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Seasonal incidence and estimation of yield losses due to insect pest in small millets at scarce rain fall zone of Andhra Pradesh

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Abstract
The present study on seasonal incidence of major insect pests and avoidable yield loss was worked out at Institutional farm, Regional Agricultural Research Station, Nandyal, Andhra Pradesh during *kharif*, 2016 and 2017. The highest thrips damage was recorded in finger millet (78.0 and 55% leaf damage), high shoot fly incidence was recorded in little millet (75 and 51%) and proso millet (100 and 46% dead hearts) during 2016 and 2017. During 2016, a high *Helicoverpa armigera* larval population per $m^2$was recorded in foxtail millet (15.0), barnyard millet (12.0), Kodo millet (5.0) and Finger millet (5.0) at grain maturity stage. A yield loss of 15.2 and 7.9% in foxtail millet were mainly due to thrips and *Helicoverpa* armigera and a yield loss of 8.5% and 5.1% in barnyard millet were mainly attributed to *Helicoverpa* armigera during 2016 and 2017. There was 100 and 16.6% yield loss in proso millet and 34.8 and 22.3% yield loss in little millet was mainly due to shoot fly incidence at tillering stage.

Keywords: small millets shoot fly, thrips, proso millet, foxtail millet

Introduction
Small millets comprising of foxtail millet (*Setaria italica*), kodo millet (*Paspalum scrobiculatum*), proso millet (*Panicum miliaceum*), little millet (*Panicum sumatrense*), barnyard millet (*Echinochloa frumentaceae*) and finger millet*(Eleusine coracana)* also called nutri cereals are a group of highly variable small-seeded grasses widely grown globally for human food, feed and fodder. They are cultivated in adverse climatic conditions, diverse agro-ecological situations as well as in diverse soils with varying rainfall well suited for contingency crop planning, addressing the issues of climate change. In India, Madhya Pradesh has the highest area of small millets (32.4%) followed by Chhattisgarh (19.5%), Uttarakhand (8%), Maharashtra (7.8%), Gujarat (5.3%) and Tamil Nadu (3.9%). Uttrakhand has highest productivity of 1174 Kg/ha followed by Tamil Nadu (1067 Kg/ha) and Gujarat (1056 Kg/ha) (Anbukkani *et. al*, 2018) [1].

Even though these are hard crops and tolerant many insect pests, insect pest viz., thrips, shoot flies, stem borers, head caterpillars (*Helicoverpa armigera*) and ear head midges are considered major pests causing yield losses in addition to army worms, grasshoppers, leaf beetles, and head bugs as a minor and occasional pest. Shoot fly, *Atherigona destructor M.* alone could bring per cent reduction in yield to the extent of 90.9 in proso, 78.5 in little, 44.9 in barnyard, 35.0 in kodo, and 1.8 in foxtail millets (Nageshchandra and Musthak Ali, 1983) [4]. However, occasional or minor pests are becoming a menace in some regions due to changes in ecology and cultural practices. The pest of small millets at different stages are tackled by various management techniques like cultural, mechanical, biological and insecticides based on location and severity of the pest.

The chemical protection is the most commonly used method of crop loss assessment, where the yield of a naturally infested field is compared with fields protected with desired levels of insecticides treatments (Chatterji *et al.*, 1969, Ouma *et al*., 2003, Berg and Rensburg, 1991 [3, 2, 6,] in Maize against stem borers). In this context, the present study was taken up to record the seasonal incidence of insect pests of small millets in the scarce rain fall zone of Andhra Pradesh and their respective yield losses in small millet crops.

