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Susceptibility of different varieties of wheat and barley to cereal leafminer *Syringopais temperatella* Led. (Lep., Scythrididae) under laboratory conditions

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Abstract

The use of insecticides against the cereal leafminer *Syringopais temperatella* Led. has generally lagged due to cost constraints associated with wheat and barley as low-input crops and the developed insecticidal resistance by the pest. Therefore, this study aimed to investigate susceptibility of wheat and barley varieties commonly grown in Jordan to this pest to facilitate the use of such varieties as one of the most economically effective and environmentally friendly control measures. Two leaf ages, six different varieties of each crop and two different larval groups were used as experimental factors, which were examined at 25±1°C under laboratory conditions. Results indicated that mean leaf area consumed from wheat by both early and late instars was significantly more in Horani Nawawi and least in Acsad 65. Acsad 176 and Rum 2 barley varieties showed most susceptible and Athroh exhibited the least susceptibility. All instars larvae showed preference to old leaves than young ones in barley, but they did not show any significant preference to leaf age in wheat. In general, barley varieties were more susceptible than wheat varieties to larval attack and feeding.

Key words: Barley, cereal leafminer, susceptibility, *Syringopais temperatella*, wheat.

Introduction

Wheat, *Triticum durum* L. and barley, *Hordeum vulgare* L., are the main cereal crops grown in Jordan. The area cultivated with wheat and barley was 23,577 and 18,073 hectares, respectively. Many varieties of both crops are commonly grown in Jordan. However, Jordan is not self-sufficient in wheat and barley production and depends on imports to cover national needs. In 2006, Jordan produced 26,380 and 16,390 tons and imported 591,200 and 876,800 tons of wheat and barley, respectively [1].

Many of the major insect pests on wheat and barley worldwide have their origins in the rain-fed lands of West Asia and along the Mediterranean rim [12]. However, there are many insects infesting wheat and barley worldwide, and some of them cause serious annual forage and yield reductions. As intensive pesticide usage eliminates the natural enemies that would normally control their populations, many insects have erupted into severe outbreaks led to total destruction to the crops [12]. Efforts to control insect pests of wheat and barley as low-input cereal crops generally take a back seat to the more pressing problems of abiotic production constraints, such as heat, drought, low soil fertility and salinity[24].

The cereal leafminer, *Syringopais temperatella* Led. (Lep., Scythrididae) is reported in many countries [2-4, 6]. In the Middle East, *S. temperatella* is a major insect pest of wheat and barley, and it causes quantitative and qualitative damages through feeding on plant leaf tissues [3, 11, 15]. This insect is endemic to Jordan and was reported in the country more than 50 years ago [18]. *S. temperatella* was considered a non-serious pest on wheat and barley, but since 2001 the insect has become a destructive pest in the south of the country, especially Karak District and became as one of the major constraints to the wheat and barley production in Jordan [3, 4, 13]. Infestation has exceeded 90% in some fields in Jordan [23]. Such infestation was also mentioned by many researchers in other countries of the region [15, 20, 22, 27].

Moreover, many insecticides have been tested against this pest. In Jordan, Al-Zyoud [4] reported that diazinon, chlorpyrifos, imidacloprid and fenitrothion caused mortality higher than 90% to the pest under laboratory conditions. In Cyprus, diazinon, fenitrothion, phosphamidon and trichlorphon caused mortalities greater than 90% to the pest larvae [21]. In Turkey, Kaya [17] and in Iran, Jemsi and Rajabi [15] reported that diazinon proved effective against the pest larvae. The use of insecticides is neither economic nor sustainable, and has a negative impact on the environment, natural enemies and farmers. In addition, the use of insecticides has generally lagged due to cost constraints associated with wheat and barley as low-input crops [7]. Moreover, in Cyprus, *S. temperatella* has developed resistance to some insecticides [10]. Therefore, broad efforts to develop IPM strategies for the pest are urgently needed. One of the most economically effective and environmentally friendly control measures is the use of resistant

plant varieties [13]. However, to date and to the best of our knowledge, nothing is known and published about resistance of varieties for this pest in Jordan. Therefore, this study aimed to investigate susceptibility of the most commonly grown wheat and barley varieties in Jordan to *S. temperatella* under laboratory conditions. The outcome of this study will help in reducing the constraints to wheat and barley production caused by *S. temperatella* in Jordan through the development and application of an appropriate low-cost and environmentally acceptable IPM approaches.

