Asian Journal of Plant Sciences

ISSN 1682-3974

science alert

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Asian Journal of Plant Sciences 8 (5): 380-384, 2009
ISSN 1682-3974

Study of Genetic Variation of Resistance to Sunn Pest using SPT Index

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Abstract: To study the response of advanced wheat genotypes to sunn pest, a research was conducted under free and non-free selection for sun pest attack, using a randomized complete block design with 5 replications and 25 genotypes including, 19 advanced bread wheat, 4 durum wheat and 2 checks (Sardari and Azar-2). These genotypes were evaluated in Dryland Agricultural Research Sub-Institute, Kermanshah, Iran during 2007-2008. To identify tolerant genotypes to sunn pest we used SPTI (Sunn pest tolerance index). Significant difference were observed between genotypes for number of damaged central bud, number of adult sunn pest, number of new generation sunn pest, percent of damaged seed, grain yield and thousand seed weight. Based on mean ranks of SPTI, number of damaged central buds and percentage of damaged seeds, PATO1 was the most tolerant genotype and among durum wheat genotype Pgs was the best genotype. This result indicated selection based on grain yield is better than thousand seed weight. Sunn pest tolerance index is an index related to grain yield and it is a new good index for genotype selection. We purpose this index for new experiments.

Key words: Sunn pest tolerance index, PATO1, means of ranks, bread wheat, durum wheat

INTRODUCTION

Wheat, (*Triticum aestivum* L.) is very important food crop in the, Middle East and South-Western Asian countries. It is very strategic crop for Iran as well as many other countries (Fatehi *et al*., 2009) . Wheat is grown on approximately 6.4 million hactares in Iran. Total production of wheat is 14.308 million tons and the yield is 2343.7 kg ha^{-1} in average (Fatehi *et al*., 2009). The sunn pest (*Eurygaster integriceps*) is the most important insect pest of wheat in Iran and other countries (Moore, 2000; Aykut *et al*., 2006; Genc *et al*., 2008). Adults of the sunn pest attack the leaves and stems of young, succulent wheat and barley plants, causing them to wither and die before spike formation. They also suck the base of the spike during the early growing period, resulting in whitish sterile spikes (Canhilal *et al*., 2005). This pest also injects chemicals into the grain that destroy the gluten and greatly reduce the baking quality of the flour (Hariri *et al*., 2000). Control of sunn pest is mainly based on chemical control (Kivan and Kilic, 2005). Chemical control for sunn pest is very costly, hazardous to human and environment health and also affects the beneficial insects which maintain sunn pest populations under check (Voegele, 1996; Moore, 2000). Sunn pest damage varied from 0 to 14% on different varieties of wheat (Kinaci and Kinaci, 2004). Some studies presented insecticide resistance in populations of agricultural pests (Sukhoruchenko and Dolzhenko, 2008). 1.8 million hectares of cereal producing areas of Iran were sprayed with chemical insecticides against sunn pest during 2003-2004 crop season (Najafi and Mohammadi, 2004). Therefore, other methods like genetic resistance is useful (Kinaci *et al*., 2004). In this study, it is aimed to recognize genetic variation for resistance to wheat sunn pest in advanced wheat genotypes using a new index (SPTI).

MATERIALS AND METHODS

To study response of advanced wheat genotypes to sunn pest, a field research was conducted under free and non-free selection for sunn pest attack in Dryland Agricultural Research Sub-Institute at Sararood station, Kermanshah, Iran (Latitude; 34° 20′ N, Altitude; 1351.6 m, Köppen climate classification). Mean annual temperature and rainfall were 17°C and 0.458 m, respectively. Experimental design was Randomized Complete Block Design (RCBD) with five replications for free and non-free selection. Twenty five genotypes including 19 advanced bread wheat, 4 durum wheat and 2 checks (Sardari and Azar-2) were evaluated (Table 1). In free selection condition each genotype was planted on 0.5×0.6 m^2

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Table 1: List of 25 genotypes including, 19 advanced bread wheat, 4 Durum wheat, and 2 checks (Sardari and Azar-2)