Materials and Methods

The field trial was carried out at Instructional Farm of Regional Agricultural Research Station, Nandyal, Andhra Pradesh during *kharif*, 2016 and 2017. All the six millet crops viz foxtail millet, Barn yard millet, proso millet, little millet, kodo millet and finger millet were sown at a spacing of 30 X 10 cm with a plot size of 4m × 3.6m. All the millet crops were raised in protected and unprotected blocks replicated thrice duly following randomized block design with all recommended agronomic practices. Seasonal incidence of major insect pest in the entire crop period was recorded at ten days intervals from germination to harvesting. Thrips damage was recorded in terms of percent leaf damage on ten randomly selected plants, shoot fly incidence was recorded as percent dead hearts and *Helicoverpa armigera* incidence was observed as a number of larvae per square meter. Whenever pest crossed economic thresh hold level recommended insecticides like Monocrotophos @ 320 ml/acre against thrips, Carbofuran 3 G @ 20 kg/acre against shoot fly and for the management of *Helicoverpa armigera* thiodicarb @300 g/acre was sprayed, whereas water was sprayed in untreated block. The yield was recorded in protected and unprotected plots replication wise as kg per plot and converted into Kg/ hectare. The avoidable yield loss due to insect pest was worked out with the differences in yields between the treatment and untreatment blocks by using the formula. (Pradhan, 1988) [7] Yield loss (%) = {(Yield in treated plot - Yield in untreated)/Yield in treated)} X 100. The statistical analysis was done by using analysis of variance (ANOVA) and least significance difference (LSD) test.

Result and Discussion

Seasonal Incidence of insect pests in minor millets

In minor millets**,** thrips incidence was started from 10 days after sowing to the early vegetative stage, shoot fly incidence was recorded at tillering stage and *Helicoverpa armigera* incidence was recorded at grain formation to grain maturity stage.

During *kharif* 2016, the highest thrips damage (78.0% leaf damage) was recorded in finger millet followed by proso millet (40.5) and the lowest leaf damage (4.25%) was recorded in kodo millet. Monocrotophos 36 SL @1.6 ml/l was sprayed in a treated block to manage the thrips and water was sprayed in the untreated block. Severe incidence of shoot fly was recorded in little millet (75%) and proso millet (100%) during *kharif*, 2016. For the management of shoot fly, carbofuran 3 G granules were applied @ 8 kg/acre in treated block. Seven days after the granular application, the treated block of little and proso millets was recovered with the emergence of fresh leaves and new tillers. At grain maturity stage high *Helicoverpa armigera* larval population per $m^2$was recorded in foxtail millet (15.0), barnyard millet (12.0), Kodo millet (5.0) and Finger millet (5.0). Thiodicarb @ 300 g/acre was sprayed to manage the *Helicoverpa* in treated blocks. During *kharif*, 2017, in foxtail millet thrips incidence was recorded at ten days after the germination (9.0 percent leaf damage) and three *Helicoverpa armigera* larvae per meter square were recorded at grain maturity stage. Barnyard millet was almost pest free except for 14.5% leaf damage by thrips. In proso millet 24.6% leaf damage was recorded by thrips at vegetative stage, 46.0 percent dead hearts were recorded by shoot fly. In little millet 12.5% leaf damage by thrips followed by 51.0% dead hearts by shoot fly and 3.0 *Helicoverpa armigera* larvae per m^2 at grain maturity stage were recorded. In finger millet high incidence of thrips were recorded (55% leaf damage) followed by two *H. armigera* larvae per square meter was recorded at grain maturity stage. Among the six small millet crops, kodo millet was free from pest throughout the cropping period in 2017.

Yield loss due to insect pest in minor millets

During *kharif*, 2016 in foxtail millet and barnyard millet the estimated yield losses of 15.2 and 8.5% in untreated plots were mainly attributed to the incidence of thrips at germination to the tillering stage and *H. armigera* larvae at the grain formation stage. There was 100% yield loss in proso millet and 34.8% yield loss in little millet were recorded and these avoidable yield losses were mainly due to the shoot fly infestation. In kodo millet the yield loss of 8.8% was majorly due to the incidence of *H. armigera* at the grain formation stage, whereas 5.8 yield losses in finger millet were due to thrips at germination to tillering stage followed by *H. armigera* at grain formation stage. During the year 2017, the high yield loss of 22.3 percent in little millet and 16.6 percent in proso millet was mainly attributed to shoot fly incidence at tillering stage. The present study is in agreement with Natarajan *et al*., 1974 [5] who reported that avoidable yield loss of 59.3 per cent in proso millet due to shoot fly *Atherigona destructor M*. alone and Selvaraj *et al*., 1974 [8] reported 9.2 to 39.0 per cent yield loss in case of little millet. In foxtail millet and Finger millet the estimated yield losses of 7.9 and 6.5 percent in untreated plots were mainly attributed to the incidence of thrips at the germination to tillering stage and *Helicoverpa* at the grain formation stage. In Barn yard millet the 5.1% yield loss was mainly due to thrips at the germination to tillering stage.

