



Damage of Sunn Pest *Eurygaster integriceps* Put. on to Wheat Quality in Israel

Aviv Rapaport, Elazar Quinn, Avihai Harush, Moshe Kostyukovsky*, and David J. Bonfil

Department of Food Quality and Safety, Agricultural Research Organization, Israel

Abstract

Sunn pest *Eurygaster integriceps* Put. on is one of the most serious factors affected the gluten quality of wheat grain in Israel. The object of this study was to evaluate the damage of sunn pest to wheat quality of some cultivars of spring wheat. Field experiments were conducted in three cultivars with a different phenology: Zahir - early ripening, Bar-Nir - medium, Ruta - later ripening. The isolated by net plots were infested by unsexed wintering adults of sunn pest. The isolated uninfested plots serve as a control. The sunn pest's effects on quantitative parameters of wheat quality, such as thousand kernels weight, test weight, and the effects on gluten quality and quantity, such as gluten index, IDK test, wet gluten content, were examined. In addition, samples at varying degrees of the bug-damaged kernels were constructed in order to examine the quality and quantity of gluten. A high level of bug-damaged kernels of 15-20% did not affect the thousand kernel weight and test weight of the three tested cultivars. At a very high level of bug-damaged kernels of 40-60%, the sunn pest caused a significant reduction in thousand kernels weight in Zahir and Ruta cultivars. Test weight decreased significantly in all three cultivars. A damage of up to 4% of the kernels has significantly affected gluten quality but not gluten content. The results of this study indicate that the cultivar of wheat is of high importance for the level of the gluten quality and the degree of sunn pest's damages

Keywords: *Eurygaster integriceps*; Gluten quality; Wheat grain quality

Abbreviations

ARO: Agricultural Research Organization; GI: Gluten Index; IDK: The Device for Identification of Deformation of "Kleikovina" (Gluten in Russian)

Introduction

Sunn pest *Eurygaster integriceps* Put. on (Heteroptera: Scutelleridae) is well known as a serious limiting factor for production of wheat grain with strong gluten in the wide area of the Near and Middle East, Eastern and South Europe and North Africa. The bug attacks about 150 million hectares of fields each year [1]. Bug damaged wheat contains enzymes, which degrade gluten proteins, causes rapid relaxation of dough and results in the production of bread with poor volume and texture with financial losses of millions of dollars [2-6].

In Israel, in the years of the bug outbreak, the numbers of new generation were very high; reaching on some fields 58 nymphs per 1 square meter [7]. A significant part of the grain yield was characterized by low gluten quality. One of the most serious factors affected the gluten quality is sunn pest. Different cultivars of wheat present a large diversity in their response to the sunn

pest [2,8-12].

In the case of low numbers of bug population and low level of damaged kernel, role of genetic, agro-technical and ecological factors, which affect the gluten quality, is increased.

The object of this study was to evaluate the damage of sunn pest to wheat quality in Israel.

The level of damage caused by sunn pest is significantly dependent on the characteristics of the wheat cultivars, particularly the quality of the wheat. In order to examine the effect of the sunn pest's damage on the quality of some cultivars of spring wheat (*Triticum aestivum* L.) in Israel, a field experiments were conducted in the Gilat research center of ARO for three years. Sunn pest's wintering adults were collected from wheat fields at the stage of the wheat flowering and plots of 2 square meters were infested at a level of 10 unsexed bugs per 1 square meter. A net of 50 mesh isolated the infested and uninfested plots. The uninfested isolated plots served as a control. The experiments were conducted in three spring wheat cultivars with a different phenology: Zahir- early ripening, Bar-Nir-medium, Ruta- later ripening, in three replicates. Zahir and Bar-Nir are considered as strong gluten cultivars, Rutaas moderate [13]. Before harvesting, the nets were replaced; the sunn pest adults of the new generation were counted. All the infested and uninfested plots were harvested separately. The sunn pest's effects on quantitative parameters of wheat quality, such as thousand kernels weight, test weight, and the effects on gluten quality and quantity, such as GI, IDK test (the common method for gluten quality evaluation in the former Soviet Union), wet gluten content, were examined. In addition, samples at varying degrees of the bug-damaged kernels (from 0 to 8%) were constructed in order to examine the quality and quantity of gluten.

The current study showed the influence of the spring wheat cultivars growth in Israel on the level of gluten quality and on the degree of sunn pest's damages.