Materials and Methods

Acquisition and maintenance of insects and plants: Stock culture of *S. temperatella* was maintained on wheat and barley plants in the tillering stage, in which first larval instars were collected at the beginning of crop infestation in Karak District. The infested plants were kept in mesh cages of 50 cm x 50 cm x 80 cm and held under laboratory conditions at the Faculty of Agriculture, Mu'tah University, Karak. The meshed cages were sealed with gauze from their sides and tops to provide adequate ventilation. In addition, each cage has a glass door for monitoring. Wheat and barley plants were grown in pots (12 cm in diameter) held in an air-conditioned glasshouse. The plants were grown without fertilizers and insecticides. The rearing were kept in two different meshed cages, in which the first cage contained the six varieties of wheat, and the second one contained the six varieties of barley. This step was necessary in order to reduce the possibility that *S. temperatella* might get adapted to a particular plant variety or crop. To maintain adequate host-plants supply for *S. temperatella* rearing, three potted plants from each variety of both crops were grown and frequently released inside the cages whenever needed. In total, 36 potted plants were used during the rearing. For the experiments, wheat and barley seeds were sown at two different dates. The first date was at November 28, 2007 and the second one at December 17, 2007. At each sowing date, two potted plants of each variety of both crops were grown. In total, 48 potted plants were used. The 20 days interval between the two sowing dates provided younger leaves of 70-75 day old, and older leaves of 90-95 day-old.

Obtaining the appropriate larval instars of S. temperatella for experiments: Two different groups of *S. temperatella* larvae were used in the experiments. The first group (early instars larvae) was consisted of the second (L_2) and the third (L_3) larval instars, while the second group (late instars larvae) was consisted of the fourth (L_4) and the fifth (L_5) larval instars. The appropriate larval instars of *S. temperatella* for the different experiments were randomly selected and then picked up gently by a camel hair-brush from the fore-mentioned rearing cages. After that, larvae were further checked under a binocular microscope to confirm their instars.

Experimental conditions and arenas: All experiments were conducted in a climatically controlled chamber at a temperature of 25±1°C, a relative humidity of 60±10% and a photoperiod of 12:12 (L: D). All the experiments were set up in Petri dishes of 5.5 cm in diameter. The Petri dishes were partially filled with 0.5 cm thick layer of wetted cotton pad, and the lid of each Petri dish had a hole closed with organdie fabric for ventilation. The Petri dishes were provided with wheat or barley leaf discs from the different varieties of known area for the larvae to feed on. Twenty replicates were used with each leaf age and larval group as well as plant species and variety.

Susceptibility of plant species and varieties to larval feeding: The susceptibility of 12 wheat and barley varieties was comprehensively investigated. Six varieties of each crop were used. The wheat varieties were Sham, Acsad 65, Horani Nawawi, Em-Qees, Horani 27 and Deer Alla, and the barley varieties were Mu'tah, Athroh, Acsad 176, Yarmuk, Rum 1 and Rum 2. Freshly picked leaves were punched from the different varieties using a blade. Leaf discs of 100 mm^2 area were provided for the early instars larvae (L_2 and L_3) as well as leaf discs of 200 mm^2 area were provided for the late instars larvae (L_4 and L_5) from each variety. Subsequently, each leaf disc was separately placed above the cotton pads in a labeled Petri dish, with either one early instar or late instar *S. temperatella* larvae for a period of two days. Hereafter, the larvae individuals were removed after 48 h, and the leaf area consumed was measured using leaf area meter.

