to be the hot spot for shoot fly
4	Foxtail millet	-	7.84	-		12.44	Need to take up few more trials at other centers also. First time noticed the stem borer in Ranichauri.
5	Barnyard millet	-	-	-	15.38 Stem borer – 2.63 to 16.36	29.43	
6	Browntop millet	-	-	-	-	1-3	New crop introduced AICRP



The Per cent shoot fly incidence on different small millets at different centres of India

401.1.3: Seasonal incidence with different dates of sowing on incidence of insect pests on finger millet

- a. **Bangalore:** Six different dates of sowing experiment were carried out at Zonal Agriculture Research Station GKVK to know the seasonal incidence of different insect pest of ragi. Insect pest of finger millet was recorded with weekly interval (Table 4.1.4).

First date of sowing (DOS) 30. 06. 2017: There was low population of grass hopper (0 to 0.58/plant). *Mylocerous* weevil incidence was ranged from 0 to 0.86/ plant. There was very negligible incidence of stem borer and earhead caterpillar was noticed after 70 days of sowing. Early stage higher leaf hopper population was observed (4.34/plant), moderate level incidence of shoot aphid (0 to 8.66 plants affected out of 30 plants) was observed at early stage of crop. With respect to natural enemies there was moderate number of coccinellids and spiders were observed but syrphids population is found to be very low.

Second date of sowing (DOS) 15. 07. 2017: At early stage there was considerable level population of grass hopper (0.06 to 0.42/plant). *Mylocerous* weevil incidence was ranged from 0 to 0.56/ plant. There was no incidence of stem borer and very negligible level earhead caterpillar incidence was noticed. Higher leaf hopper population was observed (0.23 to 3.30/plant), higher level incidence of shoot aphid (0 to 17.33 per cent affected) was observed at 40 days after sowing of crop. With respect to natural enemies there was moderate number of coccinellids (0.06 to 1.72/plant) and spiders (0 to 0.91/plant).

Third date of sowing (DOS) 30. 07. 2017: There was higher population of *Mylocerus* weevil (0.20 to 1.01 /plant); grass hopper (0.08 to 0.61/plant) throughout the cropping period was noticed. At 50 days after sowing 0 to 7.33 per cent stem borer incidence and 0.08 to 3.11 percent level incidence of earhead caterpillar were observed. Higher leaf hopper population was observed (0.69 to 1.38 /plant) was noticed at early stage of the crop. With respect to natural enemies there was considerable number of coccinellids (0.06 to 0.55/plant) and spiders (0 to 1.11/plant) were noticed throughout the cropping period.

Fourth date of sowing (DOS) 15. 08. 2017: There was maximum population of *Mylocerus* weevil (0.13 to 1.02 /plant), grass hopper (0.28 to 0.80/plant) and leafhopper (0.11 to 1.61/plant) were observed throughout the cropping period. At 30 days after sowing stem borer incidence (0.67 to 6.00/plant) was

noticed. At later stages 0.00 to 1.33 per cent level incidence of earhead caterpillar was observed. Negligible level of shoot aphid incidence at early stage was noticed but as the crop stage advances the incidence level reached peak per cent of 4.67/plant. With respect to natural enemies there was higher number of coccinellids (0.0 to 0.88/plant) and spiders (0 to 0.72/plant) were noticed throughout the cropping period and no incidence of flea beetle and chrysomelid during this stage.

Fifth date of sowing (DOS) 30. 08. 2017: There was constant population of *Mylocerus* weevil (0.00 to 0.55 /plant), grass hopper (0.07 to 0.70/plant) and leafhopper (0.56 to 3.13/plant) were observed throughout the cropping period. At later stages 50 days after sowing stem borer incidence (0.67 to 4.67/plant) was noticed and 0.23 to 1.07 percent level incidence of earhead caterpillar was observed at 75 to 80 days after sowing. Shoot aphid incidence started at 45 days after sowing stage was noticed the incidence level reached peak per cent of 8.67/plant. With respect to natural enemies there was higher number of coccinellids (0.0 to 0.73/plant) and spiders (0 to 1.11 /plant) were noticed throughout the cropping period and no incidence of flea beetle and chrysomelid during this crop stage.

