RICE GERMPLASM EVALUATION FOR AGRONOMIC TRAITS AND THEIR INFLUENCE ON STEM BORER (*CHILO AGAMEMNON* BLES.) RESISTANCE

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ABSTRACT

A study was conducted at Rice Research Training Centre, Sakha, Kafr Al Sheikh, Egypt during 2003-2006. Forty-six lines were selected from four populations. These populations were produced from five parents namely; M204, M202 and 98-Y-116 (American varieties) that were used as highly susceptible varieties and two Egyptian (Giza177 and Sakha102) as resistant varieties. F_1 crosses were conducted at experimental farm of Department of Agronomy and Range Science, University of California, Davis CA95616-8515, USA. The selected lines were evaluated for agronomic traits and stem borer attack. The results revealed that lines expressed considerable range of variation. On the other hand, phenotypic and genotypic variance showed wide differences. Maximum ranges of variation were observed for number of filled grains per panicle followed by white head, grain yield per plant, plant height and maturity days. Heritability ranged from 41.74 for number of panicles per plant to 99.64 for white head. A highly significant positive correlation was found between white head percentage and heading date, plant height and flag leaf area, indicating the importance of these characters for breeding white head resistant varieties. The cluster analysis also confirmed the usefulness of these traits for selecting stem borer resistant lines.

KEYWORDS: *Oryza sativa;* germplasm; heritability; agronomic characters; *Chilo agamemnon;* pest resistance, Egypt.

INTRODUCTION

Rice (*Oryza sativa* L.) is an ancient food grain and important crop in the world feeding more than 50 percent of human population (1). Intensive selection and cultivation of resistant varieties have increased rice production throughout the world. However, rice is attacked by more than 100 insect species of which, stem borer is major insect pest of rice in Egypt. Yield losses

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due to stem borer range from 10 to 30 percent (12). Breeding for resistance to insects is divided into two steps. First one is to create novel genetic variation and second one is to select improved variants (13). First step depends on screening of rice germplasm to identify novel donors of resistance. The second step involves use of these donors in sexual hybridization with commercial varieties to create novel combinations of genes (14).

In present study 46 genotypes selected from crosses of five rice varieties (three American and two Egyptian) were studied to explore genetic variability for determining agronomic traits and stem borer resistance.

MATERIALS AND METHODS

Forty six lines were selected from four populations produced from five parents namely; M204, M202 and 98-Y-116 (American varieties), used as highly susceptible varieties and Giza177 and Sakha102 (Egyptian) as resistant varieties. F_1 seeds were provided by D.J. Mackill, Rice Genetics Lab, University of California and Davis. Selected lines were evaluated at experimental farm of Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh, Egypt, during rice growing seasons 2003 to 2006. The populations were: SKC23808 (12 lines), SKC2319 (24 lines), SKC23822 (5 lines) and SKC23824 (5 lines). Selected lines were arranged in a randomized complete block design with three replications. Stem borer damage was recorded as white head percentage at maturity stage by counting number of white heads per 100 plants according to standard evaluation system for rice (3).

Analysis of variance was computed by IRRISTAT program whereas heritability percentage was estimated according to Allard (4) on a plot basis considering ratio of genotypic and phenotypic variance. Phenotypic genotypic coefficients of variability and expected genetic advance from selection ($\Delta g\%$) were calculated according to Burton (5) and Gamble (11).

Pearson correlation coefficient were estimated among selected lines for agronomic characters namely heading date, plant height, number of tillers per plant, flag leaf area, grain yield per plant, 1000-grain weight, panicle weight,

number of panicles per plant, number of filled grains per panicle, panicle length and white head percentage (WH%).
Darwin software programme was used for diversity assessment following Perrier and Jacquemoud-Collet (16) elucidation of dissimilarity. Tree was constructed based on unweighted-neighbour-joining method.

RESULTS AND DISCUSSION

Agronomic traits

Analysis of variance (Table 1) revealed that genotypes were highly significant for all studied characters and expressed considerable range of variation. These results are in line with those of earlier researchers (7, 8, 10, 15, 16).

Table 1. Analysis of variance for agronomic and stem borer characters.