No.	Full name of genotype	Short name of genotype
1	14-GB	14 GB
2	914-GB	914 GB
3	WW33G/vee"s"//Mm/4/HD217	WW33
4	Ghods*3/Kavvko//Ghods*3/k	Ghods
5	Unknown-11	Unknown-11
6	NWT/3/TAST/SPRW//TAW12	NWT1
7	NWT/3/TAST/SPRW//TAW123	NWT2
8	PATO/CAL/3/7C//BB/CNO/5/CA	PATO1
9	PATO/CAL/3/7C//BB/CNO/5/CAL//	PATO2
10	UNKNOWN-18AP-0APP-2MAR	UNKNOWN-18
11	TAST/SPRW/4/ROM-TAST/BOYM	TAST
12	Ardabil 82 –56	Ardabil 82-56
13	4/SEL14.53/3LANCER//ATL66/CMN	4SEL
14	Ardabil 82 – 118	Ardabil 82
15	G1252@	G1252
16	Pgs-charp 1215631@	Pgs
17	Syrian-4@	Syrian-4
18	Heidar//MT/HO@	Heidar
19	Sardary	Sardary
20	Azar-2	Azar-2
21	Rashid	Rashid
22	Falat	Falat
23	Ghafghaz	Ghafghaz
24	Tabacy	Tabacy
25	GB-140	GB140

@ Means durum wheat

plots. The distance between plots was 0.5 m. A large mesh tent (50×4×2 m) was placed in all plots at the wheat elongation stage for evaluation of adult insect. One replication (check) was preserved and in 4 replications one thousand adult sunn pests were released in the tent. In non-free selection each genotype was planted on 1×1 m^2 plots. A cylindric mesh cage (0.2 m ray and 1 m height) was set up in the each plot and 40 $instars_{2,3}$ were released in the every cage for evaluation of new generation sunn pests damage. In free selection number of damaged central bud, number of adult sunn pest, grain yield and thousand seed weight were measured. In non-free selection number of new generation sunn pest and percent of damaged seed, were measured. In free selection experiment to identify tolerant genotypes to sunn pest invasion a new index (SPTI) was applied. SPTI (Sunn Pest Tolerance Index) similar to STI index introduced by Fernandez (1992) for drought tolerance. Sunn pest tolerance index was calculated by following equation:

$$SPTI = (Y_{SPF})(Y_{SPI})/(\bar{Y}_{SPF})^2$$

where, Y_{SPF} is grain yield of each genotype in check replication without sunn pest presence. Y_{SPI} is grain yield of each genotype with sunn pest presence. $\bar{Y}_{SPF}$ is means of grain yield of genotypes with sunn pest presence.

RESULTS AND DISCUSSION

Results of ANOVA: Results of ANOVA in free and non-free selection expriments showed significant differences between bread wheat and durum wheat genotypes (Table 2). A researche showed significant difference between wheat cultivar for sunn pest damage and thousand grain weight (Kinaki and Kinaki, 2007). Orthogonal comparing showed significant difference between bread wheat and durum wheat genotypes for Percent of damaged seed and grain yield ($p<0.01$) (Table 2). Gene action for resistance to sunn pest was reported (Fatehi *et al*., 2009). Maybe, new studies for differences between bread and durum wheat produce better results. Identification of gene action related this subject is important. Molecular studies can discover genetical and biochemical pathways for resistance to sunn pest.

Ranking of genotypes: Adult sunn pest damage central buds of wheat plants (Canhilal *et al*., 2005). Adult and new generation sunn pest damage quality of grains (Hariri *et al*., 2000). For identification of the resistant genotype to adult and new generation wheat sunn pest invasion, we ranked genotypes based on number of damaged central bud, percent of damaged seed and SPTI. Then genotypes ranked based on means of these three ranking (Table 4). Rank of PATO1 genotype was 1. This means PATO1 had minimum damaged central buds. Although rank of PATO1 for SPTI was 6, more than checks (ranks of Sardary and Azar-2 were 9 and 11, respectively) (Table 3). We select PATO1 as the most resistant genotype to adult and new generation wheat sunn pest. In durum wheat genotypes (arrayed in 15-18 rows) Pgs genotype, had 5 rank was more resistant than other durum wheat and checks.

Means comparing for grain yield and thousand seed weight: Duncan multiple range test for grain yield and thousand seed weight (Fig. 1, 2) showed significant differences between advanced wheat genotype ($p<0.05$). some researches showed same results (Najafi and Mohamadi, 2004). The PATO1 genotype based on ranking was the most resistant genotype the grain yield and thousand seed weight of this genotype was higher than 2 checks. This results showed the resistant genotype to adult and new generation sunn pest had acceptable yield. Genetic diversity for grain yield was much more than thousand seed weight. This result indicated selection based on grain yield is better than thousand seed weight; SPTI is an index related to grain yield and it is an new good index for genotype selection.