Statistical analysis: All analyses were performed using the proc GLM of the statistical package SigmaStat 2.03 [26]. One factor analysis of variance was performed in order to analyze the data. Significant differences among several means were determined utilizing LSD test at 5% probability level. The t-test was used for comparisons between only two means [5].

Results

Results of susceptibility of wheat varieties showed that Horani Nawawi is the most susceptible variety recording total leaf area consumed by all larval instars of 24 mm^2 during 2 days, while Acsad 65 showed 18 mm^2 area of leaf consumption representing the least susceptible variety (Fig. 1).

Early instars larvae preferred old leaves in all wheat varieties except for Horani 27. The highest consumed leaf area from young and old leaves was from both Horani 27 and Horani Nawawi. Late instars showed the same preference to old leaves except for two varieties (Fig. 2). The highest damage of late instars larvae was recorded for Horani Nawawi. The situation is nearly the same in barley; old leaves are more preferred than young ones in all tested varieties (Fig. 3). Among the six barley varieties, Acsad 176 was the most susceptible variety to leafminer feeding while Athroh was the least susceptible one. Acsad 176 was the most preferred by both early and late instars larvae (Fig. 1). The net results for both early and late instars larvae feeding on both young and old leaves showed that barley crop is more susceptible to leafminer larval feeding than wheat crop (Fig. 4).

Discussion

Wheat and barley are the main important cereal crops grown in Jordan, but their yearly average yield is still low [1]. However, one of the major constraints to the production has been the *S. temperatella* attack [3]. It causes quantitative and qualitative damages through feeding on plant foliage. The infestation is increasing yearly in Jordan, where three areas were infested in 2001[23] compared to eighteen areas in 2006 [3].

Results showed that barley is more susceptible than wheat to leafminer. Such result can be explained by the nature of leaves. Differences of leaves in chemical composition, especially the oxalic

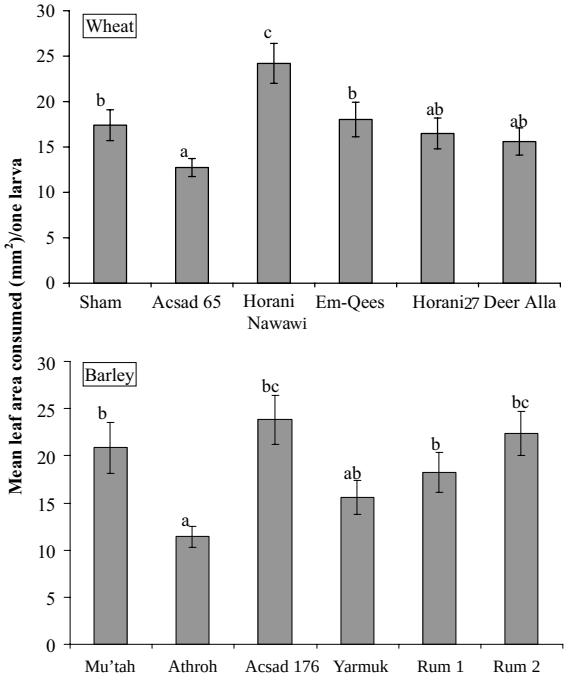

Figure 1. Mean (±SE) leaf area (mm^2) consumed by both early and late *Syringopais temperatella* larvae by feeding upon different wheat and barley varieties of both leaf ages during a period of two days at 25±1°C. Different letters above bars indicate significant differences among the different wheat varieties within the same leaf age at $p<0.05$ (one-factor analysis of variance).