SOV	d.f	Duration (day)	Plant height (cm)	No. of tillers/plant	No. of panicles/ plant	Flag leaf area (cm)	Grain yield/ plant (g)
Replication	2	5.183	6.087	13.281	10.059	0.636	68.147
Genotypes	50	85.70**	171.56**	11.73**	9.53**	41.61**	269.21**
Error	100	1.103	0.633	1.114	1.852	0.386	3.330
S.O.V	**d.f**	**1000-grain weight (g)**	**Panicle weight (g)**	**Panicle length (cm)**	**No. of filled grains/ panicle**	**No. of unfilled grains/ panicle**	**WH%**
Replication	2	0.249	0.156	1.430	151.59	21..732	0.862
Genotypes	50	71.52**	0.82*	6.46**	874.02**	78.06**	281.19**
Error	100	0.244	0.025	0.558	28.78	2.712	0.326

Estimates of phenotypic and genotypic variance (Table 2) showed different ranges. Maximum range of variation was observed for number of filled grains per panicle followed by white head percentage, grain yield per plant, plant height and maturity days, indicating a better scope for genetic improvement in these characters.

On the other hand, heritability ranged from 41.74 for number of panicles per plant to 99.64 for white heads (Table 2). Similarly, most of agronomic characters showed high estimates of heritability. However, white heads expressed maximum heritability (99.64), followed by 1000-grain weight

(98.97) and plant height (98.89). Similar results were recorded by various workers (6, 8, 9, 10, 15).

Table 2. Genetic parameters of variation for agronomic characters and stem borer attack.

Parameters	Duration (day)	Plant height (cm)	No. of tillers/plant	No. of panicles/ plant	Flag leaf area (cm)	Grain yield/ plant (g)
Genotypic	27.46	56.56	2.79	1.33	13.48	86.40
Phenotypic	28.56	57.19	3.91	3.18	13.87	89.73
Heritability (bs)	96.14	98.89	75.20	41.74	97.18	96.28
Δg	10.58	15.39	3.06	1.53	7.46	18.78
Δg%	8.14	14.69	15.08	8.14	27.24	30.70
Mean	129.97	104.75	20.31	18.82	27.36	61.18
Minimum	119.0	90.6	15.0	13.0	19.87	41.58
Maximum	139.0	122.8	26.0	24.0	38.40	83.20
Range	20.0	32.2	9.0	11.0	19.03	41.62
Parameters	1000-grain weight (g)	Panicle weight (g)	Panicle length (cm)	No. of filled grains/ panicle	No. of unfilled grains/ panicle	White heads (%)
Genotypic	23.59	0.249	1.59	262.56	23.30	93.40
Phenotypic	23.84	0.274	2.15	291.34	26.02	93.73
Heritability (bs)	98.97	90.87	74.04	90.12	89.54	99.64
Δg	9.95	0.979	2.38	31.68	9.40	19.87
Δg%	32.10	28.37	11.06	27.33	94.37	154.31
Mean	31.01	3.45	20.23	115.94	9.97	12.87
Minimum	21.20	2.390	12.30	81.0	2.00	0.10
Maximum	43.20	4.790	24.00	169.0	25.0	37.22
Range	22.00	2.40	11.70	88.0	23.0	37.12

The results further revealed that most of characters exhibited wide range of variability. As regards maturity days concerned, 21 lines were of short duration having a range from 119 to 129 days, exhibiting earliness (Table 3). For plant height, 18 lines were of short stature with plant height range of 90 to 100 cm. For grain yield per plant, all lines performed better than those of parents (41.58 to 83.20 g). The yield increase could be attributed to increased 1000-grain weight and panicle weight.

Table 3. Mean performance of 46 lines and five varieties for agronomic characters.

Genotypes	Duration (days)	Plant height (cm)	No. of tillers/plant	No. of panicles/ plant	Flag leaf area (cm)	Grain yield/ plant (g)
SKC23808-2-1-5-3-1-1	126.00	111.07	23.00	20.33	29.68	54.28
SKC23808-2-1-5-3-1-2	120.00	116.30	18.67	17.00	32.28	46.79
SKC23808-28-4-1-3-1-1	126.00	118.10	22.00	19.33	33.20	71.34
SKC23808-28-4-1-3-1-2	126.00	121.57	25.00	22.33	31.14	78.58
SKC23808-125-2-1-2-2-1	126.00	100.47	22.00	20.00	26.31	63.88
SKC23808-125-2-1-4-2-1	125.00	102.17	22.33	21.33	34.97	79.72
SKC23808-125-2-1-4-2-2	125.00	96.33	23.33	21.33	23.04	65.56
SKC23808-125-2-3-1-1-1	123.66	94.53	23.67	22.00	26.27	54.97

SKC23808-125-2-3-1-1-2	123.00	94.50	23.00	21.67	23.95	67.21
SKC23808-125-2-3-1-1-3	123.66	93.40	20.00	17.67	20.66	54.06

Table contd.