Submitted: 29 January 2019 | **Accepted:** 17 April 2019 | **Published:** 19 April 2019

***Corresponding author:** Moshe Kostyukovsky, Department of Food Quality and Safety, Agricultural Research Organization, Israel, Email: inspect@volcani.agri.gov.il

Copyright: © 2019 Rapaport et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Citation: Rapaport A, Quinn E, Harush A, Kostyukovsky M, Bonfil DJ (2019) Damage of Sunn Pest *Eurygaster integriceps* Put. on to Wheat Quality in Israel. JSM Plant Biol Res 3: 3.



Table 1: Bug-damaged kernels (%), test weight and thousand kernels weight in infected and uninfected plots in three wheat cultivars.

Year	Cultivar	Treatment	Bug-damaged kernels (%)	Test weight (kg/100 ml)	Thousand kernels weight (g)
2016	Zahir	uninfected	0.8 ± 0.0 ^A	67.7 ± 1.3 ^A	32.3 ± 0.9 ^A
		infected	13.6 ± 0.1 ^B	65.6 ± 1.6 ^A	33.2 ± 1.4 ^A
	Bar-Nir	uninfected	1.1 ± 0.0 ^A	63.8 ± 1.1 ^A	29.0 ± 0.7 ^A
		infected	20.8 ± 0.5 ^B	58.1 ± 1.3 ^A	27.9 ± 0.8 ^A
	Ruta	uninfected	1.3 ± 0.0 ^A	56.8 ± 1.1 ^A	23.5 ± 1.2 ^A
		infected	16.8 ± 0.2 ^B	57.9 ± 1.3 ^A	25.6 ± 0.8 ^A
2017	Zahir	uninfected	2.7 ± 0.9 ^A	75.1 ± 0.4 ^A	33.8 ± 0.5 ^A
		infected	60.7 ± 4.5 ^B	64.0 ± 0.6 ^B	27.5 ± 0.3 ^B
	Bar-Nir	uninfected	2.4 ± 1.2 ^A	73.9 ± 0.3 ^A	29.9 ± 0.5 ^A
		infected	40.8 ± 1.1 ^B	67.4 ± 0.5 ^B	27.4 ± 0.2 ^B
	Ruta	uninfected	0.6 ± 0.2 ^A	70.0 ± 1.1 ^A	26.2 ± 1.0 ^A
		infected	68.7 ± 2.9 ^B	58.0 ± 1.0 ^B	22.9 ± 1.2 ^A
2018	Zahir	uninfected	0.1 ± 0.1 ^A	57.7 ± 2.8 ^A	21.0 ± 0.7 ^A
		infected	0.8 ± 0.2 ^A	56.5 ± 1.2 ^A	19.8 ± 0.3 ^A
	Bar-Nir	uninfected	0.4 ± 0.2 ^A	56.7 ± 1.5 ^A	19.6 ± 0.6 ^A
		infected	1.2 ± 0.4 ^A	57.6 ± 0.8 ^A	18.8 ± 0.2 ^A
	Ruta	uninfected	0.2 ± 0.2 ^A	56.5 ± 0.8 ^A	17.4 ± 0.3 ^A
		infected	1.0 ± 0.1 ^B	60.5 ± 1.9 ^A	18.0 ± 0.7 ^A

Values represent means of three replications ± standard errors. Values followed by different letters within the same column are significantly different statistically (p < 0.05).

Table 2: Gluten index, IDK values and wet gluten content in infected and uninfected (control) plots of three cultivars.