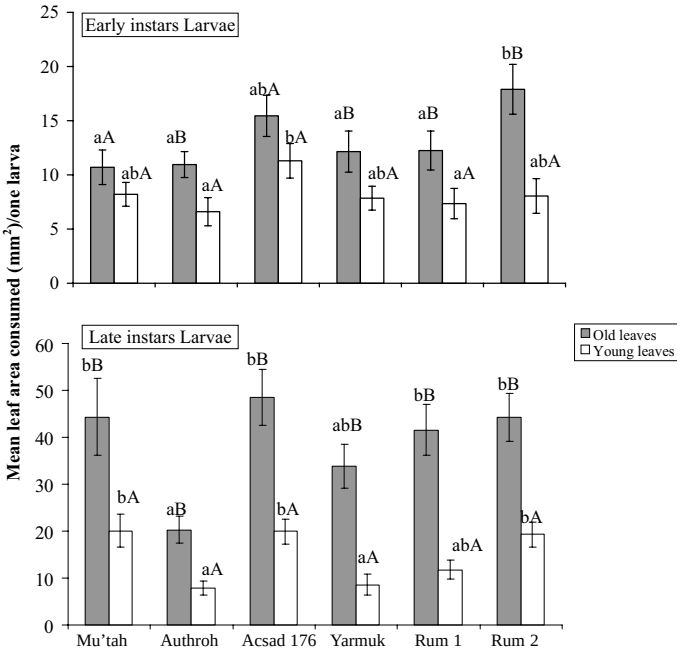

Figure 3. Mean (±SE) leaf area (mm^2) consumed by *Syringopais temperatella* larvae by feeding upon different barley varieties during a period of two days at 25±1°C. Different small letters above bars indicate significant differences among the different wheat varieties within the same leaf age and larval group, while different capital letters above bars indicate significant differences between the different leaf ages within the same barley variety and larval group at $p<0.05$ (one-factor analysis of variance).

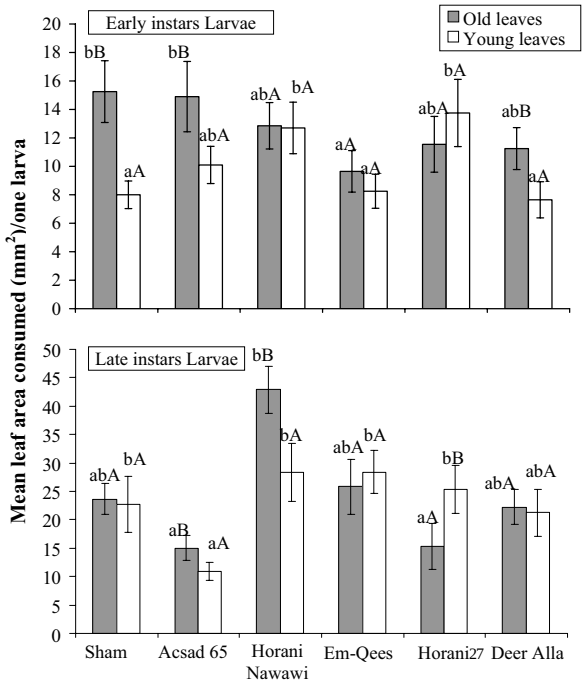

Figure 2. Mean (±SE) leaf area (mm^2) consumed by *Syringopais temperatella* larvae by feeding upon different wheat varieties during a period of two days at 25±1°C. Different small letters above bars indicate significant differences among the different wheat varieties within the same leaf age and larval group, while different capital letters above bars indicate significant differences between the different leaf ages within the same wheat variety and larval group at $p<0.05$ (one-factor analysis of variance).

