S.Ü. Ziraat Fakültesi Dergisi 18 (33): (2004) 39-43

YIELD LOSSES DUE TO DIURAPHIS NOXIA (KURD.) (HOMOPTERA: APHIDIDAE) DAMAGE ON CANARYGRASS IN KONYA PROVINCE OF TURKEY [1]

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ABSTRACT

Russian wheat aphid, Diuraphis noxia (Kurdjumov), although is an occasional pest for wheat and barley in Konya province of Turkey, it causes severe damage on canarygrass, Phalaris canariensis L. every year. To determine yield losses caused by D. noxia on this plant, trials were arranged as factorial experimental design with 14 replications for two years. The 14 canarygrass plots were weekly sprayed by oxydemeton-methyl at 200 cc /100 lt water and other 14 plots were left for natural aphid colonization. Aphid counting was done weekly during vegetation period. All yield components measured were significantly affected by D. noxia damage. The rates of reduction in these components were as follows: 81,7 % in grain yield, 57,1 % in panicula number per square meter, 55,43 % in grain weight per ten panicula, 43,97 % in grain number in panicula, 36,44 % in plant height, 26,95 % in 1000 kernel weight, and 11,03 % in panicula length. Only potassium level of the determined macronutrients (nitrogen, phosphorus and potassium) was significantly higher in infested plots than sprayed plots. As a result, canarygrass cultivation is not recommended for Konya province due to the economic losses attributable to D. noxia and possible threat to wheat cultivation.

Key words: *canarygrass, Russian wheat aphid, Diuraphis noxia, Phalaris canariensis, yield losses*

KONYA İLİNDE KUŞYEMİNDE DIURAPHIS NOXIA (KURD.) (HOMOPTERA:APHIDIDAE)' NİN NEDEN OLDUĞU VERİM KAYIPLARI

ÖZET

Rus buğday afidi, Diuraphis noxia (Kurdjumov), Konya ilinde buğday ve arpalarda sadece belirli yıllarda önemli zarara neden olurken, kuşyemine (Phalaris canariensis L.) her yıl çok ciddi zarar vermektedir.

D. noxia' nın bu bitkide neden olduğu verim kayıplarının belirlenmesi amacıyla çalışma, 1998 ve 1999 yıllarında tesadüf parsellerinde faktöriyel deneme desenine göre 14 tekrarlı olarak yürütülmüştür. 14 kuşyemi parseli oxydemeton – methyl ile 200 cc /100 lt su dozunda haftalık olarak ilaçlanmış, diğer 14 parsel ise doğal afit bulaşması için ilaçsız bırakılmıştır. Bitkinin vejetasyon gelişimi süresince ilaçsız parsellerde haftalık afit sayımları yapılmıştır. Sonuç olarak, ele alınan tüm verim kriterleri D. noxia zararından önemli ölçüde etkilenmiştir. Bu kriterlerdeki kayıp oranları; dane veriminde % 81,7, m^2'deki salkım sayısında % 57,1 ve 10 salkımdaki dane ağırlığında % 55,43, salkımdaki dane sayısında % 43,97, bitki boyunda % 36,44, bindane ağırlığında % 26,95 ve salkım uzunluğunda % 11,03 olarak belirlenmiştir. Makro besin elementlerinden (nitrojen, fosfor ve potasyum) sadece potasyum seviyesi afitle bulaşık parsellerde, ilaçlı parsellere göre önemli derecede daha yüksek çıkmıştır.

Sonuç olarak, Konya ilinde D. noxia ' ya bağlı verim kayıpları ve buğday üretimi için tehdit oluşturması nedeniyle kuşyemi tarımının ekonomik olmadığı kanaatine varılmıştır.

Anahtar kelimeler: *Kuşyemi, Rus buğday afidi, Diuraphis noxia, Phalaris canariensis, verim kayıpları*

INTRODUCTION

Canarygrass, *Phalaris canariensis* L. (Graminae: Phalaridae), is one of the seven *Phalaris* species distributed in different parts of the world. This spring sown species is cultivated mostly in USA, Mediterranean countries and Australia. Spain, Italy and Turkey are the main producer countries in Europe (Göçmen, 1997).

In Turkey, the highest cultivated area of canarygrass is estimated as 17,000 ha in last 50 years. At the present, it is cultivated only in Thrace (European part of Turkey) where *Diuraphis noxia* (Kurd.) (Russian wheat aphid) have not yet been recorded (Özder and Toros, 1999). In contrast, there is no noticeable canarygrass production in Konya province (Central Anatolian region) which named as “cereal store of Turkey ”. During a study aimed to ascertain whether this plant could be an alternate crop in rotation or not (Göçmen, 1997), it was firstly noticed that *D. noxia* reaches high population on canarygrass that it has not ever been seen on the other hosts.

