Varietal Screening Of Wheat Germplasms Against Resistance To Shoot Fly *Atherigona Oryzae* Malloch

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Abstract
Wheat (Triticum spp.) is a stuff of life and has been considered as the "versatile cereal food". It is also described as "King of cereals" for centuries. Greatest food grain source satisfies hunger of world population more than 35 per cent. Today, India ranks second in wheat production with 31.2 M ha as under cultivation and production of 107 million metric tonne with an average productivity of 30q/ha. The productivity of wheat is very low (988 kg/ha) in Karnataka as compared to the national average of 2900 kg/ha. This is mainly due to the fact that large area of wheat (60%) is grown under rain fed condition, non-adaptability of improved technologies and attack of many insect pests and diseases. In the past fifty years there has been an increase in wheat productivity and have also been marked by considerable changes in the pest complex. Introduction of high yielding wheat varieties has changed the wheat ecosystem and the changes in the crop environment have become conducive for the development and multiplication of certain insect pest species and have accelerated the incidence of older but innocuous pests and also have led to emergence of new ones. In the last five years shoot fly, stem borer and aphids are causing more damage in the various district of northern Karnataka. Shoot fly is causing more than 26 per cent dead heart in the early stage of the crop. However, the information available on pest of wheat is very scanty under north Karnataka conditions. There is need to document per cent damage of shoot fly in wheat, so as to generate information related economics of its incidence in wheat, particularly at Dharwad during *rabi* season of the year 2013-14. Hence, the present study was undertaken with the varietal screening of wheat germplasms against resistance to shoot fly.

Key Words: Shoot fly, wheat, Sreening germplasms and wheat insects

1. Introduction

Wheat (*Triticum* spp.) is a stuff of life and has been considered as the "versatile cereal food". It is also described as "King of cereals" for centuries and continues to retain this pride of place with its roots ramifying into the depths of human culture with evolutionary history parallel with the human civilization itself. Wheat occupies second position (next to rice) in production among all the cultivated crops in world due to its feeding boon to mankind (Borlaug 1968). It is the number one food grain consumed directly by human beings and is estimated that more than 35 per cent of the world's population depends on wheat as it supplies more nutrients particularly, essential amino acids than any other single crop. Wheat cultivation in India started 5000 years ago. Today, India ranks second in wheat production with 31.2 M ha as under cultivation and production of 95.9 million tons with an average productivity of 30q/ha (Anon, 2013). The major wheat growing states in India are Uttar Pradesh, Madhya Pradesh and Punjab during 2013-14 season. To meet out the increasing demand of wheat production without increasing area, there is need to incorporate new physiological tools. These tools will help for the improvement of breeding program under abiotic stress environment. If specific physiological trait associated with yield could be identified under stress environment, selection efficiency could be increased. These traits will contribute to more objective screening of yield for selection in early generations, when grain yield may not be properly assessed (Ramadas *et al.*, 2019). Wheat cultivation in Karnataka is unique where in all the three cultivated species are grown in typical hot tropical climate, characterized by the high temperature during the crop growth. Wheat is the one of the important Rabi crop grown mainly in Northern Karnataka both under the rainfed and irrigated conditions covering an area of 2.14 lakh hectares with an annual production of 2.3 lakh tones (Singh, 2014). Much of this area is concentrated in North parts of Karnataka comprising twelve revenue districts viz., Belagavi, Bellary, Bidar, Vijayapura, Bagalkot, Dharwad, Gadag, Haveri, Kalaburgi, Yadagir, Raichur and Koppal districts. The productivity of wheat is very low (988 kg/ha) in Karnataka as compared to the national average of 2900 kg/ha (Anon, 2013). This is mainly due to the fact that large area of wheat (60%) is grown under rain fed condition, non-adaptability of improved technologies and attack of many insect pests and diseases (David and Ramamurthy 2011). Although damage caused by most of these insects is either insignificant or limited to isolated areas, other pests inflict serious yield and forage losses. Some of these pest problems are directly linked to the unique farming system employed in a particular area, while other pests are opportunistic or generalist herbivores that do not specifically target wheat as a host (Miller and Pike, 2002). So far more than twenty six (26) insect pests have been recorded on this crop under Indian conditions (Anon, 2013). In the past fifty years there has been an increase in wheat productivity and have also been marked by considerable changes in the pest complex. Introduction of high yielding wheat varieties has changed the wheat ecosystem and the changes in the crop environment have become conducive for the development and multiplication of certain insect pest species and have accelerated the incidence of older but innocuous pests and also have led to emergence of new ones. Consequently over the years, various regions of the country have witnessed limited epidemics of pests like army worm; g