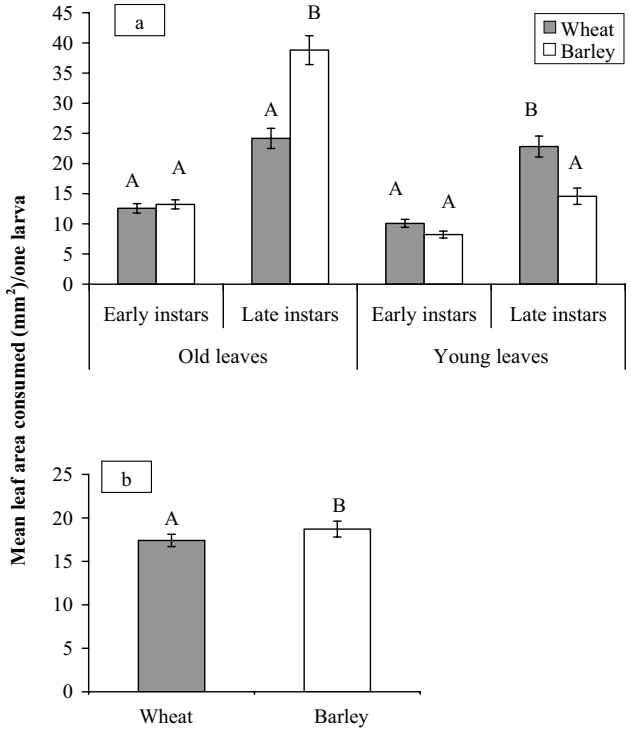

Figure 4. Mean (±SE) leaf area (mm^2) consumed during a period of two days at 25±1°C (a) by all larval instars of *Syringopais temperatella* from both leaf ages of wheat and barley. Different letters above bars indicate significant differences between wheat and barley within the same leaf age and larval group (b) by small and big larvae from both leaf ages of wheat and barley. Different letters above bars indicate significant differences between wheat and barley at $p<0.05$ (one-factor analysis of variance).

acid content, hairiness, hardiness and in leaf thickness are factors that may stand behind these differences in susceptibility. ICARDA researchers have found that leaf oxalic acid content was significantly higher in the least preferred varieties by the chickpea leafminer than in the most preferred ones [13]. Preference of larvae to old leaves was clear in the results. Thickness of such leaves form more suitable substrate for larvae to mine in than in young leaves. In addition, larvae of chewing mouth parts, in general, prefer hard tissues while insects with piercing sucking mouth parts prefer the succulent parts.

In conclusion, Acsad 65 and Athroh showed the least susceptible wheat and barley varieties, respectively, and can be used in Jordan to minimize the cereal leafminer damage and the number of insecticide sprays currently used against the pest. Finally, further studies are needed to analyze the leaf factors of wheat and barley varieties associated with such resistance or susceptibility.

References

[1]Agricultural Statistics 2006. Department of Statistics, Amman, the Hashemite Kingdom of Jordan.

[2]Al-Momany, A. and Mustafa, T. 1990. Garden and House Pests. Al-Dar Al-Arabia for Publishing and Distribution, Cairo, Egypt, 360 pp.

[3]Al-Zyoud, F.A. 2007. Investigations on certain biological and ecological parameters of the cereal leaf miner *Syringopais temperatella* Led. (Lep., Scythrididae). Bull. Fac. Agric. Cairo Univ. **58**:164-172.

[4]Al-Zyoud, F.A. 2008. Effects of direct spray and residual exposure of different insecticides on the cereal leaf miner *Syringopais temperatella* Led. (Lep., Scythrididae) under laboratory conditions. Jordan J. Agric. Sci. **4**(1):1-11.

[5]Anonymous 1996. Reference Manual of the Statistics Program for Windows Winstat. Kalmia Company Inc., Cambridge, MA, 267 pp.

[6]Daamen, R.A., Wijnands, F.G. and Vliet, G. 1989. Epidemic of diseases and pests of winter wheat at different levels of agrochemical input. J. Phytopath. **125**:305-319.

[7]Debach, P. and Rosen, D. 1991. Biological Control by Natural Enemies. Cambridge University Press, Cambridge, UK, 440 pp.

[8]Duran, M., Altinayar, G., Koyuncu, N. and Dortbudak, Y. 1979. Investigations on survival in the soil, crop loss and control measures relating to the cereal leaf-miner, *Syringopais temperatella* Led. in a cereal field in Isparta. Bitki Koruma Bulteni **19**:1-15.