Sixth date of sowing (DOS) 01. 08. 2017: There was higher rain fall occurred during this cropping period so germination of crop severely affected although observation made with lower plant population. The higher incidence *Mylocerus* weevil (0.17 to 0.87 /plant), grass hopper (0.22 to 0.96/plant) and leaf hopper (0.17 to 3.13/plant) were observed throughout the cropping period. At later stages 45 days after sowing stem borer maximum incidence (1.33 to 16.00 /plant) was noticed very low with negligible percent incidence of earhead caterpillar was observed. Shoot aphid incidence started at 45 days after sowing stage was noticed the incidence level reached peak per cent of 5.33/plant at 70 days after sowing. With respect to natural enemies there was higher number of coccinellids (0.08 to 1.19 /plant) and spiders (0 to 0.82 /plant) were noticed throughout the cropping period and no incidence of flea beetle and chrysomelid during this crop stage.

Study on correlation on incidence of insect pest of ragi with weather parameters during Kharif, 2017

Ragi crop was sown at 15 days interval starting from 30th June, 2017 to 15 November, 2017. During the study period different insect pests were recorded and data were correlated with weather parameters viz., maximum and minimum temperature, rainfall (mm), rainy days, maximum and minimum relative humidity pertaining to study period and results were discussed below.

Minimum temperature, number of rainy days and maximum relative humidity parameters were found positively correlated with incidence of *Mylocerus* weevil, stem borer, earhead caterpillar and shoot aphid and natural enemies like coccinellids and spiders whereas remaining weather parameters were found negatively correlated with insect pest. It clearly indicates that minimum temperature and erratic rainfall may favours the incidence of insect pests of ragi may be because of the luxuriant crop growth and higher temperature may lead to diapause of weevils.

- b. **Berhampur:** Six different dates of sowing experiment was carried out at research station. The Insect pest of finger millet was recorded with 10 days interval (Table 4.1.5).

First Date of Sowing (DOS) - 02.07.2017: There was high population of grass hopper (1.0 to 2.4/m²) and negligible damage by grasshopper 0.6 to 0.7 per cent. Similarly there was high level incidence of *Mylocerus* weevil (1.6 to 1.8/plants) and Ear head caterpillar (3.3 to 5.8/plant) was noticed. However no incidence of shoot aphids and stem borer throughout the crop period was observed. Meagre level populations of natural enemies were observed viz., lady bird beetles, syrphids and spiders.

Second DOS: There was low population of grass hopper (0.6 to 0.8 /m²) and very low per cent damage by grasshopper 0.3 to 0.4 per cent. Earhead caterpillar incidence was high (2.2/plant). Similarly, the *Mylocerus* weevil incidence was ranges from 1.2 to 1.4/m² and higher incidence of ear head caterpillar ranged from (2.2/plant).. However there was no incidence of stem borer, leaf hopper and shoot aphid. Considerable level of natural enemy populations was observed viz., lady bird beetles (3.0 to 3.67 /m²), syrphids (2.33 to 3/ m²) and spiders (2.0 to 3.33/m²).

Third DOS: There was high population of grass hopper (2.6 to 3.2/ m²) and *Mylocerus* weevil (2.4 to 3/plant) negligible per cent damage by grasshopper on leaves. There was no incidence of stem borer, leaf hoppers and shoot aphid. Higher incidence of *Mylocerus* weevil (2.4 to 3 /30 plants) was observed. However natural enemy populations were observed viz., lady bird beetles (0.67 to 1.33 /m²), syrphids (1/pant) and spiders (0.0 to 1.0 /m²).

Fourth DOS: There was high population of grass hopper (3.2 to 5.4/ m²) and *Mylocerous* weevil (3.8 to 4.4/plant) considerable percent (1.4) damage by grasshopper on leaves. There was no incidence of stem borer, leaf hoppers and shoot aphid. Higher incidence of *Mylocerus* weevil (3.8 to 4.4 /30 plants) was observed. However natural enemy populations were noticed viz., lady bird beetles (0.67 to 1.00 /m²) and syrphids (01/plant).

Fifth and sixth date of sowing vitiated due topoor germination of crop

Seasonal incidence of insect pests of small millets

Bangalore: Six different dates of sowing experiment at 15 days interval for five millets were conducted at Zonal Agricultural Research Station, GKVK, and Bangalore. Insect pest of small millets was recorded with weekly interval after 15 days of seedling emergence (Table 4.1.6).