Ghujiya weevil etc., while pests like shoot fly, pink stem borers, brown wheat mite, foliar aphids, termites, have become common and of almost regular occurrence and some new emerging threats to wheat i.e., pink stem borer with the regular involvement of the entomologist in the All India Wheat and Barley Improvement Project. According to Duveiller *et al*. (2007) chewing and feeding insects usually do not cause major direct damages in wheat, unless populations reach very high levels. In the last five years shoot fly, stem borer and aphids are causing more damage in the various district of northern Karnataka. Shoot fly is causing more than 26 per cent dead heart Kalappanavar *et al* (2010), pink stem borer causing 10 per cent dead heart at seedling stage and white ear heads at later crop growth stage, followed by Aphids (Anon, 2013). However, the information available on pests of wheat is very scanty under north Karnataka conditions. There is need to document important pest of wheat, so as to generate information related economics of insect pest incidence in wheat, particularly at Dharwad. Hence, the present study was undertaken with the following objective, varietal screening of wheat germplasms against resistance to shoot fly.

2. Materials and methods

Materials used and methods employed on varietal screening of wheat germ-plasms against shoot fly investigations were carried out during rabi 2012-13 at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad on medium black soil. The field experiment was conducted in D block plot no. 108 which is located at 150 26' N latitude, 750 07' E longitudes and at an altitude of 678 m above mean sea level. The research station comes under Northern Transition Zone (Zone-8) of Karnataka which lies between the Western Hilly Zone (Zone 9) and Northern Dry Zone (Zone-3).

The field experiment was conducted at Main Agriculture Research Station, University of Agricultural Sciences, Dharwad during rabi season 2012-2013. Totally 273 wheat germplasms of wheat were evaluated for their resistance or susceptibility against shoot fly. The observation on per cent dead heart was recorded from each row for shoot fly at 20, 40 and 60 days after sowing (DAS). All the crop production technologies were adopted to get good crop stand except plant protection measures against insects. The wheat germplasms used were as follows.

Northern hill zone: NHESZ 1201, NHESZ 1202, NHESZ 1203, NHESZ 1204, NHESZ 1205, NHESZ 1206, NHESZ 1207, NHESZ 1208, NHESZ 1209, NHESZ 1210, NHESZ 1211, NHESZ 1212, NHESZ 1213, NHTSZ 1201, NHTSZ 1202, NHTSZ 1203, NHTSZ 1204, NHTSZ 1205, NHTSZ 1206, NHTSZ 1207, SONALIKA, IWP 711, A 9-30-1 NHTSZ 1208, NHLSZ 1201, NHLSZ 1202, NHLSZ 1203, NHLSZ 1204, NHLSZ 1205, NHLSZ 1206, NHLSZ 1207, NHLSZ 1208, NHLSZ 1209, NHLSZ 1210, NHLSZ 1211, NHLSZ 1212.

North western plain zone: NW-TS- 01, NW-TS-02, NW-TS- 03, NW-TS- 04, NW-TS- 05, NW-TS- 06, NW-TS- 07, SONALIKA, IWP 711, A 9-30-1, NW-TS- 08, NW-TS- 09, NW-TS- 10, NW-TS- 11, NW-TS- 12, NW-TS- 13, NW-TS- 14, NW-TS- 15, NW-TS- 16, NW-TS- 17, NW-DM-01, NW-DM-02, NW-DM-03, NW-DM-04, NW-DM-05, NW-DM-06, NW-DM-07, NW-DM-08, NW-DM-09, NW-DM-10, SONALIKA, IWP 711 A 9-30-1, NW-DM-11, NW-LS – 01, NW-LS – 02, NW-LS – 03, NW-LS – 04, NW-LS – 05, NW-LS – 06, NW-LS – 07, NW-LS – 08, NW-LS – 09, NW-LS – 10, NW-LS – 11, NW-LS – 12, NW-LS – 13, NW-LS – 14, NW-LS – 15, NW-LS – 16, NW-LS – 17, NW-RF- 01, NW-RF- 02, SONALIKA, IWP 711 A 9-30-1, NW-RF- 03, NW-RF- 04, NW- - 05, NW-RF- 06, NW-RF- 07, NW-RF- 08, NW-RF- 09, NW-RF- 10, NW-RF- 11, NW-RF- 12, NW-RF- 13, NW-RF- 14, NW-RF- 15, NW-RF- 16, NW-RF- 17, NW-RF- 18, NW-RF- 19, NW-RF- 20, NW- RI- 01, NW- RI- 02, SONALIKA, IWP 711, A 9-30-1, NW-RI- 03, NW- RI- 04, NW- RI- 05, NW- RI- 06, NW- RI- 07, NW- RI- 08, NW- RI- 09, NW- RI- 10, NW- RI- 11, NW-RI- 12, NW- RI- 13, NW- RI- 14.