Correlation coefficients: Positive and significant correlation coefficient was observed between thousand seed weight and Percent of damaged seed ($r = 0.369$) (Table 5). Correlation coefficient between thousand seed weight and number of new generation sunn pest was positive and significant ($r = 0.320$). Correlation coefficient

Table 2: Results of ANOVA and orthogonal comparing for free and non-free selection experiments

SOV	df	No. of damaged central bud	No. of adult sunn pest	No. of new generation sunn pest	Percent of damaged seed	Grain yield	Thousand seed weight
Replication	4	0.08	18.02	299.90	0.01	6.99	17.26
Genotype	24	0.38*	32.23*	388.80*	0.15*	20.31*	31.43*
Bread wheat vs. durum wheat	1	0.17	32.22	91.68	571.90**	4357.00**	8.20
Error	96	0.25	19.83	260.9	0.03	6.51	15.05
Coefficient of variation		12.59	20.82	13.4	20.43	16.78	13.64

*p< 0.05. **p<0.01

Table 3: Ranking of genotypes based on SPTI

No.	Short name of genotypes	SPTI	Rank
1	14 GB	0.6	10
2	914GB	0.2	13
3	WW33	1.3	4
4	Ghods	1.1	5
5	Unknown-11	0.2	13
6	NWT1	1.0	6
7	NWT2	0.8	8
8	PATO1	1.0	6
9	PATO2	1.7	1
10	UNKNOWN-18	1.4	3
11	TAST	1.4	3
12	Ardabil 82 –56	0.9	7
13	4SEL	1.4	3
14	Ardabil 82	1.5	2
15	G1252	0.8	8
16	Pgs	0.6	10
17	Syrian-4	0.5	11
18	Heidar	0.8	8
19	Sardary	0.7	9
20	Azar-2	0.5	11
21	Rashid	0.5	11
22	Falat	0.5	11
23	Ghafghaz	0.3	12
24	Tabacy	0.3	12
25	GB140	0.5	11

Table 4: Ranking of genotypes based on means of ranks for damaged central bud, Percent of damaged seed and SPTI

No.	Short name of genotypes	Mean of ranks	Rank
1	14 GB	19.0	21
2	914GB	14.7	14
3	WW33	10.3	7
4	Ghods	14.0	12
5	Unknown-11	17.0	19
6	NWT1	11.3	9
7	NWT2	14.3	13
8	PATO1	5.0	1
9	PATO2	7.0	2
10	UNKNOWN-18	12.7	11
11	TAST	9.7	6
12	Ardabil 82 –56	10.7	8
13	4SEL	8.3	3
14	Ardabil 82	9.0	4
15	G1252	12.4	11
16	Pgs	9.3	5
17	Syrian-4	16.7	18
18	Heidar	19.7	22
19	Sardary	14.0	12
20	Azar-2	14.3	13
21	Rashid	15.3	16
22	Falat	12.3	10
23	Ghafghaz	15.0	15
24	Tabacy	16.3	17
25	GB140	17.3	20

between number of damaged central bud and number of new generation sunn pest was negative and significant (r = 0.443). Between number of adult sunn pest and number of new generation sunn pest, correlation coefficient was positive and significant (r = 0.408). A positive and significant correlation coefficient was observed between percent of damaged seed and number of adult sunn pest (r = 0.440). Between percent of damaged seed and number of new generation sunn pest correlation coefficient was positive and significant (r = 350).

Kinaci and Kinaci (2007) reported a reduction of thousand seed weight and grain yield in wheat genotypes due to sunn pest damage. Also, in this study (Fig. 2) thousand seed weight was decreased due to sunn pest damage but in few genotypes (G4 and G12) and grain yield decreasing was happened in 8 genotypes comparable with checks (Fig. 1). These results were similar to their findings. Lessening of genotypes had thousand seed weight and yield decreasing in this experiment indicated genetical resistance to sunn pest was not identification completely. Being of specific loci in some genotype were reason of high thousand seed weight and yield under sunn pest invasion . Fatehi *et al.* (2009) reported a high narrow-sense heritability for two crosses for resistance to sunn pest. But some researches on gene action were not sufficient. In this experiment many genotpes had yield more than Falat (genotype 22) (Fig. 1) and many genotypes had thousand seed weight similar to Falat (Fig. 2). Najafi *et al.* (2008) reported resistance of Falat. this opposite result was due to vast gene source in wheat and was cleared in new genotype or crosses. Maybe some useful gene interaction was created in advanced line that there was not in previous genotypes. Fatehi *et al.* (2009) reported some gene interaction in wheat for resistance to sunn pest. Correlation coefficients showed new generation sunn pest damaged thousand seed weight but adult sunn pest damaged central bud. Because correlation coefficient between thousand seed weight and number of new generation sunn pest was positive but between number of damaged central bud and number of new generation sunn pest was negative. Kinaci and Kinaci

Table 5: Correlation coefficient between number of damaged central bud, number of adult sunn pest, number of new generation sunn pest, Percent of damaged seed, grain yield and thousand seed weight