Table 3 Contd....

SKC23808-125-2-3-1-1-4	122.66	96.57	21.00	20.00	26.60	63.77
SKC23808-125-2-3-5-1-1	127.33	96.60	18.00	16.67	26.09	63.64
SKC2319-189-1-1-2-2-1	135.00	99.53	21.00	19.33	22.72	77.39
SKC2319-189-1-1-2-2-2	135.00	96.67	19.00	18.33	29.53	73.01
SKC2319-192-2-2-1-2-4-1	136.00	95.27	20.00	18.67	25.99	57.53
SKC2319-192-2-2-1-1-1	130.00	100.43	20.33	19.00	21.65	74.82
SKC2319-192-2-2-1-1-2	135.00	93.53	18.00	17.00	21.09	66.66
SKC2319-192-2-2-1-2-1	126.00	112.93	22.00	21.00	29.02	55.52
SKC2319-192-2-2-1-2-2	126.00	103.37	22.00	20.00	29.13	73.16
SKC2319-192-2-3-2-2-1	135.00	107.03	21.00	19.33	27.43	65.60
SKC2319-192-2-3-2-2-2	137.00	105.90	20.67	19.00	26.74	65.32
SKC2319-192-2-3-2-2-3	138.00	106.80	20.67	19.00	30.91	75.28
SKC2319-192-2-3-2-2-4	131.00	104.47	22.00	20.67	28.40	64.42
SKC2319-192-3-1-1-1-1	134.66	112.07	20.67	20.00	27.83	61.18
SKC2319-192-3-1-1-1-2	135.66	112.00	22.00	19.67	33.28	56.81
SKC2319-192-3-1-1-1-3	134.00	101.90	18.00	17.33	27.41	64.52
SKC2319-192-3-1-1-1-4	132.33	98.37	22.33	20.33	27.76	63.09
SKC2319-192-3-1-1-1-5	135.00	98.33	20.00	18.00	25.58	71.82
SKC2319-192-3-1-1-2-1	134.33	103.10	16.00	15.00	24.57	43.89
SKC2319-194-1-2-1-1-1	134.00	90.80	16.67	16.00	29.89	54.21
SKC2319-194-1-2-1-2-1	134.66	95.67	21.33	20.00	27.02	68.18
SKC2319-194-1-2-1-2-2	135.33	107.07	23.00	21.00	27.21	75.05
SKC2319-194-1-2-1-2-3	134.66	108.77	20.00	19.33	27.52	57.22
SKC2319-194-1-2-1-2-4	135.00	109.10	18.33	17.00	25.70	58.56
SKC2319-194-1-2-1-2-5	134.00	103.63	18.67	18.00	31.71	60.36
SKC2319-194-1-2-1-2-6	134.00	117.70	21.33	20.33	25.23	64.06
SKC23822-330-3-2-2-2-1	134.66	115.10	20.00	18.00	29.64	56.18
SKC23822-330-3-2-2-2-2	134.33	114.37	19.00	18.33	26.03	54.99
SKC23822-330-3-2-2-2-3	134.00	109.30	21.00	20.33	21.61	55.35
SKC23822-330-3-2-2-2-4	134.66	111.70	19.00	18.00	22.35	67.79
SKC23822-330-3-2-2-2-5	134.33	114.00	17.00	15.67	24.98	57.15
SKC23824-360-3-1-2-2-1	121.00	106.40	19.33	17.67	22.96	50.41
SKC23824-360-3-1-2-2-2	121.00	102.60	20.00	19.67	20.58	50.45
SKC23824-422-3-3-3-1-1	122.00	105.57	18.33	17.33	26.30	52.20
SKC23824-422-3-3-3-1-2	121.66	109.43	20.00	18.67	28.62	66.04
SKC23824-422-3-3-3-2-1	130.00	115.50	16.00	15.00	30.14	61.68
98-Y-116	129.00	103.67	20.33	18.33	36.93	48.57
Sakha102	124.33	106.67	21.00	19.00	28.43	50.84
L204	127.33	103.00	19.67	17.00	30.80	45.60
Giza177	123.33	98.00	19.00	18.00	26.07	48.57
M202	131.00	101.00	19.00	16.00	32.47	42.85
L.S.D.	1.701	1.288	1.710	2.205	1.006	2.956