(Due to heavy rains at GKVK, a fifth and sixth date of sowing experiment plots poor germination was observed, although observations were made with low plant population.)

401.1.4 Seasonal incidence with different dates of sowing on incidence of insect pests of little millet

- a. **Berhampur:** Six different dates of sowing experiment was carried out at research station. Insect pest of little millet were recorded with 10 days interval

First Date of Sowing (DOS: Shoot fly or deadheart incidence ranged from 9.60 to 12.30 per cent with mean of 10.80 %.

Second DOS: Shoot fly incidence ranged from 16.60 to 20.00 per cent with mean of 18.30 per cent.

Third, fourth, fifth and sixth date of sowing vitiated due to poor germination of crop

- b. **Bangalore:** Six different dates of sowing experiment was carried out at ZARS, GKVK, Bangalore. Insect pest of little millet were recorded with weekly interval 15 days after sowing. There was higher per cent incidence of shoot fly (0- 51.11 %) at early stages up to 30 days of seeding emergence was observed in all dates of sowing. Considerable level of grass hopper, flea beetle and bugs population were noticed. With respect to natural enemies higher population of coccinellids and spiders were noticed (Table 4.1.6).

401.1.5 Seasonal incidence with different dates of sowing on incidence of insect pests of Proso millet

- a. **Bangalore:** Shoot fly incidence was noticed in all dates of sowing, but higher incidence (up to 57.58 %) was observed in crop sown in August first week. In addition to this grass hopper, flea beetle low incidence of leaf roller was noticed. Considerable levels of coccinellids were noticed (Table 4.1.7).
- b. **Berhanpur :** D.O.S. : 05.07.2017, 20.07.2017, 04.08.2017,19.08.2017,04.09.2017 (poor germination) The crop growth was very poor and the crop was severely damaged by sheath blight infection (> 90% damage).

401.1.6 Seasonal incidence with different dates of sowing on incidence of insect pests of Barnyard millet

Shoot fly incidence was noticed in all six dates of sowing, but higher incidence up to 47.78 per cent was observed in crop sown at last week of July with respect to natural enemies coccinellids, spiders and syrphids were common (Table 4.1.8).

401.1.7 Seasonal incidence with different dates of sowing on incidence of insect pests of foxtail millet

- a. **Bangalore:**Shoot fly incidence was noticed in all the different dates of sowing, but higher incidence up to 45.56 per cent was noticed in crop sown at last week of July. Similarly incidence of grasshopper, flea beetle and sucking pest like plant bugs were common to all dates of sowing. However, shoot aphid incidence was noticed only in crop sown at last week of July after this there was no incidence of shoot aphid. With respect to natural enemies higher population of coccinellids and spiders observed (Table 4.1.9).
- b. **Berhampur:** Different date of sowing on 05.07.2017, 20.07.2017, 04.08.2017, 19.08.2017, 04.09.2017 experiments vitiated due to poor germination. The crop growth was very poor in both vegetative and reproductive stage.

401.1.8 Seasonal incidence with different dates of sowing on incidence of insect pests of Kodomillet

Kodomillet: Shoot fly incidence was ranged from 1.11 to 33.33 % in all the different dates of sowing, although higher incidence was observed in crop sown at second week of August. Similarly considerable level of grasshopper and bugs were noticed. However, low incidence of shoot aphid was observed throughout the different dates of sowing. With respect to natural enemies higher population of spiders followed by coccinellids were observed (Table 4.1.10).

401.1.9 Seasonal incidence with different dates of sowing on incidence of insect pests of Brown top millet

Higher shoot fly incidence was noticed in all dates of sowing, although maximum incidence of 82.22% was observed in crop sown at first week of July. However, higher incidence of grasshoppers, flea beetle and leaf roller was observed. Whereas higher incidence of shoot aphid was observed in crop sown at second week of July up to 31.11%. With regard to natural enemies higher population of spiders (0-1.0/plant) and low population of coccinellids were recorded (Table 4.1.11).