Year	Cultivar	Bug-damaged kernels (%)	Gluten index (%)	IDK value	Wet gluten (%)
2016	Zahir	0	65.1 ± 7.7 ^A	90.7 ± 6.2 ^A	26.5 ± 0.1 ^A
		2	40.1 ± 5.2 ^B	101.5 ± 3.6 ^{AB}	27.7 ± 0.1 ^A
		4	18.0 ± 11.4 ^B	108.7 ± 5.7 ^B	27.8 ± 0.2 ^A
	Bar-Nir	0	67.7 ± 12.7 ^A	88 ± 3.6 ^A	32.7 ± 0.1 ^A
		2	31.3 ± 8.5 ^{AB}	99.9 ± 1.9 ^{AB}	34.2 ± 0.5 ^A
		4	25.1 ± 15.7 ^B	101.4 ± 4.2 ^B	33.7 ± 0.1 ^A
	Ruta	0	34.3 ± 12.3 ^A	100.8 ± 0.9 ^A	36.5 ± 0.1 ^A
		2	30.1 ± 6.2 ^A	100.1 ± 2.8 ^A	35.7 ± 0.1 ^A
		4	8.2 ± 2.0 ^B	106.7 ± 2.9 ^A	38.0 ± 0.2 ^A
2017	Zahir	0	81.0 ± 6.3 ^A	83.4 ± 1.4 ^A	28.3 ± 1.1 ^A
		2	72.1 ± 5.2 ^{AB}	89.0 ± 1.1 ^A	28.8 ± 0.9 ^A
		4	54.8 ± 9.7 ^B	89.5 ± 5.5 ^A	28.9 ± 1.0 ^A
	Bar-Nir	0	75.3 ± 7.7 ^A	80.2 ± 3.4 ^A	28.7 ± 1.1 ^A
		2	56.0 ± 4.5 ^B	81.4 ± 2.8 ^A	29.3 ± 1.0 ^A
		4	34.3 ± 4.7 ^C	96.5 ± 3.1 ^B	29.1 ± 1.2 ^A
	Ruta	0	63.1 ± 10.1 ^A	74.0 ± 3.3 ^A	33.5 ± 0.8 ^A
		2	49.5 ± 9.9 ^A	88.9 ± 3.0 ^A	33.3 ± 0.7 ^A
		4	40.3 ± 10.2 ^A	93.3 ± 2.6 ^B	33.3 ± 0.7 ^A



2018	Zahir	0	92.3 ± 2.7 ^A	73.6 ± 3.0 ^A	36.0 ± 0.8 ^B
		2	76.3 ± 6.1 ^{AB}	83.8 ± 2.9 ^A	38.5 ± 0.6 ^A
		4	66.1 ± 6.1 ^B	82.8 ± 3.0 ^A	38.2 ± 0.6 ^{AB}
	Bar-Nir	0	80.6 ± 14.8 ^A	77.7 ± 5.1 ^A	44.8 ± 1.6 ^A
		2	85.7 ± 0.5 ^A	79.5 ± 2.4 ^A	44.2 ± 0.7 ^A
		4	80.1 ± 1.2 ^A	74.0 ± 6.9 ^A	46.0 ± 0.9 ^A
	Ruta	0	71.5 ± 6.1 ^A	79.1 ± 3.8 ^A	51.0 ± 0.5 ^A
		2	53.0 ± 2.0 ^B	90.7 ± 1.1 ^B	53.2 ± 0.4 ^A
		4	50.2 ± 1.2 ^B	94.6 ± 1.3 ^B	51.8 ± 0.9 ^A

Abbreviation: IDK: The Device for Identification of Deformation of “Kleikovina” (Gluten in Russian)

Values represent means of three replications ± standard errors. Values followed by different letters within the same column are significantly different statistically ($p < 0.05$).

In 2016 and 2017, a very high level of the bug population and percent of damaged wheat kernels was reached in infested plots. It was found that a kernels' damage of 15-20% did not affect the thousand kernel weight and test weight of the three tested cultivars, and did not cause quantitative damage to wheat. However, at a very high level of bug-damaged kernels of 40-60%, the sunn pest caused a significant reduction in thousand kernels weight in Zahir and Ruta cultivars. Test weight decreased significantly in all three cultivars. At low level of bug damage, the quantitative parameters were not affected (Table 1).

A damage of up to 4% of the kernels has affected gluten quality but not gluten content (Table 2). Even at 8% bug-damaged kernels the gluten content did not changed significantly (the data not shown).

The gluten quality parameters, such as GI and IDK test, were much lower in the kernels affected by the sunn pest compared to the healthy kernels, while the Ruta cultivar was characterized by low gluten quality, and the sunn pest's damages were more severe in this cultivar compared to Zahir and Bar-Nir cultivars.

The significant decrease in the gluten quality by GI and IDK test in comparison to undamaged kernels, took place in most of the cases at 4% damaged kernels. While in cultivar Zahir the significant decrease of gluten quality measured by GI and IDK was recorded at 2-4% damaged kernels, in cultivar Bar-Nir at 4% (sometimes did non decreased at this level), in Ruta at 3-4%.

The results of this study indicate that the cultivar of wheat is of high importance for the level of the gluten quality and the degree of sunn pest's damages.

