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EVALUATION OF QUANTITATIVE LOSSES OF MAIZE GENOTYPES TO *SITOPHILUS ZEAMAIS* (MOTSCH) (COLEOPTERA: CURCULIONIDAE) UNDER LABORATORY CONDITION

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ABSTRACT

A study was carried out during 2012 at Grain Research, Training and Storage Management Cell, Department of Entomology, University of Agriculture, Faisalabad to evaluate the quantitative losses caused by maize weevil (*Sitophilus zeamais*) on Eight maize genotype (NK-8441, MMRI-Yellow, 30K08, Agati-2002, SWL-2002, EV-6098, EV-1098 and Pak-Afghan) were selected. The experiment was conducted in a walk-in environmental chamber maintained at 28°C, 32°C and 35°C. Physical parameters included percent insect damaged and undamaged grains, frass weight, weight loss and number of insect emerged. Frass weight was taken three times by electrical balance, while determination of weight loss, dead as well as live adult, grain dust and other excretion produced during the insect infestation was recorded. The treatments effect showed a significant difference with one another, regarding their effectiveness. Result depicted that genotype MMRI-Yellow was observed to be most susceptible while 30K08 was found to be resistant genotype. More F1 progeny of *S. zeamais* was recorded at 32°C and followed by 28°C and 35°C.

KEY WORDS: Quantitative losses; maize; genotypes; maize weevil; Pakistan.

INTRODUCTION

Maize also known as corn, is 3rd edible grain crop ranking after rice and wheat. Essential amino acids which are found in starchy body of corn are tryptophan, threonine, isolucine and lysine, (Prasana *et al*., 2001) (13). Due to edible larger starchy grin and high nutritive value it is staple food of most part of country. Maize is also known as food and industrial crop due to its

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vegetative matter which is used as fresh and preserved food for animals. In 2011-12 cultivated area of maize was recorded 1083 thousand hectare with production of 4271 tons estimated in 2011-12 (2). World Bank report revealed post harvest loses at farm and market level i.e. 7-10 to 4-5 percent respectively. Collective loses reach upto 12-16 million tons of grain. It is calculated that 5-7 percent loses in world grain production occurs due to insect pests (15). Average grain losses from these insect pests were recorded to be 1.5 t/ha which reduce from 4.9 t/ha. In developing world average annual storage lost through insect pests is 20-30 percent. Among all insect pests of stored grain, maize weevil (*Sitophilus zeamaiz*) is important insect pest. Maize weevil infestation starts in the field but mainly damage occurs during grain storage (11). Maize weevil produces 20-90 percent grain losses at storage (1). *S. zeamais* may infest the 80 percent stored maize (12). Maize weevil produces small holes in starchy grains and reduces the nutritive value (4). Female of *S. zeamais* is an internal feeder and lays its eggs inside the grain which are covered with liquid type gelatinous material. Eggs remain inside the hole for hatching (8) Grub is soft bodied and legless which is totally internal feeder. Grub produces the powder like excrete during feeding and grain become unpalatable. At one time only one larva survives in one grain (8). Grub remains inside the grain until it reaches pupal stage and a new adult crawls out from the grain.

Grub feeds inside the grain and metabolize the kernal into the heat and Co_2 (3). This heat and Co_2 produces the hot spot area which further promotes the fungal growth (9). Grubs infestation also enhances the fatty acid and uric acid quantity in grains which causes the rancidity (10). Grub infestation also causes the deterioration of stored products due to decrease in air flow (9). 30-50% of the Whole grain is spoiled 30-50 percent by adult of *S. zeamais* while a single grub consumed 5-7 percent (17). Resistant variety construct the base of integrated control which may be helpful in other control system (6) The present Ento was conduted to identify the response by different available genotypes of maize to *S. zamias* in order to determine resistance/ susceptibility.