Promising entries with less susceptibility to pests of small millets

Sl. No.	Trial	Grasshopper	<i>Mylocerus</i> weevil	Aphids	Shoot fly (<10 per cent)
1	FMIVT	FMV 1132, 1133, 1130, 1135, 1134, 1115, 1131, 1122 (< 15 % plant affected)		-	-
2	FMAVT	<u>FMV 1104, FMV 1102</u> (< 1 % plants affected)	FMV 1103, <u>FMV 1101</u> <u>NZ</u> : FMV 1105, FMV 1109, GPU 67 (< 1 weevil/plant)	<u>FMV 1101</u> , VL 352	-
3	KIAVT				KMV 541, KMV 547, TNAU 86 (Check), KMV 546, GPUK 3 (Check) and RK 390-25 (Check)
4	LIAVT				LMV 512, LMV 515, LMV 514, LMV 518, LMV 520, LMV 511, LMV 513, LMV 523, LMV 516, LMV 522 and LM524
5	PIAVT				PMV 443, PMV 442 (20-30%)
6	FAVT				FXV 610, FXV 602, FXV 612, FXV 601 FXV 604, FXV 603 and FXV 613
7	BIAVT				BMV 582 and BMV 583

Note: Underlined entries recorded as tolerance to more than one pest, NZ- North Zone

SM (E) 402:Multipest resistance screening trial (IVT, AVT I & II)

402.1.1: Evaluation of finger millet IVT against insect pests (FMIVT)

Total thirty initial and advanced entries were evaluated against insect pests of finger millet (Table 4.2.1)

Leaf infestation by Grasshopper: The incidence of grasshopper population was recorded in Bangalore, Berhampur (Odisha) and Ranchi (Jharkhand). Across the locations and genotypes the per cent leaf affected by grass hopper ranged from 2.94 to 10.31 % with an average of 5.70 %. The mean leaf infestation was recorded lowest at Ranchi (0.20 %), Bangalore (0.67%) followed by Berhampur (6.85%) and highest at Berhampur (14.91 %).

Affected plant by grasshopper: Across the locations and genotypes the per cent plant affected by grass hopper ranged from 8.17 to 21.98 % with an average of 0.61 % at Bangalore centre. However, Berhampur centre recorded low incidence.

***Mylocerus* sp. Weevil:** The incidence of *Mylocerus* weevil population was recorded in Bangalore, Berhampur and Ranchi. The lowest *Mylocerus* weevil/plant was recorded ranged from 0.6 to 10.40 with mean of 4.08. Very low incidence noticed in Berhampur.

Aphid: A meagre aphid incidence was noticed on leaf and panicle initiation stage.

Lady bird beetles and spiders: The higher number of aphid predatory lady bird beetles was recorded and it ranges from 1 to 3. High spider population noticed and it also ranges from 1.0 to 3.0.

402. 1. 2 Evaluation of finger millet AVT against insect pests (FMAVT)

Total nine advanced entries were evaluated including four varieties with five checks against insect pests of finger millet. The incidence of insect pest population was recorded in Bangalore, and Berhampur under south zone whereas Ranchi and Ranichauri comes under North zone

South Zone: (Table 4.2.2a)

***Myllocerous* sp. Weevil:** The incidence of *Myllocerous* weevil population was recorded in Bangalore and Berhampur. The lowest *Myllocerous* weevil/plant was recorded ranged from 0.10 to 0.23 with mean of 0.14. Very low incidence noticed in Bangalore.

Leafhopper: Number of leaf hopper observed on 30 plants were recorded and converted into percentage and it ranges from 15.66 to 24.09 with mean of 19.81.

Grasshopper: The incidence of grasshopper population was recorded in Bangalore and Berhampur. The lowest grasshopper/ 100 plant incidence was recorded at Bangalore. The grasshopper population ranged from 0.33 to 1.22 for 100 plants with mean 0.81 at Bangalore centre.

Per cent leaves affected by GH: The per cent leaves affected by grasshopper ranged from 0.33 to 1.0 % at Bangalore centre. Berhampur centre also noticed grass hopper affected leaves ranges from 0.10 to 0.40 for 100 plants.

Aphids:

Per cent plant affected with shoot aphid: It ranges from 12.23 to 36.98 with mean of 25.11. Low incidence noticed in Bangalore centre compared to Berhampur centre.

Shoot aphid per 3 leaves: It ranges from 2.0 to 4.33 with mean of 3.07 aphid recorded at Berhampur centre.

