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Screening of finger millet genotypes against pink stem borer (*Sesamia inferens* Walker, Noctuidae, Lepidoptera)

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Abstract
Small millets are nutritionally superior to rice and wheat. Realizing the importance and nutritional superiority of millets, they are considered as nutri-cereals. Finger millet (Ragi) *Eleusine coracana* Gaertn is the most widely cultivated one among the small millet group. Ragi crop is grown generally in tribal dominated areas of Odisha. Finger millet pink stem borer, *Sesamia inferens* Walker (Noctuidae; Lepidoptera) is one of the most important insect pest of finger millet during *Rabi* season in Odisha. Among the eco-friendly pest management practices, the identification of pest resistant cultivars is an economical, easy and sustainable strategy which is very essential to increase the production and productivity. An experiment was conducted at CPR, Berhampur of Odisha University of Agriculture and Technology (OUAT) for screening of finger millet (Ragi) genotypes against stem borer incidence during *Rabi*, 2012-13 and *Rabi*, 2013-14. Twenty nine finger millet genotypes were included in the test. The genotypes, PRM 9002, KOPN 933, OEB 28, RAU 8 and Champabati recorded less stem borer incidence both in tillering(<10%) stage and panicle stage(<5%). Among the tested genotypes OEB-28 recorded tallest plant (68.2 cm height), highest number of tillers (2.32 plant^{-1}), longest finger length (7.0 cm), highest grain yield (19.5 q/ha) and straw yield (2.39 t/ha).

Keywords: Dead heart (DH), finger millet, stem borer, small millet, white ear head (WEH)

Introduction
Finger millet (Ragi) *Eleusine coracana* Gaertn is a highly nutritive, climate resilient crop which can be cultivated with minimum care and management. Finger millet is a hardy crop and shows a quick rejuvenating capacity to various biotic and abiotic stresses. The dietary fibers and polyphenols present in finger millet have several health benefits. Regulation of glucose homoeostasis and prevention of dyslipideamia can be achieved by regular consumption of finger millet [3]. So in this context of special health enhancing characters of finger millet, its production in an organic background is the need of the hour.

Some insect-pests like aphids, stem borers and grass hoppers attack finger millets. Among all the insect-pests, pink stem borer, *Sesamia inferens* Walker (Noctuidae; Lepidoptera) is widely distributed in all finger millet growing countries. The pink stem borer, *S. inference*, which was once an important insect pest of sugarcane has shifted its infestation to rice and have been dispersed to other crops [1]. In India it is more regularly recorded in parts of Odisha, Karnataka, Tamil Nadu and Andhra Pradesh [5]. It has limited host range like ragi, sorghum, wheat, sugarcane, rice and maize. Irrigated ragi crop is the most preferred host [10] of pink stem borer. It causes extensive damage to the crop in the peninsular India throughout the year and across the country [12]. While low winter temperature is a major environmental constraint on the survival of most insect species, the mechanism of *S. inferens* has the capacity to tolerate freezing temperature [8]. Injury of stem borers in finger millet starts typically when the crop is about 30 days old and onwards. The adult moths of *S. inferens* are straw colored. The female moth lays creamy white eggs in clusters in between the leaf sheath and the whorl. Eggs hatch in about 7 days. On hatching larvae enter into the stem reach the soft tissues, start feeding downwards. It bores the nodes and reach the base of the plant where fully grown pink colored larvae measures 25-30 mm length pupates inside the tunneled stem [2]. The larvae form 'S' shaped tunnels which is filled with excreta inside the stem [13]. The typical symptom of pink borer infestation is 'dead heart' at tillering stage. If the infestation is after ear head emergence, it develops completely white, chaffy panicle known as 'White ear head (WEH)'. *S. inferens* also causes severe infestation in maize result in stunted plant growth [11].

Stem borers can be managed effectively by following preventive measures than the application of insecticides, which are difficult to reach to borers. Chemicals are also proved costlier in finger millet crop [10]. Some cultural practices like stubble burning, pulling and destruction of dead hearts (DH) in the early stage, adjusting the date of sowing to avoid stem borer attack are very useful to minimize the incidence. Apart from these, identification of pest resistant cultivars is the backbone of IPM against finger millet stem borer in endemic areas like Odisha. Considering the need some promising genotypes of finger millet were included in the experiment of screening against stem borer.

2. Materials and Methods

An experiment was conducted at CPR, Berhampur of Odisha University of Agriculture and Technology (OUAT) for screening of finger millet (Ragi) genotypes against stem borer incidence. The experiment was conducted during *Rabi*, 2012-13 and *Rabi*, 2013-14. Twenty nine genotypes of finger millet were included in the test and replicated thrice in Randomized Block Design (RBD). Individual genotypes were directly sown in each treatment plot at 22.5cm row spacing. At 20 Days after sowing (DAS) thinning of plants were done maintaining 10cm plant to plant spacing. Recommended dose of fertilizer (50-25-25kg N, P_2O_5 and K_2O) were applied.

Observations on stem borer affected tillers/dead heart (DH) were collected at 45 Days after Sowing (DAS). Randomly selected ten plants were taken into consideration in each treatment plot of each replication. Then the total number of dead heart and total tillers of the individual treatment plot was calculated by adding ten samples. Percentage of dead heart was calculated by the following formula.