MATERIALS AND METHODS

The present research was conducted at Grain Research, Training and storage management cell, Department of Entomology, University of Agriculture, Faisalabad during 2012 to evaluate the quantitative losses caused by maize weevil (*Sitophilus zeamais*) Eight maize genotypes (NK-8441, MMRI-Yellow, 30K08, Agati-2002, SWL-2002, EV-6098, EV-1098 and Pak-Afghan) were included in this research. The samples of different maize

genotypes/ varieties were taken from Maize and Millet Research Institute Yousafwala Sahiwal. After collecting from the old godowns, homogenous population of *Sitophilus zeamais* was prepared in the Stored Grain Pest Management and Research Laboratory, University of Agriculture, Faisalabad. Culture was reared in sterilized flour and after 5 days the flour was sieved out and kept in the incubator until the emergence of F1 adults. The adults were allowed to mature for three weeks and then these adults were used for the experimental studies. In the laboratory material was treated with heat to eliminate any prior infestation before starting the experiment. Samples were washed with water and then dried in oven at high temperature to homogenize moisture. Layout of experiment was CRD with three replications for each treatment. Sample of each genotype weighing 50g was taken in glass jars. Thirty adults of *Sitophilus zeamais* (M.) were released separately in each jar. The experiment was conducted in a walk-in environmental chamber maintained at 28, 32 and 35°C with 60-65% RH. For quantitative analysis of maize genotypes, all samples were drawn and analyzed to record the observations. Approximate analyses were performed in Food Science and Technology Laboratory, University of Agriculture, Faisalabad. Physical parameters included percent insect damaged and undamaged grains, frass weight, weight loss and number of insect emerged.

For the calculation of percent weight loss set of sieves were used. The infected grains in each jar were subjected to sieving to split frass, grain dust and other excretion added due to *Sitophilus zeamais* (M.). A sample weighing 100 gram was taken from the cleaned maize for assessment of percent weight loss. For this purpose, number and weight of damaged and undamaged grains were recorded and put in the next given equation for determination of weight loss. Frass weight was taken three times by electrical balance after 45, 90 and 120 days, while determination of weight loss, dead as well as live adult, grain dust and other excretion produced during the insect infestation was recorded. After removing the frass, samples of cleaned grain each weighing 100 gram was drawn from each replication of the respective maize variety. The grains were segregated and counted for insect damaged and undamaged grains by using the following equations.

$$\text{Percent Insect damaged grains} = \frac{\text{No. of insect damaged grains} \times 100}{\text{Total number of grains in the sample}}$$

$$\text{Percent insect undamaged grains} = \frac{\text{No. of healthy grains} \times 100}{\text{Total number of grains in the sample}}$$

RESULTS AND DISCUSSION

The results (Table 1) showed that mean of number of insect emerged after 45 days is differed from each other in different varieties. Greater number of insects emerged in MMRI-Yellow (43.44) and it variedy significantly from all other treatments. The genotype 30K08 showed the lowest number of insect emergence (22.56) followed by genotype NK-8441(23.78) and both are statistically at par with each other. More F1 progeny was recorded at 32°C with mean value of 51.54 followed by 28°C (35.71) and 35°C (4.67). The results further showed that more weight of frass was observed in MMRI-Yellow (1.32g) and it significantly differed from those observed in all other treatments. The lowest weight of frass was found in 30K08 (0.03g). More frass weight was recorded at 32°C with mean value of 0.58g and followed by 28°C (0.28g) and 35°C (0.2g). The results (Table 1) also revealed that percentage weight losses varied from each other in different varieties. High percentage weight loss was recorded in MMRI-Yellow (6.9%) and it differs significantly from those found in all other genotypes. The lowest weight of frass was recorded in 30K08 (0.21%) which did not show a significant variation with EV-1098 (1.791%), Agati-2002(1.76%), Pak-Afghan (1.41%), EV-6098 (0.67%) and SWL-2002 (0.45%). More percentage loss was observed at 32°C with mean value of 4.35% and followed by 28°C (1.13%) and 35°C (0.41%). The results (Table 1) also reveals that data regarding percentage damage grains after 45 days varied from each other in different varieties. High percentage damage grains were found in MMRI-Yellow (15.98%) which differed significantly from those observed in all other treatments. The lowest percentage damage grains was observed in 30K08 (3.42%) with non-significant difference with Agati-2002 (5.35%), Pak-Afghan (5.27%) and EV-6098 (4.68%). The result (Table 1) showed that mean high percentage un-damage grains after 45 days were observed in EV-6098 (67.46%) which did not show significant difference with 30K08 (66.49%), SWL-2002(66.48%) and EV-1098 (66.48%) while lowest percentage un-damage grains were observed in NK-8441(64.44%). The result also showed that more percentage un-damaged grains were observed at 35°C with mean value of 98.13% and followed by 28°C (96.03%) and 32°C (3.021%). The results (Table 2) indicate that number of insects emergence after 90 days varied from each other in different varieties at different temperature.