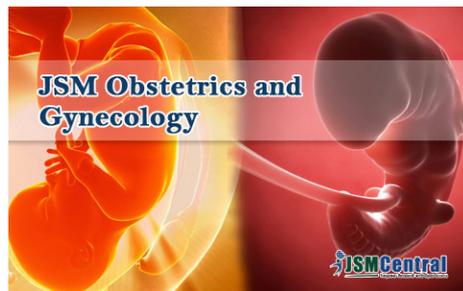
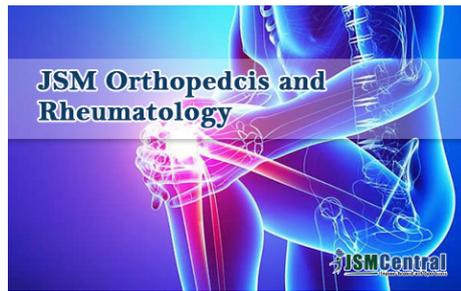
A difference in the tolerance of cultivars with different phenology to the sunn pest's damage was established; emphasize the importance of using strong gluten quality cultivars, especially in years with a high sunn pest population, and the importance of wheat phenology in terms of quality of wheat.

Acknowledgments

This study was supported in part by grant from the Chief Scientist of the Israeli Ministry of Agriculture (grant # 20-10-0066).

References

- Salis L, Goula M, Izquierdo J, Gordún E. Population density and distribution of wheat bugs infesting durum wheat in Sardinia, Italy. *J Insect Sci.* 2013; 13: 50.
- Critchley BR. Literature review of sunn pest *Eurygaster integriceps* Put. (Hemiptera, Scutelleridae). *Crop prot.* 1998; 17: 271-287.
- Alekhin VT. The wheat bug and the problem of quality grain production. *Zashchitai Karantin Rastenii.* 2009; 5: 6-7.
- Kostyukovsky M, Zohar D. Sunn pest *E. integriceps* and wheat quality in Israel. *Proc Int Qual Grain.* 2004; 1-7.
- Kostyukovsky M, Trostanetsky A, Menasherov M, Yasinov G, Naftaliyahyu U, Zohar D, et al. Management of Sunn pest for better wheat quality and stable profitability. *Isr Agri.* 2010; 20-21.
- Dizlek H, Islamoglu M. Effects of Sunn Pest (*Eurygaster maura* L. Heteroptera; Scutelleridae) sucking number on physical and physicochemical characteristics of wheat varieties. *J Appl Bot Food Qual.* 2015; 88: 10-15.
- Kostyukovsky M, Trostanetsky A, Ngumbi E, Zohar D, Kitain S, Melamed Y. Danger! Sunn pest is in the wheat. *Gan sadevemeshek.* 2003; 3: 5-8.
- Kinaci E, Kinaci G. Quality and yield losses due to sunn pest (Hemiptera: Scutelleridae) in different wheat types in Turkey. *Field Crop Res.* 2004; 89: 187-195.
- Kinaci E, Kinaci G. Genotypic variations in yield and quality of wheat damaged by Sunn pest (*Eurygaster* spp.). *Pak J Bot.* 2007; 39: 397-403.
- Bouhssini M, Street K, Joubi A, Ibrahim Z, Rihawi F. Sources of wheat resistance to Sunn pest, *Eurygaster integriceps* Put. on, in Syria. *Genet Resour Crop Evol.* 2009; 56: 1065-1069.
- Emebiri L, Bousshini M, Tan MK, Ogonnaya FC. Field-based screening identifies resistance to Sunn pest (*Eurygaster integriceps*) feeding at vegetative stage in elite wheat genotypes. *Crop Pasture Sci.* 2017; 68: 126-133.
- Tonk FA, Kaya E, İstipliler D, İlker E, Turanlı F, Tosun M, et al. Identification of resistance to *Eurygaster integriceps* Put. on some bread wheat genotypes. *J Appl Bot Food Qual.* 2017; 90: 52-57.
- Naftaliyahyu U, Nir U, Izenkot A, Goren O, Giladi Y, Rabinovitch O, et al. Summary of wheat cultivars national test - 2008. *Gan sadevemeshek.* 2008; 10: 8-19.



Our motto is to advance scientific excellence by promoting open access. We are committed in the widest possible dissemination of research and uplift future innovation



Submit Manuscript