North eastern plain zone: NE-TS 01, NE-TS 02, NE-TS 03, NE-TS 04, NE-TS 05, NE-TS 06, NE-TS 07, NE-TS 08, SONALIKA, IWP 711, A 9-30-1, NE-TS 09, NE-TS 10, NE-TS 11, NE-TS 12, NE-TS 13, NE-TS 14, NE-TS 15, NE-TS 16, NE-LS 01, NE-LS 02, NE-LS 03, NE-LS 04, NE-LS 05, NE-LS 06, NE-LS 07, NE-LS 08, NE-LS 09, NE-LS 10, NE-LS 11, NE-LS 12, SONALIKA, IWP 711, A 9-30-1, NE-LS 13, NE-LS 14, NE-RF01, NE-RF 02, NE-RF 03, NE-RF 04, NE-RF 05, NE-RF 06, NE-RF 07.

Central zone: CZ-TS-01, CZ-TS-02, CZ-TS-03, CZ-TS-04, CZ-TS-05, CZ-TS-06, CZ-TS-07, CZ-TS-08, CZ-TS-09, CZ-TS-10, CZ-TS-11, SONALIKA, IWP 711, A 9-30-1, CZ-TS-12, CZ-TS-13, CZ-TS-14 ,CZ-TS-15, CZ-TS-16, CZ-RF-01, CZ-RF-02, CZ-RF-03, CZ-RF-04, CZ-RF-05, CZ-RF-06, CZ-RF-07, CZ-RF-08, CZ-RF-09, CZ-RF-10, CZ-RF-11, CZ-RF-12 ,CZ-RF-13, CZ-RF-14, CZ-RF-15, SONALIKA, IWP 711, A 9-30-1, CZ-RF-16, CZ-RF-17, CZ-RF-18, CZ-LS-01, CZ-LS-02, CZ-LS-03, CZ-LS-04, CZ-LS-05, CZ-LS-06, CZ-LS-07, CZ-LS-08

Peninsular zone: PZ-TS-01, PZ-TS-02, PZ-TS-03, PZ-TS-04, PZ-TS-05, PZ-TS-06, PZ-TS-07, PZ-TS-08, PZ-TS-09, SONALIKA, IWP 711, A 9-30-1,PZ-TS-10, PZ-TS-11, PZ-TS-12, PZ-TS-13, PZ-TS-14, PZ-TS-15, PZ-LS-01, PZ-LS-02, PZ-LS-03, PZ-LS-04, PZ-LS-05, PZ-LS-06, PZ-LS-07, PZ-LS-08, PZ-LS-09, PZ-LS-10, PZ-LS-11, PZ-LS-12, PZ-LS-13, PZ-LS-14, SONALIKA, IWP 711, A 9-30-1, PZ-LS-15, PZ-RF-01, PZ-RF-02, PZ-RF-03, PZ-RF-04, PZ-RF-05, PZ-RF-06, PZ-RF-07, PZ-RF-08, PZ-RF-09, PZ-RF-10, PZ-RF-11, PZ-RI-01, PZ-RI-02, PZ-RI-03, PZ-RI-04, PZ-RI-05, PZ-RI-06, PZ-RI-07, PZ-RI-08, SONALIKA, IWP 711, A 9-30-1, PZ-RI-09, PZ-RI-10, and PZ-RI-11.

Southern hills zone: SHZ-01, SHZ-02, SHZ-03, SHZ-04, SHZ-05, SHZ-06, SHZ-07, SHZ-08 and SHZ-09.
Special trial: SPL-DIC-01, SPL-DIC-02, SPL-DIC-03, SPL-DIC-04, SPL-DIC-05, SPL-DIC-06, SPL-DIC-07, SPL-DIC-08, SONALIKA, IWP 711, A 9-30-1, SPL-DIC-09, SPL-DIC-10, SPL-AST-01, SPL-AST-02, SPL-AST-03, SPL-AST-04, SPL-AST-05, SPL-AST-06, SPL-AST-07, SPL-AST-08, SPL-AST-09, SPL-AST-10 and SPL-AST-11.

3. RESULTS AND DISCUSSIONS

Results of the investigations screening of AVT elite germplasms on wheat conducted during 2012- 13 at the Main Agricultural Research Station Dharwad are presented below.

The mean and standard deviation was calculated for the sown genotypes as separately against per cent dead heart for the shoot fly, where mean was 34.40 and standard deviation was 18.75 and by considering mean and standard deviation, the per cent dead heart effected by the pests was calculated and the incidence was categorized into highly resistant (Mean-2SD), resistant (Mean-SD), moderately resistant (Mean), susceptible (Mean+SD) and finally highly susceptible (Mean+2SD).

None of the entries were found highly resistant against shoot fly with dead heart score below -3.1 per cent.

Thirty five (35) entries viz., NHLSZ 1210, NW-TS- 08, NW-DM-05, NW-RF- 09, NW-RF- 20, NE-LS 01, NE-LS 09, CZ-TS-05, CZ-TS-06, CZ-TS-09, CZ-TS-12, CZ-TS-14, CZ-RF-09, CZ-RF-16, CZ-LS-06, CZ-LS-07, CZ-LS-08, PZ-TS-03, PZ-TS-04, PZ-TS-07, PZ-LS-02, PZ-LS-03, PZ-LS-05, PZ-LS-06, PZ-LS-12, PZ-LS-14, PZ-RF-03, PZ-RF-04, PZ-RF-07, PZ-RF-08, PZ-RI-04, PZ-RI-06, PZ-RI-07, SPL-DIC-07 and SPL-DIC-09 were found to be resistant against shoot fly with per cent dead heart of -3.1 to 15.65.