High number of insects emerged in MMRI-Yellow (88.44) which showed significant difference from those observed in all other treatments while the lowest number of insects emerge in 30K08 (42.44) which was statistically at par with NK-8441. Genotypes Agati-2002, SWL-2002, EV-6098, EV-1098

Table 1. A mean comparison of the data, regarding physical parameter at different temperature on maize in different treatments, after 45 days.

Treatments	Insect Emergence				Weight of Frass			
	Temperatures °C				Temperatures°C			
	28°C	32°C	35°C	Means	28°C	32°C	35°C	Means
MMRI-Yellow	46.67cde	72.33a	11.33g	43.44a	0.63bc	2.22a	1.12b	1.32a
Pak-Afghan	32.67ef	64.00ab	4.00g	33.56b	0.57bc	0.14bc	0.07c	0.26b
EV-6098	40.0def	52.67bcd	2.33g	31.67b	0.35bc	0.66bc	0.14bc	0.38b
SWL-2002	33.0ef	59.33abc	1.66g	31.333b	0.2bc	0.43bc	1.33c	0.2105b
EV-1098	38.0def	45.67cdef	9.33g	31.00bc	0.32bc	0.81bc	0.14bc	0.43b
Agati-2002	33.0ef	43.0def	7.33g	27.78bcd	0.04c	0.17bc	0.10c	0.11b
NK-8441	31.67ef	38.33def	1.33g	23.78cd	0.07c	0.13bc	0.01c	0.07b
30K08	30.67 f	37.0def	0.00g	22.56d	0.02c	0.07c	0.00c	0.03b
Temp Mean	35.71b	51.54a	4.67c		0.28b	0.578a	0.2b	
	Percentage weight loss				Percentage damage grains			
	2.8bcd	16.26a	1.66cd	6.90a	5.22cdefgh	36.36a	6.38cdefg	15.98a
	0.94cd	2.85bcd	0.43cd	1.41bc	4.72defgh	9.60cd	1.5fgh	5.27cd
	0.59cd	1.99cd	0.03d	0.67bc	1.95fgh	10.42c	1.68fgh	4.68cd
	0.56cd	0.73cd	0.06d	0.45c	2.85fgh	16.3b	0.35h	6.5bc
	1.43cd	3.57bc	0.38cd	1.8bc	4.88defgh	19.60b	1.79fgh	8. 76b
	1.51cd	3.31bcd	0.47cd	1.76bc	4.07efgh	9.2cde	2.79fgh	5.35cd
	0.98cd	5.78b	0.23cd	2.33b	6.73cdef	18.84b	0.65h	8. 74b
	0.23cd	0.39cd	0.000	0.21c	1.35gh	8.92cde	0.00h	3.42d
	1.13b	4.36a	0.41b		3.97 b	16.16a	1.89c	
	Percentage undamaged grains							
	94.78 bcd	6.15e	93.81cd	64.92b				
	95.28abcd	1.34ef	98.50abc	65.04b				
	98.05abcd	6.02e	98.32abc	67.46a				
	97.15abcd	2.65ef	99.65ab	66.48ab				
	95.12abcd	4.29ef	99.21abc	65.87ab				
	95.93abcd	2.19ef	97.21abcd	65.11b				
	93.27d	0.72f	99.35ab	64.45b				
	98.65abc	0.81f	100.0a	66.49ab				
	96.03b	3.02c	98.13a					

*Means sharing similar letters are not significantly different by LSD Test at P = 0.05

and Pak-Afghan were statistically at par with each other. More F1 progeny was observed at 32°C with mean value of 100.67 and followed by 28°C (66.08) and 35°C (11.79). The results (Table 2) also reveal that weight of frass after 90 days varied from each other in different varieties at different temperature. High weight of frass was recorded in MMRI-Yellow (2.94%) and it differ significantly from those observed in all other treatments while lowest weight of frass was recorded in 30K08 (0.06g) which was statistically at par with all other genotypes. More weight of frass was recorded at 32°C with mean value of 1.16g and followed by 28°C (0.55g) and 35°C (0.52g). The results (Table 2) also show percentage weight losses after 90 days varied from each other in different varieties at different temperature. High percentage weight loss was recorded in MMRI-Yellow (7.55%) which did not differ significantly from Agati-2002 (4.49 %) and lowest weight of frass was recorded in 30K08 (0.33%). More percentage loss was recorded at 32°C with mean value of 5.17% and followed by 35°C (1.9%) and 28°C (2.08%).