Table 1: Seasonal incidence of different insect pests in minor millets and yield losses during *kharif* 2016.

S. No	Minor millets	Leaf damage (%) Thrips	Dead hearts (%) Shoot fly	No. of *H. armigera* larvae/ m2	Yield (kg/ha) in Protected	Yield (kg/ha) in Un Protected	Yield loss (%)
1	Foxtail millet	14.00	-	15	3158	2678	15.2
2	Barnyard millet	23.25	-	12	2758	2525	8.5
3	Proso millet	40.5	100	-	1983	0	100.0
4	Little millet	24.38	75	-	831	542	34.8
5	Kodo millet	4.25	-	5	2275	2075	8.8
6	Finger millet	78.00	-	5	4708	4438	5.8
Insecticide sprayed		Monocrotophos @ 320 ml/acre	Carbofuran 3 G @ 8 kg/acre	Thiodicarb @300 g/acre			

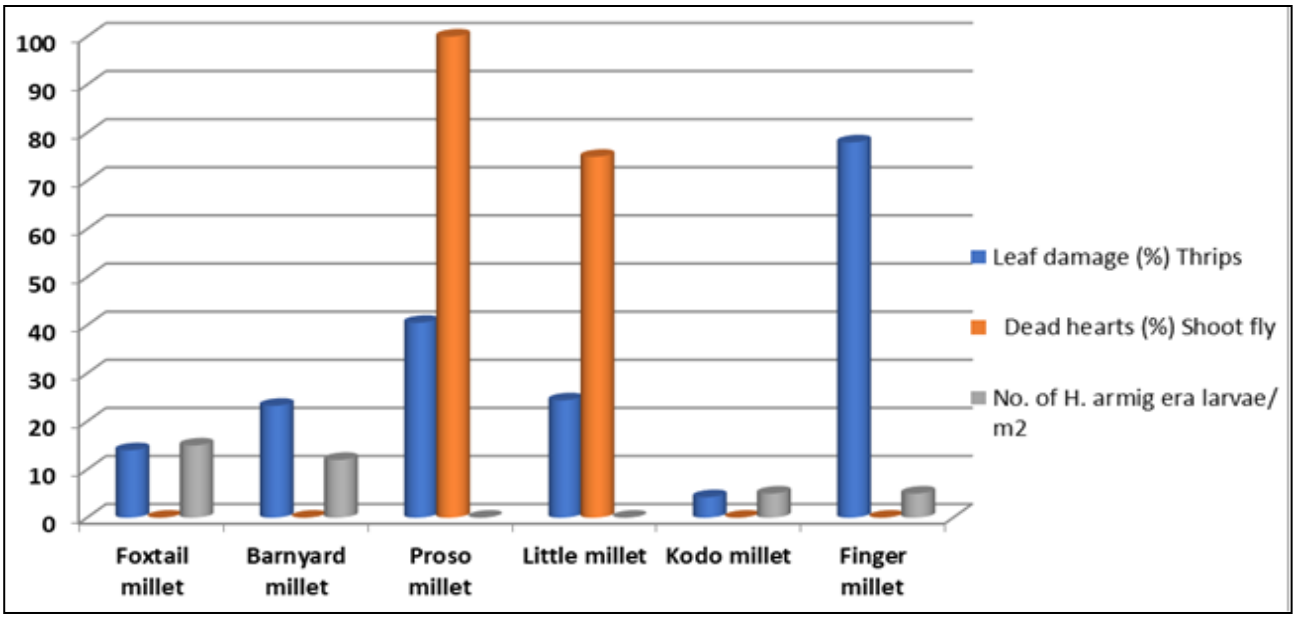

Fig 1: Seasonal incidence of insect pests in minor millets during *kharif* 2016.

Table 2: Table 1: Seasonal incidence of different insect pests in minor millets and yield losses during *kharif* 2017.