P. canariensis, which remains green all summer long when winter varieties of small grains become dry, is the most preferential host and one of the two dominant alternate hosts of *D. noxia* in the Konya province (Elmalı, 1998). The population begins in tillering stage and peaks in heading stage on this plant (Elmalı, 1997).

Except for cited reports, the paper of Stoetzel (1987) is the only article recording *P. canariensis* as a host of *D. noxia*. There are some records for the other *Phalaris* spp. (Bodenheimer and Swirski, 1957; Kindler and Springer, 1989; Hammon et al., 1997). No research on *D. noxia* and *P. canariensis* could be traced.

Due to the fact it became a global problem in 1990s years, a lot of research was conducted on *D. noxia*. Many of them normally were about wheat and barley because of their economic importance.

Yield losses in wheat due to *D. noxia* in South Africa were reported as 21 % to 92 % (Hewitt, 1998), and above 90 % (Du Toit and Walters, 1984). By 1994,

[1] *The 1998's data of this study were accepted as M.sc. thesis of Tevfik Turanlı in 25,01,2000 by S.U. Graduate School of Natural and Applied Science*

economic losses due to *D. noxia* in the USA were in excess of 900 million $ since 1986 (Webster et al., 1994). Kieckheffer and Gellner (1992) studied the effect of low densities of Russian wheat aphid (RWA) on yield loss in winter wheat in USA and showed that the aphid could significantly reduce tiller number at densities 10 aphid/per plant. According to Riedell (1990), nitrogen fertilization, however, reduces yield loss due to infestation in wheat.

Miller and Haile (1988) recorded yield losses in wheat in Ethiopia as 68 % and in barley as 41 to 71 %. Calhoun et al. (1991) reported yield loss in spring barley artificially infested with RWA as up to 59 %. Robinson (1993) also studied on barley and determined that all agronomic traits measured were affected by RWA damage. During an epidemic occured in 1962 in Konya province of Turkey, RWA caused 25-60 % yield loss (Duran and Koyuncu, 1974).

Whereas RWA is an occasional pest for wheat and barley in the province, it causes considerable damage on canarygrass every year. Present study was conducted to determine yield losses of RWA on *P. canariensis*.

MATERIAL AND METHODS

The study was arranged in randomized complete block design with 14 replications. Sowing date was mid April in 1998 and 1999. The plots were fertilized with 3 kg P_2O_5 / da (as triple super phosphate, 42-44 % P_2O_5) and 4,3 kg N/da (as ammonium sulphate, 21% N) at sowing, and irrigated at least 4 times.

After germination in the end of May, 14 canarygrass plots were weekly sprayed by a systemic insecticide, oxydemeton - methyl, in 200 cc/100 lt water rate. The lower doses were not enough to control the aphid. In the other 14 unsprayed plots, aphid counting was continued till the plants become dry. Ten shoots were randomly taken from each replication, and *D. noxia* numbers in all parts of the plant were recorded.

At the heading stage, due to the special anatomy of canarygrass panicula, some difficulties appeared in aphid counting. When panicules immersed to 15 % propyl alcohol and shaked, nearly all aphid specimens were passed to the liquid and consequently, counted directly. This method can also be useful in aphid counting on the other plants which have same flower type and other concealed plant tissues.

Plants were harvested in the first week of August in both years. Some measurements and observations were made according to Göçmen (1997), to determine yield losses of RWA on plant and some morphological differences. These were as follows: plant height, panicula number per square meter, grain number per panicula, grain weight per ten panicules, grain yield and 1000 kernel weight.

The determine macronutrient levels of grain, grain samples were digested in a sulphuric acid (H_2SO_4) + hydrogen peroxide (H_2O_2) mixture. In the digest, nitrogen was determined by the micro – Kjeldahl procedure, phosphorus by the Barton method and potassium by the flame emission photometry (Jackson, 1967).

The data were analyzed by ANNOVA appropriate in randomized complete block experimental design using MINITAB packed programme.

RESULTS AND DISCUSSION

Population development of *D. noxia*:

The occurence and population development period of *D. noxia* were quite similar in different years (Fig.1). It was first recorded on June 8, 1998 and June 3, 1999. However, the population level was generally higher in 1998 than 1999. Peak point was observed on July 20, as 123,64 aphid/shoot in first year, whereas it was only 76,58 aphid/shoot on July 15, 1999. This peak period was in accordance with the heading stage of the canarygrass. In both years, the number of natural enemies of the aphid was very low. Only parasitoids , *Diaretiella rapae* (M'Intosh), but especially aphelinids , were noticeable compared to the other rare enemies.