Genotypes	1000-grain weight (g)	Panicle weight (g)	Panicle length (cm)	No. of filled grains/ panicle	No. of unfilled Grains/ panicle
SKC23808-2-1-5-3-1-1	25.57	2.65	19.93	107.00	8.33
SKC23808-2-1-5-3-1-2	23.13	2.93	20.13	127.00	14.33
SKC23808-28-4-1-3-1-1	29.47	3.72	19.72	128.00	7.00
SKC23808-28-4-1-3-1-2	31.20	3.34	19.79	110.67	16.67
SKC23808-125-2-1-2-2-1	26.57	3.35	20.52	122.67	5.00
SKC23808-125-2-1-4-2-1	27.43	4.06	20.23	141.67	5.00

Table Contd.....

Table 3 contd....

SKC23808-125-2-1-4-2-2	27.33	3.06	19.39	113.67	6.00
SKC23808-125-2-3-1-1-1	24.90	2.61	17.98	114.67	8.67
SKC23808-125-2-3-1-1-2	27.90	3.10	20.08	112.33	5.00
SKC23808-125-2-3-1-1-3	27.30	2.79	20.32	111.67	7.00
SKC23808-125-2-3-1-1-4	30.30	3.31	21.23	116.67	5.00
SKC23808-125-2-3-5-1-1	38.37	3.97	16.88	131.00	8.00
SKC2319-189-1-1-2-2-1	37.10	4.66	17.69	121.67	11.00
SKC2319-189-1-1-2-2-2	34.27	4.10	19.19	120.33	5.00
SKC2319-192-2-2-1-2-4-1	30.37	3.29	20.74	92.33	6.00
SKC2319-192-2-2-1-1-1	42.97	4.12	18.25	135.67	12.67
SKC2319-192-2-2-1-1-2	30.40	4.47	19.43	102.33	2.33
SKC2319-192-2-2-1-2-1	30.70	2.68	19.51	90.00	5.00
SKC2319-192-2-2-1-2-2	32.57	4.20	21.62	133.33	5.33
SKC2319-192-2-3-2-2-1	38.03	3.40	19.54	110.00	6.00
SKC2319-192-2-3-2-2-2	36.47	4.30	20.05	119.67	7.67
SKC2319-192-2-3-2-2-3	28.30	4.06	21.47	108.33	12.67
SKC2319-192-2-3-2-2-4	28.97	3.23	21.25	114.33	11.33
SKC2319-192-3-1-1-1-1	34.17	3.60	21.16	106.67	13.67
SKC2319-192-3-1-1-1-2	34.16	2.92	21.25	88.67	11.00
SKC2319-192-3-1-1-1-3	33.77	3.63	19.03	111.00	10.00
SKC2319-192-3-1-1-1-4	36.10	3.13	19.45	87.33	9.67
SKC2319-192-3-1-1-1-5	36.77	3.83	17.46	113.67	3.00
SKC2319-192-3-1-1-2-1	35.30	3.45	18.22	103.00	14.33
SKC2319-194-1-2-1-1-1	34.50	3.52	19.40	101.67	5.00
SKC2319-194-1-2-1-2-1	34.33	3.76	19.24	112.67	6.00
SKC2319-194-1-2-1-2-2	34.43	3.74	20.44	112.33	22.00
SKC2319-194-1-2-1-2-3	36.10	3.22	20.52	98.67	20.00
SKC2319-194-1-2-1-2-4	33.40	3.66	22.14	111.00	18.33
SKC2319-194-1-2-1-2-5	35.80	3.46	22.19	101.33	19.33
SKC2319-194-1-2-1-2-6	40.60	3.55	21.09	96.67	20.67
SKC23822-330-3-2-2-2-1	22.23	3.19	21.21	141.00	13.00
SKC23822-330-3-2-2-2-2	23.90	3.23	20.53	140.67	7.00
SKC23822-330-3-2-2-2-3	25.43	3.19	19.84	136.67	7.00
SKC23822-330-3-2-2-2-4	24.77	4.12	22.13	158.33	6.33
SKC23822-330-3-2-2-2-5	25.93	3.94	20.04	157.67	5.67
SKC23824-360-3-1-2-2-1	29.57	2.75	18.19	93.67	5.33
SKC23824-360-3-1-2-2-2	29.03	2.56	18.18	91.67	6.33
SKC23824-422-3-3-3-1-1	30.73	3.05	20.72	102.00	11.00
SKC23824-422-3-3-3-1-2	30.17	3.46	22.11	104.33	16.33
SKC23824-422-3-3-3-2-1	36.83	4.23	20.71	121.33	19.33
98-Y-116	24.95	3.30	22.90	114.00	11.33
Sakha102	27.60	2.63	23.13	148.00	10.00
L204	26.23	3.37	23.57	127.00	13.00
Giza177	28.33	2.93	20.73	128.00	7.33
M202	25.70	3.20	21.40	120.00	15.67
L.S.D.	0.801	0.258	1.210	8.691	2.668