The results (Table 2) also indicate percentage damage grains after 90 days varied from each other in different varieties at different temperature. High percentage damage grains were recorded in MMRI-Yellow (23.83%) and the lowest percentage damage grains was recorded in 30K08 (6.04%). These both genotypes differ significantly from each other. More percentage damage grains was recorded at 32°C with mean value of 26.95% and followed by 28°C (8.85%) and 35°C (5.24%). The results (Table 2) also reveal that percentage undamaged grains after 90 days varied from each other in different varieties at different temperature. High percentage damage grains were recorded in 30K08 (93.96%) and lowest percentage undamaged grains was recorded in MMRI-Yellow (76.0%). These both genotypes differ significantly from each other. More percentage damage grains was recorded at 35°C with mean value of 94.76% and followed by 28°C (87.54%) and 32°C (72.59%).

Table 2. A mean comparisons of the data, regarding physical parameter at different tempeature on maiz in different treatments, after 90 days.

Treatments	Insect Emergence				Weight of Frass			
	Temperatures				Temperatures			
	28 °C	32°C	35°C	Means	28 °C	32°C	35°C	Means
MMRI-Yellow	80.0def	154.67a	30.66g	88.44a	1.31bc	4.53a	2.99ab	2.94a
Pak-Afghan	64.33ef	125.00b	9.00gh	66.11b	1.11bc	0.27c	0.18c	0.52b
EV-6098	60.0f	98.66bcd	7.00gh	55.22bc	0.7c	1.31bc	0.37c	0.79b
SWL-2002	64.33ef	115.0bc	7.33gh	62.22b	0.39c	0.86c	0.13c	0.42b
EV-1098	75.66def	88.0cde	21.66gh	61.77b	0.64c	1.57bc	0.37c	0.86b
Agati-2002	63.33ef	83.0def	15.33gh	53.88bc	0.073c	0.33c	0.23c	0.21b
NK-8441	61.0ef	73.66def	3.33gh	46.00c	0.13c	0.26c	0.04c	0.14b
30K08	60.0f	67.33ef	0.00h	42.44c	0.037c	0.13c	0.00c	0.06b
Temp Mean	66.08b	100.67a	11.79c		0.55b	1.16a	0.52b	
	Percentage Weight Loss				Percentage Damage Grains			
MMRI-Yellow	3.09b	15.5a	4.08b	7.55a	13.78bcdef	43.29a	14.42bcdef	23.83a
Pak-Afghan	2.11b	1.31b	0.91b	1.44bc	9.45def	15.81bcdef	4.52def	9.93b
EV-6098	1.2b	3.75b	1.65b	2.20bc	3.03ef	19.67abcdef	4.87def	9.19b
SWL-2002	2.07b	6.42b	2.22b	3.57bc	6.95def	27.36abcd	3.55ef	12.62ab
EV-1098	1.99b	3.82b	1.20b	2.34bc	11.43cdef	33.45abc	5.21def	16.70ab
Agati-2002	2.99b	6.71b	3.76b	4.49ab	8.38def	36.350ab	6.97def	17.24ab
NK-8441	2.73b	3.32b	1.35b	2.46bc	14.10bcdef	26.01abcde	2.38ef	14.16ab
30K08	0.49b	0.50b	0.000b	0.33c	4.46def	13.66bcdef	0.00f	6.04b
Temp Mean	2.08b	5.17a	1.9 b		8.85b	26.95a	5.24b	
	Percentage Undamaged Grains							
MMRI-Yellow	86.22abc	56.71cd	85.58abc	76.17b				
Pak-Afghan	90.55abc	84.19abc	95.48ab	90.07ab				
EV-6098	96.97ab	80.33abc	95.13ab	90.81ab				
SWL-2002	94.93bcd	72.64abcd	96.44ab	8.00ab				
EV-1098	88.57abc	44.67d	94.79ab	76.01b				
Agati-2002	91.62ab	81.88abc	93.03ab	88.84ab				
NK-8441	85.90abc	73.99abcd	97.62ab	85.84ab				
30K08	95.54ab	86.34abc	100.0a	93.96a				
Temp Mean	87.53a	72.59b	94.76b					

*Means sharing similar letters are not significantly different by LSD Test at P = 0.05

The present study discussed the assessment of quantitative losses in different maize varieties. The present finding depict that *S. zeamais* had significant effect on sound grains. The present study are in accordance with

the results of Rogers and Mills (14) who concluded that sorghum genotype which had enclosed seed found to be resistant. The present findings are in partial agreement with Dhliwayo and Pixley (5) who found high percentage weight loss and F1 progeny of *S. zeamais* was recorded after 90 days. The results of present experiments are in accordance with Canappele *et al*. (3) who reported that attack of *S. zeamais* significantly reduced the nutritive value of grain which affects the physical quality and finally commercial worth of grains decreased. The main aim of present study was to evaluate the effect of *S. zeamais* on physical and physiological quality of maize. Voweter *et al.* (17) conducted experiment to check the morphological effects of maize genotypes against growth and development of *S. zeamais*. The finding showed that stored maize varieties had no effects on eggs of *S. zeamais*. While the results of the present research revealed that different stored maize varieties had significant effects on *S. zeamais* emergence.