One hundred and twenty three genotypes (123) viz., NHTSZ1208, NHLSZ1204, NW-TS-01, NW-TS-13, NW-TS-17, NW-DM-02, NW-DM-04, NW-DM-07, NW-DM-08, NW-DM-09, NW-DM-10, NW-LS–03, NW-LS–04, NW-LS–06, NW-LS– 07, NW-LS–08, NW-LS–09, NW-LS–12, NW-LS–14, NW-LS–16, NW-RF-01, NW-RF-02, NW-RF-03, NW-RF-06, NW-RF- 07, NW-RF-10, NW-RF-12, NW-RF-13, NW-RF-17, NW-RF-18, NW-RF-19, NW-RI-05, NW-RI-06, NW- RI- 08, NW- RI- 09, NW- RI- 10, NW- RI- 11, NW- RI- 12, NW- RI- 13, NW- RI- 14, NE-TS 03, NE-TS 04, NE-TS 05, NE-TS07, NE-TS 08, NE-TS 11, NE-TS 12, NE-TS 13, NE-TS 14, NE-LS 02, NE-LS 03, NE-LS 04, NE-LS 06, NE-LS 10, NE-LS 11, NE-LS 14, CZ-TS-02, CZ-TS-03, CZ-T08, CZ-TS-10, CZ-TS-11, CZ-TS-15, CZ-RF-01, CZ-RF-02, CZ-RF-03, CZ-RF-04, CZ-RF-10, CZ-RF-11, CZ-RF-12, CZ-RF-14, CZ-RF-15, CZ-RF-18, CZ-LS-02, CZ-LS-03, CZ-LS-04, CZ-LS-05, PZ-TS-01, PZ-TS-02, PZ-TS-05, PZ-TS-06, PZ-TS-08, PZ-TS-10, PZ-TS-11, PZ-TS-12, PZ-TS-13, PZ-TS-14, PZ-LS-01, PZ-LS-07, PZ-LS-08, PZ-LS-09, PZ-LS-11, PZ-LS-13, PZ-LS-15, PZ-RF-01, PZ-RF-02, PZ-RF-05, PZ-RF-06, PZ-RF-09, PZ-RF-10, PZ-RI-02, PZ-RI-03, PZ-RI-05, PZ-RI-08, PZ-RI-09, PZ-RI-10, SHZ-01, SHZ-03, SHZ-04, SHZ-06, SHZ-07, SHZ-08, SPL-DIC-01, SPL-DIC-05, SPL-DIC-06, SPL-DIC-08, SPL-DIC-10, SPL-AST-01, SPL-AST-03, SPL-AST-04, SPL-AST-05, SPL-AST-07 and SPL-AST-10 showed moderate resistance to shoot fly with per cent dead heart of 15.65 to 34.40.

Seventy eight entries like NHESZ 1207, NHESZ 1208, NHESZ 1209, NHESZ 1210, NHESZ 1211, NHESZ 1213, NHTSZ 1201, NHTSZ 1205, NHTSZ 1206, NHTSZ 1207, NHLSZ 1201, NHLSZ 1202, NHLSZ 1203, NHLSZ 1208, NHLSZ 1209, NHLSZ 1212, NW-TS- 02, NW-TS- 03, NW-TS- 04, NW-TS- 09, NW-TS- 10, NW-TS- 11, NW-TS-12, NW-TS- 14, NW-DM-01, NW-DM-03, NW-DM-06, NW-LS – 01, NW-LS – 02, NW-LS – 05, NW-LS – 10, NW-LS – 15, NW-LS – 17, NW-RF- 05, NW-RF- 08, NW-RF- 11, NW-RF- 14, NW-RF- 15, NW-RF- 16, NW- RI- 07, NE-TS 01, NE-TS 02, NE-TS 09, NE-TS 10, NE-TS 15, NE-TS 16, NE-LS 07, NE-LS 08, NE-LS 12, NE-LS 13, NE-RF 01, NE-RF 02, NE-RF 03, NE-RF 04, NE-RF 06, NE-RF 07, CZ-TS-04, CZ-TS-07, CZ-TS-13, CZ-TS-16, CZ-RF-05, CZ-RF-06, CZ-RF-07, CZ-RF-08, CZ-RF-17, PZ-TS-09, PZ-TS-15, PZ-LS-04, PZ-LS-10, PZ-RI-11, SHZ-02, SHZ-05, SPL-DIC-04, SPL-AST-02, SPL-AST-06, SPL-AST-08, SPL-AST-09 and SPL-AST-11 recorded susceptibility to shoot fly with per cent dead heart range of 34.40 to 53.16