Per cent panicles affected by shot aphid: It ranges from 8.28 to 10.22 with mean of 7.65.

Coccinellids: The predatory on aphids recorded per 30 plants ranged from 0.10 to 0.20

North zone (Ranchi and Ranichauri):(Table 4.2.2b)

Total 16 advanced entries were evaluated including 11 varieties with five checks against insect pests of finger millet.

***Myllocerous* sp. Weevil:** The lowest *Myllocerous* weevil/plant was recorded ranged from 1.0 to 2.0 with mean of 1.33.

Leafhopper: Number of leaf hopper observed on 30 plants were recorded and converted into percentage and it ranges from 0.2 to 6.43 with mean of 2.24.

Per cent leaves affected by grasshoppers: The per cent leaves affected by grasshopper ranged from 0.6 to 5.4 % at Ranchi centre.

Per cent plant affected by grasshoppers: it ranges from 1.53 to 5.03 with mean 3.62

Shoot aphid per 3 leaves: It ranges from 0.0 to 6.6 with mean of 4.13.

Coccinellids: The predatory on aphids recorded per 30 plants ranged from 1.0 to 2.0

402. 2 Evaluation of kodo millet Initial advanced varieties against shoot fly (KIAVT)

Shoot fly (*Atherigona* sp. Rond): (Table 4.2.3)

14 DASE: Deadhearts caused due to shoot fly was recorded at Dindori and Ranchi. Ten initial advanced entries of kodo millet were evaluated against shoot fly incidence. The range was from 0.00 to 26.63% DH with an average of 16.39 % deadhearts. The very less incidence of shoot fly was noticed on kodo millet at Dindori.

21 DASE: Across the locations and genotypes the range was from 0.80 to 16.04 % DH with an average of 9.80 % deadhearts. The entries KMV 541, KMV 547, TNAU 86 (Check), KMV 546, GPUK 3 (Check) and RK 390-25 (Check) recorded low deadhearts (<10 %) and rest of the entries were moderately suffered damage from shoot fly. Ranchi place has been considered as hot spot for shoot fly incidence in kodo millet. The mean shoot fly infestation was lowest and highest at Dindori (0.0 to 30.0 % DH).

28 DASE: Deadhearts caused due to shoot fly was recorded at 28 DASE in Bangalore and Dindori. The CV% was high at both centers. Across the locations and genotypes the range was from 3.14 to 8.82 % DH with an average of 5.65 % deadhearts. All the tested entries found less than 10 per cent dead heart (Table 5).

402. 3 Evaluation of little millet Initial advanced varieties to shoot fly (LIAVT)

Shoot fly (*Atherigona pulla* Rond): Total fifteen advanced entries were evaluated against little millet shoot fly incidence. The observations were recorded at 21 and 28 days after seedling emergence (DASE). Deadhearts caused by shoot fly at peak period were recorded at Bangalore, Berhampur, Dindori and Ranchi. (Table 4.2.4)

21 DASE: Across the locations and genotypes the per cent shoot fly incidence ranged from 4.62 to 11.74 % DH with an average of 8.12 % deadhearts. The mean shoot fly infestation was recorded lowest at Dindori (4.66%), Berhampur (2.78%) followed by Bangalore (14.93% DH) and highest at Ranchi (10.09 % DH). The entries LMV 512, LMV 515, LMV 514, LMV 518, LMV 520, LMV 511, LMV 513, LMV 523, LMV 516, LMV 522 and LM524 recorded low deadhearts (<10 %) and rest of the entries were moderately suffered damage from shoot fly. Ranchi and Bengaluru place has been considered as hot spot for shoot fly incidence in little millet. The highest shoot fly infestation was recorded at Ranchi and Bengaluru were 14.80 and 26.66 per cent dead heart, respectively.

28 DASE : Deadhearts caused due to shoot fly was recorded at 28 DASE at four centres. Across the locations and genotypes the range was from 9.36 to 19.47 % DH with an average of 5.65 % deadhearts. The entries LMV 518 and LMV 512 recorded low deadhearts (<10 %) and rest of the entries were moderately suffered damage from shoot fly.