Percentage of dead heart (DH %) = (Number of stem borer affected tillers/ Total number of tillers in each entry) × 100

The percentage of white ear head (WEH %) was also calculated for stem borer infestation at panicle stage. At the heading stage the number of stem borer affected tillers / white ear head and total tillers were counted in each plant. Ten plants were taken into consideration in each treatment plot of each replication. Then the total number of white ear head and total tillers of the individual treatment plot was calculated by adding ten samples. Average of the replication data was calculated considering each replication data. Percentage of white ear head was calculated by the following formula.

Percentage white ear head (WEH %) = (Number of stem borer affected panicles/ Total Number of panicles in each entry) × 100

Average dead heart and white ear head was calculated considering each replication data.

Plant growth parameters like plant height, number of tillers/plant were recorded at 45DAS in ten randomly selected plants in each treatment plot. Then the average plant height and number of tillers were calculated. Yield attributing characters like finger length were measured in ten randomly selected plants of each treatment plot and mean finger length were calculated for each entry. Grain yield and straw yield per treatment plot were recorded in each replication. Then average yield of three replications were made for each genotype and converted to yield per hectare.

3. Results

3.1 Dead Heart (DH)

During *Rabi*, 2012-13 the dead heart (DH) percentage in different genotypes ranged from 6.4- 29.5% where as it varies from 9.5% to 27.2% during *Rabi* 2013-14 respectively. The pooled mean of two season data indicates that the finger millet genotypes: PRM 9002, KOPN 933, OEB 28, RAU 8 and Champabati recorded less than 10% dead heart (DH). Among these genotypes, OEB 28 recorded lowest dead heart (8.4% DH) which is at par with PRM 9002 (8.6%DH). The genotypes GPU 75, VL 352, BR 4, BBM 11, VL 352, GPU 79, OEB 87, OEB 303, OEB 265, Godavari, Dibyasinha, Nilachala, Subhra, Chilika, OEB532, VL 149, OEB 22, Bhairabi, AKP 2, OEB 312 had dead heart incidence within 10-20%. Rest finger millet genotypes: OEB 225, OEB 311, OEB 52 and OEB 526 recorded more than 20% DH incidence in the experiment (Table-1).

3.2 White Ear Head (WEH)

From table-1 it can be revealed that the percentage of white ear head (WEH %) varies from 0.7% to 13.3% and 1.5% to 12.5% during *Rabi*, 2012-13 and *Rabi* 2013-14 respectively. The pooled data of both the seasons reveals that the genotypes where less than 5% white ear head (WEH) observed are PRM 9002, KOPN 933, BR 4, BBM 11, OEB 87, OEB 303, OEB 265, Godavari, OEB 28, Dibyasinha, Nilachala, Subhra, Chilika, OEB 530, OEB 532, OEB 526, RAU 8, VL 149, OEB 22, Bhairabi, AKP 2 and Champabati. At heading stage OEB 28 and PRM 9002 were statistically at par and found to have less than 2% white ear head (WEH).

Table 1: Percentage of dead heart (DH) and white ear head (WEH) in different genotypes of finger millet.

Finger millet genotypes	Dead Heart (%DH)			White Ear Head (%WEH)		
	(*Rabi*, 2012-13)	(*Rabi*, 2013-14)	Pooled Mean of two seasons	(*Rabi*, 2012-13)	(*Rabi*, 2013-14)	Pooled Mean of two seasons
PRM 9002	7.7	9.5	8.6	1.3	2.4	1.9
KOPN 933	8.7	10.4	9.6	3.7	5.3	4.5
GPU 75	14.0	11.2	12.6	13.3	12.5	12.9
BR 4	14.1	13.9	14.0	3.0	5.6	4.3
BBM 11	9.6	12.5	11.1	3.0	6.8	4.9
VL 352	15.4	16.2	15.8	6.3	8.3	7.3
GPU 79	18.3	15.6	17.0	6.3	7.2	6.8
OEB 87	16.8	17.2	17.0	3.3	5.3	4.3
OEB 225	29.5	27.2	28.4	4.7	5.2	5.0
OEB 311	21.5	19.6	20.6	6.0	8.2	7.1
OEB 303	17.2	16.4	16.8	2.7	3.8	3.3
OEB 265	18.5	19.8	19.2	1.0	3.2	2.1
Godavari	15.2	16.8	16.0	1.7	2.9	2.3
OEB 52	19.1	21.7	20.4	4.0	6.4	5.2
OEB 28	6.4	10.3	8.4	0.7	2.5	1.6