Stem borer infestation

The reaction of genotypes evaluated for stem borer infestation was classified into five categories according to standard evaluation of Rice Research and Training Center (RRTC), Sakha, Egypt (2) i.e. resistant (R) = 0 – 3 %,

Moderately resistant (MR) = 3 - 6 %, Moderately susceptible (MS) = 6 - 9%, Susceptible (S) = 9 - 12% and highly susceptible (HS) = 12%.
Among tested genotypes, 20 genotypes were ranked as highly susceptible. Infestation of these genotypes was more than 12 percent white heads. The highest infestation was recorded in genotypes SKC 2319-2-3-2-2-2 (36.64%), SKC 2319-194-1-2-1-2-5 (33.89%) and SKC 2319-192-2-3-2-2-3 (32.43%) (Tables 4).

Nine genotypes were found as susceptible. The most susceptible genotypes was SKC 23808-2-1-5-3-1-1 (11.07 % WH), followed by SKC 23824-360-3-1-2-2-1 (10.86 % WH) and SKC 23822-330-3-2-2-2-5 (10.54 % WH) (Table 4).

Nine genotypes with damage range of 6-9 percent white heads were classified as moderately susceptible (Table 4). Similarly seven genotypes, had white heads ranging from 3 to 6 percent and were considered as moderately resistant genotypes.

Six genotypes were found as resistant with zero to 3 percent WH. The most resistant genotype was SKC 23808-125-2-3-1-1-2 (0.14 % WH) followed by SKC 23824-422-3-3-3-1-2 (0.407 % WH) (Table 4).

Table 4. Susceptibility of rice genotypes to rice stem borer (avg. of 2003-2005 seasons).

Genotypes	WH%	Category
SKC23808-2-1-5-3-1-1	11.07	S
SKC23808-2-1-5-3-1-2	7.34	M S
SKC23808-28-4-1-3-1-1	4.17	M R
SKC23808-28-4-1-3-1-2	8.25	M S
SKC23808-125-2-1-2-2-1	2.91	R
SKC23808-125-2-1-4-2-1	17.78	H S
SKC23808-125-2-1-4-2-2	10.21	S
SKC23808-125-2-3-1-1-1	2.63	R
SKC23808-125-2-3-1-1-2	0.14	R
SKC23808-125-2-3-1-1-3	6.22	M S
SKC23808-125-2-3-1-1-4	6.29	M S
SKC23808-125-2-3-5-1-1	2.30	R
SKC2319-189-1-1-2-2-1	6.63	M S
SKC2319-189-1-1-2-2-2	4.48	M R
SKC2319-192-2-2-1-2-4-1	4.13	M R
SKC2319-192-2-2-1-1-1	10.20	S
SKC2319-192-2-2-1-1-2	4.19	M R
SKC2319-192-2-2-1-2-1	8.30	M S
SKC2319-192-2-2-1-2-2	2.31	R
SKC2319-192-2-3-2-2-1	30.46	H S

SKC2319-192-2-3-2-2-2	36.64	H S
SKC2319-192-2-3-2-2-3	32.43	H S

Table contd….

Table 4 Contd....