Thirty seven (37) entries were highly susceptible to shoot fly with per cent dead heart ranging from 53.16 to 71.15 and the genotypes *viz*., NHESZ1201, NHESZ1202, NHESZ1203, NHESZ1204, NHESZ1205, NHESZ1206, NHESZ1212, NHTSZ 1202, NHTSZ1203, NHTSZ1204, NHLSZ1205, NHLSZ1206, NHLSZ1207, NHLSZ1211, NW-TS-05, NW-TS-06, NW-TS-07, NW-TS-15, NW-TS-16, NW-DM11, NW-LS –11, NW-LS – 13, NW-RF-04, NW- RI-01, NW- RI-02, NW- RI-03, NW- RI-04, NE-TS06, NE-LS05, NE-RF05, CZ-TS-01, CZ-RF-13, CZ-LS-01, PZ-RF-11, SHZ-09, SPL-DIC-02 and SPL-DIC-03.

Screening of 273 elite entries indicated that none of the genotype was found to be highly resistant against shoot fly but the genotypes like PZ-RI-07, CZ-T8-and CZ-RF-16 showed 6.9, 9.4 and 9.7 per cent dead heart, were found resistant and can be utilized as resistance sources in future breeding programme. However, the genotypes NW-RI-02, SPL-DIC-03 and NW-RI-01 showed 100, 84.2 and 75.1 per cent dead heart which were highly susceptible to shoot fly. Kalappanavar *et al* 2010: Kumar et al 2010.

In wheat, there is a scanty research and literature pertaining to utilization of resistant germplasms to tackle shoot pests like shoot fly which has been a minor pest. But now, it is attaining major pest status Kalappanavar *et al* 2010. In the earlier reports (Anon., 2008; Anon., 2009), PBW-550 and K- 0343 wheat genotypes were found to be promising against shoot fly when they tested in three locations for three seasons. Among the 41 varieties screened by Kalappanavar *et al*. (2010), HI-8682, HP-1913, HI-8680 and HD-2987 genotypes were found to be resistant against shoot fly *Atherigona oryzae*. Kumar *et al*. (2010) concluded that NIDW-309, HW-3070, PBW-525, MACS-6165, NIDW-295, AKDW-2997-16, PBW-52 were categorized as resistant against shoot fly, *Atherigona naqvii*.

References

Anonymous 2013, Hundred years of wheat research in India. Directorate of Wheat Research, Karnal, India. pp. 171-172
Borlaug, E., 1968, Wheat Breeding and Its Impact on World Food Supply. Public lecture at the Third International Wheat Genetics Symposium, Canberra August 5-9.
David, B. V and Ramamurthy,V.V., 2011, Elements of Economic Entomology. 6th edn. Namrutha publications.
Duveiller, E., Ravi, P., Singh, E. and Julie, M. N., 2007. The challenges of maintain Wheat productivity: pests, diseases, and potential epidemics. Euphytica., 157:417–430.
Kalappanavar, I. K., Patil, R. K. and Babu, K. S., 2010, Evaluation of elite wheat genotypes against shoot fly (*Athergona oryzae* Malloch). Karnataka J. Agric. Sci., 23 (4): 656-657.
Kumar J, Kanchan C, Bahar J, Singh N B, Shukla I N, Singh D K, Sing R. 2010. Screening of wheat varieties against shoot fly (*Atherigona naqvii* Steyskal), Current Advances in Agricultural Sciences 2(1): 57-58.
Miller, R. H. and Pike, K. S., 2002, Insects in Wheat-Based Systems. Pages 367-393. In B.C. Curtis, S. Rajaram and H. Gomez Macpherson (Eds.). Bread wheat, improvement and production. FAO Plant Production and Protection Series, No.30. Rome. pp. 553
Ramadas S, Kirankumar T M, Singh G P. 2019. Wheat production in India: Trends and prospects. Recent Advances in Grain Crops Research 1: 1-16.
Singh, S. S., 2014, National Conference on Agriculture for Rabi Campaign, *Rabi* Strategy increasing productivity of Wheat Region wise Recommendations September 17, 2014

Table1. Scoring of per cent dead heart in elite wheat germplasms of wheat under field conditions