Table 3. A mean comparison of the data, regarding physical parameter at different tempeature on maiz in different treatments, after 120 days.

Treatments	Insect Emergence				Weight of Frass			
	Temperatures				Temperatures			
	28°C	32°C	35°C	Means	28 °C	32°C	35°C	Means
MMRI-Yellow	148.33de	297.0a	67.67j	171.0a	2.99cd	9.48a	6.67b	6.38a
Pak-Afghan	126.00fghi	153.0d	21.00lm	100.0c	0.207e	0.5e	0.31e	0.34cd
EV-6098	121.68ghi	183.0c	17.00lmn	107.22c	1.35cde	1.76cde	0.76de	1.29bc
SWL-2002	128.0fghi	213.0b	17.67lmn	19.56b	0.136e	0.63de	0.44e	0.40cd
EV-1098	43.33def	138.67defg	44.33k	108.78c	1.22cde	3.20c	0.73de	1.71b
Agati-2002	132.33efgh	138.33defg	31.33kl	100.67c	0.14e	0.63de	0.44e	0.4cd
NK-8441	118.33hi	129.0fghi	9.67mn	5.67d	0.26e	0.55e	0.06e	0.29cd
30K08	115.67hi	11.67i	1.33n	6.22e	0.07e	0.22e	0.001e	0.1d
Temp Mean	129.21b	170.46 a	26.25c		0.87b	2.25a	1.13b	
	Percentage Weight Loss				Percentage Damage Grains			
MMRI-Yellow	14.96bcde	48.28a	7.42cde	23.55 a	41.07b	54.5a	31.09 cde	42.22a
Pak-Afghan	2.68e	1.73e	5.02de	.14cd	16.95ijkl	23.10efghi	11.39 jklm	7.15c
EV-6098	3.082e	21.62bc	3.11e	9.27bc	7.05mn	29.05cdef	8.57 lmn	14.89c
SWL-2002	7.61cde	20.04bcd	3.97de	0.54bc	15.59ijklm	30.76cdef	10.53jklm	18.96bc
EV-1098	7.02cde	28.47b	2.58e	12.69b	21.87fghi	37.21bc	10.27jklm	23.12b
Agati-2002	8.81cde	6.193cde	6.611cde	7.203bcd	17.550hijk	27.030defg	9.849jklmn	18.143c
NK-8441	3.71de	9.22cde	4.80de	5.91bcd	26.04defgji	33.38bcd	8.89klmn	22.77b
30K08	2.37e	1.25e	0.33e	1.32d	8.35lmn	18.11ghij	1.28n	9.25d
Temp Mean	6.28b	17.1a	4.23b		19.31b	31.64a	11.48c	
	Percentage Undamaged Grains							
MMRI-Yellow	148.33de	297.00a	67.67j	58.9d				
Pak-Afghan	126.0fghi	153.0d	21.00lm	82.54b				
EV-6098	121.67ghi	183.0c	17.00 lmn	85.11b				
SWL-2002	128.0fghi	213.0b	17.67lmn	1.04bc				
EV-1098	143.3def	138.67defg	44.33k	76.88c				
Agati-2002	132.33efgh	138.33defg	31.33kl	3.032b				
NK-8441	118.33hi	129.0fghi	9.67mn	7.23c				
30K08	115.67hi	111.67i	1.33n	90.75a				
Temp Mean	80.69 b	69.14 c	88.6 a					

*Means sharing similar letters are not significantly different by LSD Test at P = 0.05

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Asmat Nawaz	**:**	**Planned and conducted whole research**
Zulfiqar Ali	**:**	**Provided technical assistance**
Muhammad Saddiq Aasi	**:**	**Provided maize genotypes and financial assistance**
Muhammad Nadeem	**:**	**Supervised and maintained culture**
Jamshaid Iqbal	**:**	**Statistically analysed data**