SKC2319-192-2-3-2-2-4	16.37	H S
SKC2319-192-3-1-1-1-1	12.64	H S
SKC2319-192-3-1-1-1-2	31.34	H S
SKC2319-192-3-1-1-1-3	9.52	S
SKC2319-192-3-1-1-1-4	8.23	M S
SKC2319-192-3-1-1-1-5	20.55	H S
SKC2319-192-3-1-1-2-1	22.30	H S
SKC2319-194-1-2-1-1-1	10.45	S
SKC2319-194-1-2-1-2-1	9.43	S
SKC2319-194-1-2-1-2-2	21.59	H S
SKC2319-194-1-2-1-2-3	7.11	M S
SKC2319-194-1-2-1-2-4	15.00	H S
SKC2319-194-1-2-1-2-5	33.89	H S
SKC2319-194-1-2-1-2-6	12.24	H S
SKC23822-330-3-2-2-2-1	17.11	H S
SKC23822-330-3-2-2-2-2	23.24	H S
SKC23822-330-3-2-2-2-3	23.06	H S
SKC23822-330-3-2-2-2-4	22.88	H S
SKC23822-330-3-2-2-2-5	10.54	S
SKC23824-360-3-1-2-2-1	10.86	S
SKC23824-360-3-1-2-2-2	5.00	M R
SKC23824-422-3-3-3-1-1	6.70	M S
SKC23824-422-3-3-3-1-2	0.407	R
SKC23824-422-3-3-3-2-1	30.44	H S
98-Y-116	19.43	H S
Sakha102	3.47	M R
L204	10.40	S
Giza177	3.01	M R
M202	20..35	H S

S = Susceptible, MS = Moderately susceptible, HS = Highly susceptible, MR = Moderately resistant and R = Resistant

Genotypes having R or MR reaction are considered good genotypes for rice stem borer resistance. None of four parental lines showed complete resistance to stem borers (Table 4). Thirteen genotypes could be used in breeding programme if these possess other desirable traits.

Relationship of white heads with agronomic traits

It is vital to know how selection of any agronomic trait in a breeding programme influences the white head resistance. Similarly, use of other traits would be helpful as indicators of white head resistance. Pearson correlation coefficients were estimated among five rice varieties and their 46 progeny lines for 11 agronomic characters (Table 5). A highly significant positive correlation between white head infestation and maturity days was determined. The results revealed that long duration line(s) enhanced white head percentage. This phenomenon may be due to longer period where rice plants are exposed to stem borer. A significant positive correlation between white head infestation and plant height was also determined. The results indicate that long statured varieties showed more susceptibility to stem borer than short ones. This may be due to the fact that more number of nodes and internodes of long statured varieties may influence insect attack. At same time, correlation between white heads and flag leaf area was positively significant. This means that wider leaves may be more attractive for stem borer egg laying. The positive correlations of three characters with white heads indicated the importance of these characters for breeding stem borer resistant varieties.

Table 5. Pearson correlation coefficients between agronomic characters derived from means of 51 rice genotypes.

Characters	White head %
Duration (day)	0.574**
Plant height(cm)	0.314*
No. of tillers/plant	-0.155
No. of panicles/plant	-0.171
Flag leaf area (cm)	0.245*
Grain yield /plant	0.019
1000-grain weight	0.145
Panicle weight (g)	0.220
Panicle length (cm)	0.196
No. of filled grains/panicle	0.021
No. of unfilled grains/panicle	281*

The dendogram (Fig.) is based on clustering of all lines according to four traits using Darwin software programme. The cluster confirms the usefulness of these traits while selecting resistant lines. Although there are some exceptions in dendogram, but this might be due to environmental factors that influenced the scoring of stem borer.

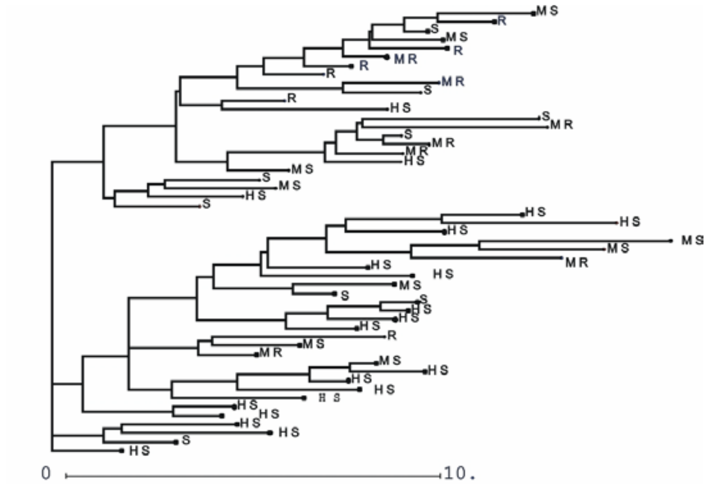

Fig. The dendogram between all lines based on the most correlated traits with stem borer attack

The knowledge generated in this study will help find out stem borer resistance in segregating population through DNA marker selection. Developing such DNA marker would enhance the selection of stem borer resistant lines at early seedling stages with better accuracy to avoid environmental influence of stem borer attack.

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