402. 4 Evaluation of proso millet initial and advanced varieties to shoot fly (PAVT)

Shoot fly (*Atherigona pulla* Rond): Total four initial advanced entries with five check varieties were evaluated against proso millet shoot fly incidence. The observations were recorded at 21 and 28 days after seedling emergence (DASE). Deadhearts caused by shoot fly at peak period were recorded at Bangalore and Ranchi. (Table 4.2.5)

21 DASE: Across the locations and genotypes the per cent shoot fly incidence ranged from 14.44 to 37.82 % DH with an average of 33.67 % deadhearts. The mean shoot fly infestation was recorded lowest at Bangalore (12.33%) and highest at Ranchi (55.07 % DH). Ranchi and Bengaluru place has been considered as hot spot for

shoot fly incidence in proso millet. The highest shoot fly infestation was recorded at Ranchi and Bengaluru were 61.2 and 23.33 per cent dead heart, respectively.

28 DASE: Deadhearts caused due to shoot fly was recorded at 28 DASE at two centres. Across the locations and genotypes the range was from 36.4 to 52.35 % DH with an average of 46.72 % deadhearts. All the entries were heavily suffered damage from shoot fly.

402.5 Evaluation of foxtail millet Initial and advanced varieties to shoot fly (FIAVT)

Oviposition preference: Thirteen initial advanced entries of foxtail millet were evaluated against shoot fly incidence. The data on per cent eggs laid by shoot fly at 21 days after seedling emergence (DASE) was recorded only at Ranchi. Shoot fly oviposition was ranged from 22.20 to 8.87 per cent eggs. The lowest oviposition was recorded in FXV 610 (8.87 per cent eggs). (Table 4.2.6)

Shoot fly (*Atherigona* sp. Rond):

21 DASE: Deadhearts caused due to shoot fly was recorded only at Ranchi. Thirteen initial advanced entries of foxtail millet were evaluated against shoot fly incidence. The range was from 2.40 to 19.70% DH with an average of 7.84 % deadhearts. The very less incidence of shoot fly was noticed on foxtail millet. All the tested entries found less than 10 per cent dead heart.

28 DASE: Deadhearts caused due to shoot fly was recorded at peak stage in Bangalore. The range was from 7.51 to 17.88 % DH with an average of 10.38 % deadhearts. The entries FXV 610, FXV 602, FXV 612, FXV 601 FXV 604, FXV 603 and FXV 613 recorded low deadhearts (<10 %) and rest of the entries were moderately suffered damage from shoot fly.

402.6 Evaluation of barnyard millet initial and advanced entries to shoot fly (BIAVT)

Shoot fly (*Atherigona pulla*Rond): Total eight varieties including six initial advanced entries with two check varieties were evaluated against barnyardmillet shoot fly incidence. The observations were recorded at 21 and 28 days after seedling emergence (DASE). Deadhearts caused by shoot fly at peak period were recorded at Bengaluru and Ranichauri.). (Table 4.2.7)

21 DASE: Deadhearts caused due to shoot fly was recorded only at Bengaluru. The range was from 3.33 to 6.66% DH with an average of 7.84 % deadhearts. The very less incidence of shoot fly was noticed on foxtail millet. All the tested entries found less than 10 per cent dead heart.

28 DASE: Deadhearts caused due to shoot fly was recorded at peak stage in Bangalore compare to Ranichauri. Bengaluru centre noticed higher CV %. The Bengaluru centre recorded per cent dead heart ranged from 24.44 to 40.0 % DH with an average of 29.43 % deadhearts. Where as in Ranichauri centre recorded per cent dead heart ranged from 5.28 to 23.18 % DH with an average of 15.38 % deadhearts. The entries BMV 582 and BMV 583 recorded low deadhearts (<10 %) and rest of the entries were moderately suffered damage from shoot fly.

402.7 Evaluation of browntop millet initial and advanced entries to shoot fly (BTIAVT)

Shoot fly (*Atherigona* sp. Rond): Total 28 varieties were evaluated against browntop millet shoot fly incidence. The observations were recorded at 21 and 28 days after seedling emergence (DASE). Deadhearts caused by shoot fly at peak period were recorded only at Bengaluru. New crop included in this year 2017-18. Feeler trial initiated to know the incidence and species of shoot fly. (Table 4.2.8)

21 DASE: Deadhearts caused due to shoot fly was recorded only at Bengaluru. The range was from 1.0 to 6.00% DH with an average of 2.0 % deadhearts. All the tested entries found less than 10 per cent dead heart.