Dibyasinha	12.0	11.8	11.9	2.7	3.8	3.3
Nilachala	17.6	15.8	16.7	1.7	2.9	2.3
Subhra	14.4	13.4	13.9	4.3	5.2	4.8
Chilika	18.8	17.9	18.4	2.7	3.4	3.1
OEB 530	24.9	25.4	25.2	1.7	3.0	2.4
OEB 532	18.0	16.6	17.3	2.3	4.2	3.3
OEB 526	23.2	22.0	22.6	2.3	5.1	3.7
RAU 8	8.4	10.4	9.4	3.3	2.1	2.7
VL 149	21.2	20.5	20.9	1.0	3.6	2.3
OEB 22	15.1	14.2	14.7	2.0	1.5	1.8
Bhairabi	12.4	14.8	13.6	2.0	3.8	2.9
AKP 2	9.5	12.4	11.0	2.7	4.8	3.8
Champabati	10.2	9.7	10.0	1.3	2.4	1.9
OEB 312	13.8	15.6	14.7	4.7	6.4	5.6
SEm(±)	0.69	0.55	0.198	0.40	0.46	0.177
CD (0.05)	1.94	1.54	0.563	1.14	1.31	0.504

3.3 Yield attributes and yield

Table-2 reveals that genotype OEB-28 was the tallest among the tested promising genotypes of finger millet. It bore more numbers of tillers 2.32 plant^{-1}, longest finger length (7.0 cm), highest grain yield (1.95 t/ha) and straw yield (2.39 t/ha). With regard to the yield varieties OEB-28, OEB-265, VL-149, PRM-9002, CHAMPABATI, Godavari, Nilachala, OEB-530, VL-352, OEB-22, Bhairabi, OEB-532, OEB-526, Chilika, OEB-303 were at par.

Table 2: Pooled yield and yield attributes of two years *Rabi*, 2012-13 and *Rabi*, 2013-2014.

Finger millet genotypes	Plant Height (cm)	Numbers of Tillers/plant	Finger Length (cm)	Grain Yield (q/ha)	Straw Yield (t/ha)
PRM 9002	61.2	2.16	6.8	18.5	2.28
KOPN 933	59.2	1.46	5.5	13.1	1.64
GPU 75	60.4	1.5	6.1	14.5	1.52
BR 4	62.3	1.4	6.0	14.3	1.86
BBM 11	64.4	1.2	5.6	14.1	1.76
VL 352	56.5	2.00	6.4	17.5	2.15
GPU 79	59.4	1.25	5.2	12.2	1.50
OEB 87	58.8	1.80	5.5	13.3	1.63
OEB 225	56.5	1.34	5.3	12.5	1.57
OEB 311	52.5	1.30	5.2	12.2	1.50
OEB 303	62.5	1.95	6.1	16.6	2.12
OEB 265	65.4	2.21	7.0	19.2	2.36
GODAVARI	64.2	2.15	6.5	18.7	2.30
OEB 52	55.2	1.41	5.4	13.2	1.61
OEB 28	68.2	2.32	7.0	19.5	2.39
DIBYASINHA	60.8	1.95	6.1	15.4	2.04
NILACHALA	65.2	2.15	6.5	18.3	2.25
SUBHRA	59.2	1.36	5.4	12.7	1.62
CHILIKA	66.5	1.96	6.2	17.3	2.12
OEB 530	59.6	2.14	6.4	17.5	2.15
OEB 532	65.3	1.9	6.3	16.6	2.04
OEB 526	67.5	1.95	6.2	17.1	2.10
RAU 8	62.3	1.1	5.6	13.3	1.74
VL 149	60.2	2.18	6.8	18.8	2.31
OEB 22	62.2	2.00	6.4	17.1	2.10
BHAIRABI	68.0	2.00	6.3	17.2	2.11
AKP 2	65.5	1.5	6.0	15.1	1.89
CHAMPABATI	63.5	2.17	6.5	18.3	2.25
OEB 312	54.5	1.32	5.2	12.2	1.53
SEm(±)	1.23	0.03	0.41	0.01	0.02
CD (0.05)	2.15	0.56	1.12	0.28	0.57

4. Discussion

Screening of some improved genotypes of the finger millet for resistance against *S. inferens* is an eco-friendly, economical and rational approach of stem borer management in finger millet. Finger millet genotypes IE 932, IE 982 and IE 1037 were reported to be stem borer tolerant [7]. The finger millet genotypes PES 9, PES 144, PES 224, KM 1, KM 14, HR 228, JNR 1008 and T 36-B were reported to be less infested by stem borer [6]. Finger millet genotypes KM 1, RAU 1, RAU 3, Indaf 7, Indaf 8, HR 154, HR 374, HR 1523, PES, 110, PES 400, WR 9, VL 110 were found to be comparatively tolerant to stem borer [9]. VL 109, VR 530, PR 202, HR 374 genotypes were reported to be either tolerant or less susceptible to *S. inferens* [4]. However in the present investigation the genotypes: PRM 9002, KOPN 933, OEB 28, RAU 8 and Champabati have recorded relatively less incidence of stem borer attack which may be further studied for source of resistance.

5. Conclusion

In the present experiment among the tested finger millet genotypes, PRM 9002, KOPN 933, OEB 28, RAU 8 and Champabati were found to be least infested by the pink stem borer both at tillering and panicle initiation/emergence stage in Odisha. The genotype OEB-28 has recorded tallest plant 68.2cm, more numbers of tillers 2.32/plant, longest finger length of 7.0cm with a highest grain yield of 19.5q/ha and straw yield of 2.39t/ha.

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