Parameters	Thousand seed weight	Grain yield	No. of damaged central bud	No. of adult sunn pest	No. of new generation sunn pest	Percent of damaged seed
Thousand seed weight	1					
Grain yield	0.243	1				
Number of damaged central bud	0.268	-0.126	1			
Number of adult sunn pest	0.252	-0.118	0.101	1		
Number of new generation sunn pest	0.320*	0.081	-0.443*	0.408*	1	
Percent of damaged seed	0.369*	-0.233	-0.061	0.440*	0.350*	1

*p<0.05

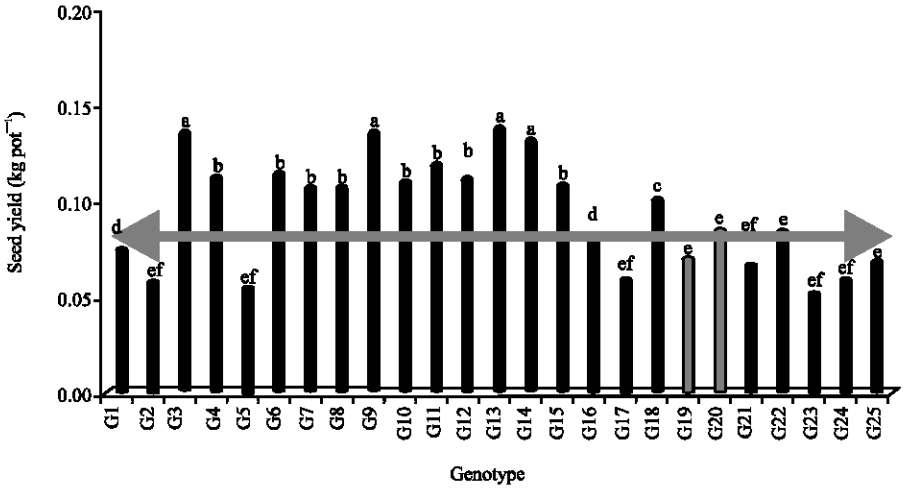

Fig. 1: Duncan multiple range test for grain yield (p<0.05). At least one same letter means non-significant differences. 19 and 20 genotypes were checks

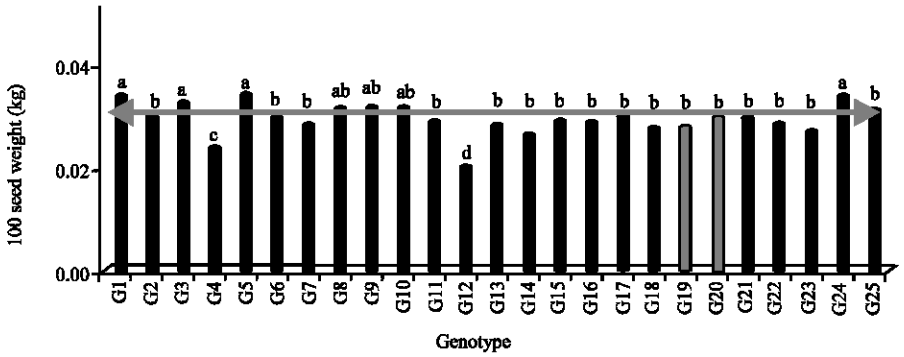

Fig. 2: Duncan multiple range test for thousand seed weight (p<0.05). At least one same letter means non-significant differences. 19 and 20 genotypes were checks

(2007) reported positive correlation coefficient for thousand seed weight and percent of damaged seeds. Damage of seeds was due to adult sunn pest and new generation sunn pest. Because correlation coefficient between percent of damged seeds and number of new generation sunn pest was significant and positive as correlation coefficient between percent of damaged seeds and number of adult sunn pest. Tolerant genotype to adult sunn pest and new generation sunn pest had special morphologic characters or special genes that other genotypes didn't have them. But Najafi *et al.* (2008) reported no significant correlation between tolerance to sunn pest and morphological characters. Therefore, genetical resistance to sunn pest maybe was originated from genes that control biochemical pathways. Molecular genomics and proteomics comparison between this wheat genotype and others must apply to detect special tolerant genes.

CONCLUSION

The resistant genotype (PATO1) to adult and new generation sunn pest had acceptable yield. Genetic diversity for grain yield was much more than thousand seed weight. This result indicated selection based on grain yield is better than thousand seed weight; SPTI is an index related to grain yield and it is an new good index for genotype selection. We purpose this index for new experiments.

ACKNOWLEDGMENT

This study was conducted in Dryland Agricultural Research Sub-Institute, Kermanshah, Iran. The authors acknowledge Saeed, poordad head of Sub-Institute.

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