Sl. No.	**Entries**	**Shoot fly Incidence (% Dead heart)**	**Sl. No.**	**Entries**	**Shoot fly Incidence (% Dead heart)**
1	HS 277	62.2	37	PBW 681	41.7
2	HS 542	59.5	38	WH 1139	73.9
3	HPW 388	56.3	39	UP 2841	69.6
4	HS 574	79.2	40	DBW 88	56.7
5	HPW 251	90	41	HD 3086	13.8
6	HPW 387	55.6	42	HUW 662	36.6
7	VL 829	50	43	DPW 621-50	37.8
8	VL 1002	53.1	44	WH 1105	35.3
9	HS 557	34.1	45	HD 3109	48.6
10	UP 2871	45	46	HD 2967	34.1
11	HPW 376	43.9	47	DBW 17	52.6
12	VL 1001	62.5	48	DBW 102	62.2
13	HS 575	40	49	DBW 101	62.8
14	HS 507	35.5	50	HUW 664	31
15	VL 907	64.7	51	NIDW 706	47.1
16	HPW 381	60.7	52	HI 8738	33.3
17	VL 967	60.6	53	HI 8735	41.3
18	HPW 349	37.5	54	DBW 17	31.6
19	VL 804	44.2	55	HI 8728	14.6
20	HS 536	40	56	UPD 94	41.7
21	HPW 380	27.5	57	MACS 3929	18.9
22	HS 578	42.4	58	PDW 291	31.4
23	VL 3003	52.5	59	HI 8739	25
24	HPW 399	36	60	HI 8736	25
25	HS 490	31	61	PDW 314	78.6
26	HPW 398	69.6	62	K 1114	39.5
27	HS 577	56	63	HUW 668	41.4
28	VL 3002	78.4	64	NIAW 1951	19.4
29	VL 892	42.4	65	DBW 71	20
30	HPW 397	50	66	HD 3091	39.3
31	HS 576	15.1	67	WH 1128	27.8
32	UP 2872	53.6	68	PBW 590	25
33	VL 3001	40.9	69	PBW 373	24
34	HUW 666	18.9	70	WH 1130	21.2
35	WH 1138	44.7	71	WH 1124	47.8
36	PBW 683	41.7	72	HD 3119	100

73	UP 2843	19.4	133	Raj 4250	100
74	HD 3117	57.1	134	HUW 668	28.6
75	WH 1129	32	135	NW 2036	48.3
76	HD 3059	37	136	DBW 14	40.4
77	WH 1021	33.3	137	HD 3118	11.8
78	DBW 90	52.5	138	DBW 107	24.5
79	PBW 675	30.6*	139	HUW 667	27.4
80	PBW 674	48	140	HD 3117	39.6
81	UP 2847	17.4	141	NW 5064	50
82	JAUW 598	85.7	142	PBW 688	24.7
83	DBW 74	43.5	143	K8027	42.4
84	UP 2848	26.9	144	UAS 347	45.1
85	PBW 644	26.5	145	HD 2888	41.3
86	WH 1098	51.7	146	DBW 110	49.1
87	HD 3121	10.5	147	WH 1127	69.2
88	WH 1126	33.3	148	BRW 3723	38.3
89	HUW 669	42.9	149	C 306	52.9
90	DBW 110	33.3	150	HI 8724	59
91	WH 1080	31	151	HI 1544	34.3
92	HD 3122	46.3	152	GW 322	32.7
93	C 306	38.1	153	HI 8735	39.5
94	PBW 689	39.3	154	GW 440	15
95	PBW 660	25	155	HI 8737	9.4
96	PBW 175	22.9	156	HI 8727	44.4
97	HD 3123	19.2	157	HI 8736	16.7
98	WH 1127	11.8	158	HI 8498	14.7
99	C 306	75	159	HI 8713	24.2
100	DBW 74	100	160	HD 3114	17.9
101	PBW 660	58.1	161	HI 8725	10
102	HD 3122	74.1	162	DDW 23	35.7
103	PBW 175	30.8	163	MP 3382	8.6
104	WH 1142	32.9	164	HI 1588	27.5
105	HD 3120	50	165	MPO 1215	36.4
106	HD 3043	20.4	166	GW 1292	32.6
107	WH 1080	16.3	167	HI 8731	22.4
108	UAS 347	17.9	168	MACS 6568	23.3
109	MP 3392	25	169	MPO 1255	23.1
110	HD 3121	16.4	170	HI 1500	36.5
111	HUW 669	28.6	171	MP 3288	19.2
112	HD 3070	28.9	172	NIAW 1885	31.6
113	HD 2733	41.3	173	K 1116	44.4
114	HUW 664	47.6	174	DBW 110	14.5
115	K 1006	30.9	175	PBW 689	27.1
116	HD 3111	17.1	176	HI 8742	32.8
117	K1105	22.1	177	WH 1142	21.1
118	HD 3110	59.4	178	HI 8627	81.8
119	K 0307	27	179	A 9-30-1	27.4
120	DBW 39	30.2	180	HD 3123	37
121	RAJ 4229	39.4	181	MACS 3915	9.7
122	PBW 661	43.1	182	UAS 348	36.2
123	HD 3076	24.6	183	UAS 446	33.3
124	NW 5054	22.4	184	MP 3336	100
125	WH 1138	24.2	185	Raj 4295	21.1
126	WH 1120	24.6	186	HD 3095	23.8
127	WH 1137	40	187	MP 3379	26.9
128	WH 1136	39.1	188	MP 4010	25
129	HD 2985	11.1	189	HD 2932	14.7
130	UP 2844	20.3	190	RAJ 4238	11.5
131	K 1114	29.1	191	HD 2864	11.3
132	HI 1563	15.9	192	MACS 6222	24