S. No	Minor millets	Leaf damage (%) Thrips	Dead hearts (%) Shoot fly	No. of *H. armig era* larvae/ m2	Yield (kg/ha) in Protected	Yield (kg/ha) in Un Protected	Yield loss (%)
1	Foxtail millet	9.00	-	3	2235	2058	7.9
2	Barnyard millet	14.5	-	0	3417	3242	5.1
3	Proso millet	24.6	46.0	0	2933	2447	16.6
4	Little millet	12.5	51.0	3	1808	1404	22.3
5	Kodo millet	0.0	-	0	1840	1800	2.2
6	Finger millet	55.0	-	2	1963	1836	6.5
Insecticide sprayed		Monocrotophos @ 320 ml/acre	Carbofuran 3 G @ 8 kg/acre	Thiodicarb @300 g/acre			

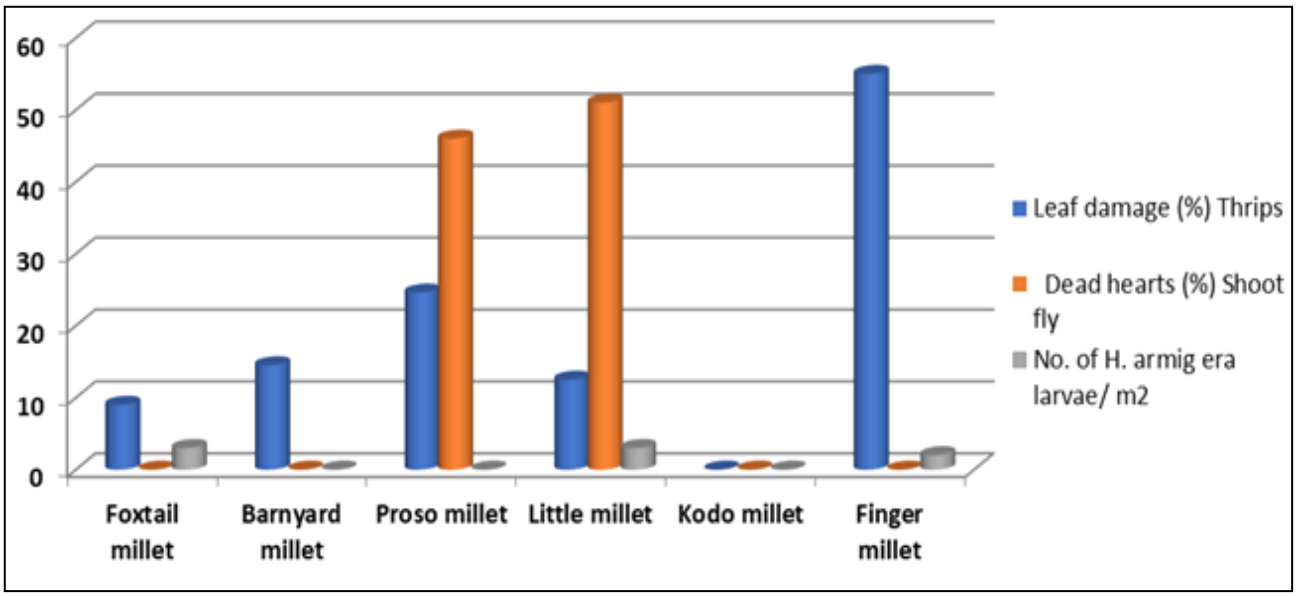

Fig 2: Seasonal incidence of insect pests in minor millets during *kharif* 2017.

Conclusions

Among the six minor millets, thrips incidence was started from 10 days after sowing to the early vegetative stage and its incidence was high in finger millet. Shoot fly incidence was recorded at tillering stage in little millet and proso millet. *Helicoverpa armigera* incidence was recorded in foxtail millet, barnyard millet, kodo millet and finger millet at grain formation to grain maturity stage. The yield losses in foxtail millet were mainly due to thrips and *Helicoverpa armigera*, the yield losses in barnyard millet were mainly attributed to *Helicoverpa armigera* and the yield losses in proso and little millet were mainly due to severe incidence of shoot fly.

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