[9]Fard, P.A. 2000. Loss evaluation of wheat leaf miner, *Syringopais temperatella* in Khuzestan Province. International Congress of Entomology, Brazil, p. 674.

[10]Georghiou, G.P. and Lagunes-Tejeda, A. 1991. The Occurrence of Resistance to Pesticides in Arthropods: An Index of Cases Reported through 1989. FAO, Rome, Italy, pp. 11-22.

[11]Gholamreza, R. 2002. Biology of cereal leaf miner *Syringopais temperatella* Led. in cereal post harvest period in Khuzestan province. 15th Iranian Plant Protect Cong, Iran.

[12]Harlan, J.R. 1992. Crops and Man. 2nd edn. American Society of Agronomy, Madison, Wisconsin, USA 284 pp.

[13]ICARDA Annual Report 2005. Mega-Project 2. Integrated Gene Management: Conservation, Enhancement and Utilization of Agro-biodiversity in Dry Areas. Cereal Leaf Miner: An Emerging Threat. ICARDA, Aleppo, Syria, 34 pp.

[14]ICARDA Annual Report 2007. Iraq-ICARDA-Australia Project: Better Crop Germplasm and Management for Improved Production of Wheat, Barley and Pulse and Forage Legumes in Iraq. 2nd Technical Report, ICARDA, Aleppo, Syria. 139 pp.

[15]Jemsi, G. and Rajabi, G. 2003. Study on harvesting agronomic measures and effect of chemical application in controlling the cereal leaf miner *Syringopais temperatella* Led. (Lep., Scythrididae) in Khuzestan province. Appl. Entom. Phytopath. **70**:13-15.

[16]Jemsi, G., Shojai, M., Radjabi, G. and Ostovan, H. 2002. Study on economic population dynamic, biology, host range and economic threshold of cereal leaf miner in Khuzestan. J. Agric. Sci. **8**(3):1-21.

[17]Kaya, O. 1976. The Cereal Leaf-miner, *Syringopais temperatella*. Report, CENTO Scientific Programme, pp. 49-50.

[18]Klapperich, J. 1968. Entomologisch und wirtschaftlich bedeutsame Schadinsekten in der jordanischen Landwirtschaft. J. Pest Sci. **41**(11): 164-168.

[19]Koyuncu, N. and Kurcman, M. 1977. Studies on the control of cereal leaf miner *Syringopais temperatella* Led. and of annual broad-leaved weeds with insecticide and herbicide combinations in cereal-growing areas. Bitki Koruma Bulteni **17**(1):60-73.

[20]Mamluk, O.F., Tahhan, O., Miller, R.H., Bayaa, B., Makkouk, K.M. and Hanounik, S.B. 1992. A checklist of cereal, food legume and pasture and forage crop diseases and insects in Syria. Arab. J. Plant Prot. **10**: 225-266.

[21]Melifronides, I.D. 1977. The cereal leaf miner, *Syringopais temperatella*, and its control in Cyprus. PANS **23**(3):268-271.

[22]Miller, R.H. and Ghannoum, M.I. 1994. Current distribution of wheat and barley insects in Syria and some implications for cereal pest management. Arab. J. Plant Prot. **12**:80-82.

[23]Mustafa, T. 2002. Cereal leaf miner: A destructive pest on wheat in Karak District. J. Agric. Eng. **71**:17-19.

[24]Osteen, C.D. and Szmedra, P.I. 1989. Agricultural Pesticide Use Trends and Policy Issues. Agricultural Economic Report No. 622, Washington DC, USDA, USA.

[25]Serghiou, C.S. 1975. Control of *Syringopais temperatella* in Cyprus. J. Econ. Ent. **68**(4):491-494.

[26]SPSS 1997. SIGMASTAT 2.03: SigmaStat Statistica Software User's Manual. Statistical Product and Service Solutions Inc., Chicago, United States.

[27]Vrieze, M. De. 2002. Interessante waarnemingen van Lepidoptera in Griekenland. Phegea **30**:41-47.