193	HI 8735	22.7	253	HW 1099	32.1
194	WHD 948	12.5	254	DDK 1042	60
195	GW 440	14.3	255	DDK 1045	84.2
196	MP 1270	17.8	256	DDK 1044	52.6
197	HD 3114	20.4	257	MACS 2971	21.7
198	UAS 342	6.2	258	MACS 5022	33.3
199	UAS 334	23.6	259	MACS 5032	12.4
200	MACS 6478	37.3	260	MACS 5031	17.1
201	MACS 6583	33.3	261	DDK 1029	14.6
202	GW 446	23.9	262	MACS 2496	18.5
203	GW 322	18.5	263	KLP 1006	26
204	NIAW 1994	30.4	264	KRL 348	51.1
205	NIDW 295	17.9	265	KRL 210	25
206	UAS 428	38.9	266	KRL 346	28.3
207	UP 2845	18	267	KRL 347	28.1
208	Raj 4083	12.5	268	KRL 330	39.3
209	NIAW 1994	13.2	269	KRL 345	28.6
210	K 1114	44.4	270	Kharchia 65	39.1
211	MP 3379	9.2	271	RAJ 4324	51.2
212	NW 5064	7.7	272	DBW 131	22.9
213	HD 3090	17.3	273	WH 1145	40.5
214	HD 3118	29.2			
215	NIAW 34	29.9		**Mean**	**34.40**
216	DBW 107	35.7			
217	GW 432	31.9			
218	HD 2932	6			
219	HD 3116	21.3		**SD**	**±18.75**
220	Raj 4295	10.2			
221	HD 3093	29.6			
222	UAS 347	33.9			
223	UAS 446	27			
224	UAS 447	12			
225	NIDW 699	12.1			
226	NI 5439	24.8			
227	NIAW 1415	31.8			
228	AKDW 2997-16	15.3			
229	NIAW 1994	10.9			
230	DBW 93	16.3			
231	DBW 110	33.3			
232	NIAW 1885	56.9			
233	UAS 347	41.4			
234	UAS 446	23.1			
235	UAS 447	24.1			
236	NIDW 699	15.4			
237	NI 5439	25			
238	NIAW 1415	15.1			
239	AKDW 2997-16	6.9			
240	NIAW 1994	30.2			
241	DBW 93	24.1			
242	DBW 110	22.7			
243	NIAW 1885	46.3			
244	HW 1900	25.6			
245	CoW(W) 1	48.8			
246	HW 4042	25.8			
247	HW 2044	31.7			
248	HW 5237	37			
249	HW 5235	18.3			
250	HW 4013	20.2			
251	HW 5224	25			
252	HW 5216	57.1			

Table 2: Categorization of per cent dead heart infestation due to shoot fly screening at MARS Dharwad (*rabi* 2012-13)

Sl. No	Category	Score	No of genotypes
01	Highly Resistant	-3.1	0
02	Resistant	-3.1 to 15.65	35
03	Moderately Resistant	15.65 to 34.40	123
04	Susceptible	34.40 to 53.15	78
05	Highly Susceptible	53.15 to 71.90	37

Mean: 34.40 SD: ±18.75

Table 1: Screening of advanced varietal trial lines against shoot fly (*Atherigona oryzae* Malloch) under late sown condition at MARS Dharwad (*rabi* 2012-13)