28 DASE: Deadhearts caused due to shoot fly was recorded at peak stage in Bangalore. The Bengaluru centre recorded per cent dead heart ranged from 1.0 to 4.33 % DH with an average of 2.08 % deadhearts. All the tested entries found less than 10 per cent dead heart.

402.8 Evaluation of proso millet germplasm to shoot fly (PMG)

Shoot fly (*Atherigona* sp. Rond): Total 22 varieties were evaluated against proso millet shoot fly incidence. The observations were recorded at 28 days after seedling emergence (DASE). Deadhearts caused by shoot fly at peak period were recorded only at Bengaluru. New experiment initiated during this year 2017-18.). (Table 4.2.9)

28 DASE: Deadhearts caused due to shoot fly was recorded at peak stage in Bangalore. The Bengaluru centre recorded per cent dead heart ranged from 1.0 to 5.33 % DH with an average of 2.81% deadhearts. All the tested entries found less than 10 per cent dead heart.

SM (E) 403: Management of shoot fly in small millets

403.1: Low cost management of shoot fly in little millet

Under management of shoot fly treatments were formulated based on low cost methods viz., seed rate (1.5 times recommended), spraying of 1500 ppm azadirachtin (at different interval 7, 15 and 25 DAS) and early sowing (7 days before normal sowing) spraying of 5 % NSKE (7 and 15 DAS). (Table 4.3.1)

30 DAG: Deadhearts caused by shoot fly at 30 DAG were recorded at Berhampur, Dindori and Ranchi. Across the locations and genotypes, the deadheart % range was from 4.30 to 8.19 % being an average of 7.52%. The mean shoot fly infestation was recorded lowest at Berhampur (4.05 %) followed by Dindori (5.91 %) and highest at Ranchi (12.58 % DH). All India average deadheart recorded lower in treatment sprayed with 1500 ppm azadirachtin at 15 DAS and NSKE 5 % at 15 DAS also significantly different from control followed by treatment spraying of 1500 ppm azadirachtin at 25 DAS.

403.2 : Low cost management of shoot fly in Proso millet

One management trial has been conducted at Ranchi (Jharkhand) with varied treatments. Under management of shoot fly treatments were formulated based on low cost methods viz., seed rate (1.5 times recommended), spraying of 1500 ppm azadirachtin (at different interval 7, 15 and 25 DAS), early sowing (7 days before normal sowing) and spraying of 5 % NSKE (7 and 15 DAS) (Table 4.3.2)

10 DAG: Low per cent incidence of shoot fly /deadheart recorded at 1500ppm azadirachtin at 15 DAS (25.0 %) and spraying of 1500ppm azadirachtin at 25 DAS (26.27 %).

20 DAG: Low per cent incidence of shoot fly /deadheart recorded in spraying of 1500ppm azadirachtin at 15 DAS (26.20 %) and spraying of 1500ppm azadirachtin at 25 DAS (27.93 %).

30 DAG: Low per cent incidence of shoot fly /deadheart recorded in spraying of 1500ppm azadirachtin at 15 DAS (27.0 %) and spraying of 1500ppm azadirachtin at 7 DAS (31.07 %).

Technology Recommendations for Package of practice

403. 3: Low cost management of shoot fly in littlemillet three year pooled data

Based on the three year pooled data (Berhampur, Ranchi and Dindori) revealed that spraying of 1500ppm azadirachtin at 15 DAS reduced the incidence of shoot fly (6.4 %) followed by spraying of 5 % NSKE 15 DAS (7.54 %). However, Control plot recorded higher dead heart 17.06 per cent. (Table 4.3.3)

403. 4: Low cost management of shoot fly in Proso millet three year pooled data

Based on the three year pooled data (Berhampur, Ranchi and Dindori) revealed that per cent dead heart noticed in 20 and 30 days after seedling emergence was very low in treatment sprayed with 1500 ppm azadirachtin at 15 DAS followed by early sowing before the normal sowing. The highest yield in treatment spraying of 1500ppm azadirachtin and spraying of NSKE at 5 % 15 DAS treatment recorded 4.09 and 3.80 quintal per hectare, respectively (Table 4.3.4).