Sl. No	Category	Genotypes
1	Highly Resistant	Nil
2	Resistant	NHLSZ 1210, NW-TS- 08, NW-DM-05, NW-RF- 09, NW-RF- 20, NE-LS 01, NE-LS 09, CZ-TS-05, CZ-TS-06, CZ-TS-09, CZ-TS-12, CZ-TS-14, CZ-RF-09, CZ-RF-16, CZ-LS-06, CZ-LS-07, CZ-LS-08, PZ-TS-03, PZ-TS-04, PZ-TS-07, PZ-LS-02, PZ-LS-03, PZ-LS-05, PZ-LS-06, PZ-LS-12, PZ-LS-14, PZ-RF-03, PZ-RF-04, PZ-RF-07, PZ-RF-08, PZ-RI-04, PZ-RI-06, PZ-RI-07, SPL-DIC-07, SPL-DIC-09
3	Moderately Resistant	NHESZ1209, NHTSZ1208, NHLSZ1204, NW-TS-01, NW-TS-13, NW-TS-17, NW-DM-02, NW-DM-04, NW-DM-07, NW-DM-08, NW-DM-09, NW-DM-10, NW-LS–03, NW-LS–04, NW-LS–06, NW-LS– 07, NW-LS–08, NW-LS–09, NW-LS–12, NW-LS–14, NW-LS–16, NW-RF-01, NW-RF-03, NW-RF-06, NW-RF- 07, NW-RF-10, NW-RF-12, NW-RF-13, NW-RF-17, NW-RF-18, NW-RF-19, NW-RI-05, NW-RI-06, NW- RI- 08, NW- RI- 09, NW- RI- 10, NW- RI- 11, NW- RI- 12, NW-RI- 13, NW- RI- 14, NE-TS 03, NE-TS 04, NE-TS 05, NE-TS07, NE-TS 08, NE-TS 11, NE-TS 12, NE-TS 13, NE-TS 14, NE-LS 02, NE-LS 03, NE-LS 04, NE-LS 06, NE-LS 10, NE-LS 11, NE-LS 14, CZ-TS-02, CZ-TS-03, CZ-T08, CZ-TS-10, CZ-TS-11, CZ-TS-15, CZ-RF-01, CZ-RF-02, CZ-RF-03, CZ-RF-04, CZ-RF-06, CZ-RF-07, CZ-RF-10, CZ-RF-11, CZ-RF-12, CZ-RF-14, CZ-RF-18, CZ-LS-02, CZ-LS-03, CZ-LS-04, CZ-LS-05, PZ-TS-01, PZ-TS-02, PZ-TS-05, PZ-TS-06, PZ-TS-08, PZ-TS-10, PZ-TS-11, PZ-TS-12, PZ-TS-13, PZ-TS-14, PZ-LS-01, PZ-LS-07, PZ-LS-08, PZ-LS-09, PZ-LS-11, PZ-LS-13, PZ-LS-15, PZ-RF-01, PZ-RF-02, PZ-RF-05, PZ-RF-06, PZ-RF-09, PZ-RF-10, PZ-RI-02, PZ-RI-03, PZ-RI-05, PZ-RI-08, PZ-RI-09, PZ-RI-10, SHZ-01, SHZ-03, SHZ-04, SHZ-06, SHZ-07, SHZ-08, SPL-DIC-01, SPL-DIC-05, SPL-DIC-06, SPL-DIC-08, SPL-DIC-10, SPL-AST-01, SPL-AST-03, SPL-AST-04, SPL-AST-05, SPL-AST-07 and SPL-AST-10
4	Susceptible	NHESZ 1207, NHESZ 1208, NHESZ 1209, NHESZ 1210, NHESZ 1211, NHESZ 1213, NHTSZ 1201, NHTSZ 1205, NHTSZ 1206, NHTSZ 1207, NHLSZ 1201, NHLSZ 1202, NHLSZ 1203, NHLSZ 1208, NHLSZ 1209, NHLSZ 1212, NW-TS- 02, NW-TS- 03, NW-TS- 04, NW-TS- 09, NW-TS- 10, NW-TS- 11, NW-TS- 12, NW-TS-14, NW-DM-01, NW-DM-03, NW-DM-06, NW-LS – 01, NW-LS – 02, NW-LS – 05, NW-LS – 10, NW-LS – 15, NW-LS – 17, NW-RF- 08, NW-RF- 05, NW-RF- 11, NW-RF- 14, NW-RF- 15, NW-RF- 16, NW- RI- 07, NE-TS 01, NE-TS 02, NE-TS 09, NE-TS 10, NE-TS 15, NE-TS 16, NE-LS 07, NE-LS 08, NE-LS 12, NE-LS 13, NE-RF 01, NE-RF 02, NE-RF 03, NE-RF 04, NE-RF 06, NE-RF 07, CZ-TS-04, CZ-TS-07, CZ-TS-13, CZ-TS-16, CZ-RF-05, CZ-RF-06, CZ-RF-07, CZ-RF-08, CZ-RF-15, CZ-RF-17, PZ-TS-09, PZ-TS-15, PZ-LS-04, PZ-LS-10, PZ-RI-01, PZ-RI-11, SHZ-02, SHZ-05, SPL-DIC-04, SPL-AST-02, SPL-AST-06, SPL-AST-08, SPL-AST-09 and SPL-AST-11
5	Highly Susceptible	NHESZ1201, NHESZ1202, NHESZ1203, NHESZ1204, NHESZ1205, NHESZ1206, NHESZ1212, NHTSZ 1202, NHTSZ1203, NHTSZ1204, NHLSZ1205, NHLSZ1206, NHLSZ1207, NHLSZ1210, NHLSZ1211, NW-TS-05, NW-TS-06, NW-TS-07, NW-TS-08, NW-TS-15, NW-TS-16, NW-DM11, NW-LS –11, NW-LS – 13, NW-RF-04, NW-RF-08, NW-RF-09, NW-RF-20, NW- RI-01, NW- RI-02, NW- RI-03, NW- RI-04, NE-TS06, NE-LS01, NE-LS05, NE-RF05, CZ-TS-01, CZ-RF-13, CZ-LS-01, PZ-RF-11, SHZ-09, SPL-DIC-02 and SPL-DIC-03

General view of screening plot