Yield loss tests

All yield components tested varied significantly (P<0.01) between sprayed and infested plots (Table 1).

Plant height: In sprayed plots, plant height was 59,05 cm as average of two years, whereas in the infested plot it was only 37,53 cm. That means plant height was reduced by RWA in the rate of 36,44 % (Table 1).

Kieckheffer and Gellner (1992) established the deleterious effect of small numbers of *D. noxia* on height of wheat. Robinson (1993) also reported the plant height in barley was decreased by the aphid.

Panicula length: Panicula length is a yield component which is effective on yield by grain number per panicula. For this component an average reduction of 11,03 % was determined in infested plots. Panicula length was 2,50 cm in infested plots, whereas it was 2,81 cm in sprayed plots.

Panicula number per square meter: For panicula number per square meter, the difference between sprayed and infested plots was also significant (P<0.01). It was 97,9 and 42 respectively. A reduction of 57,1 % was determined as a result of *D. noxia* damage. The number of shoots which will give panicula, may be decreased by *D. noxia* feeding. Kieckheffer and Gellner (1992) reported a reduction in tiller number for wheat even at low densities of RWA.

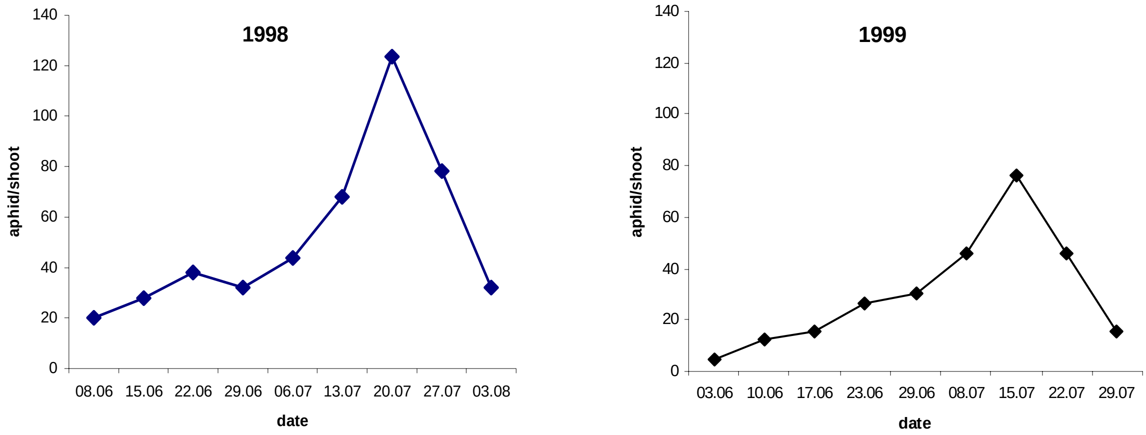

Figure 1. Population development of *Diuraphis noxia* in unsprayed canarygrass plots in different years.

Table 1. Comparison of yield components in *Diuraphis noxia* infected and sprayed canarygrass plots

Measurements and Observations	Infested Plots			Sprayed Plots			Yield loss rate (%)
	1998	1999	mean	1998	1999	mean	
Plant height (cm)	35.84 ± 1.5 *	39.22 ± 1.8 *	37.53	56.00 ± 1.9 *	62.10 ± 1.3 *	59.05	36.44
Panicula length (cm)	2.48 ± 0.06 *	2.52 ± 0.05 *	2.50	2.74 ± 0.07 *	2.88 ± 0.07 *	2.81	11.03
Panicula number (per m^2)	37.9 ± 3.4 *	46.09 ± 4.1 *	42.0	96.9 ± 5.3 *	98.9 ± 4.3 *	97.9	57.1
Grain number in panicula	12.05 ± 1.3 *	22.08 ± 1.5 *	17.06	28.88 ± 2.2 *	32.02 ± 1.8 *	30.45	43.97
Grain weight per ten panicula (g)	12.2 ± 1.2 *	16.1 ± 1.2 *	14.15	28.4 ± 2.2 *	35.1 ± 2.6 *	31.75	55.43
Grain yield (kg.da^{-1})	3.59 ± 1.8 *	11.08 ± 1.2 *	7.34	32.05 ± 2.2 *	48.05 ± 1.9 *	40.05	81.7
1000 kernel weight (g)	4.93 ± 0.16 *	5.16 ± 0.12 *	5.04	6.46 ± 0.1 *	7.34 ± 0.11 *	6.90	26.95

* *Significantly different (P<0.01)*

Panicula number per square meter is one of the most three important yield components in cereals. In the present study, the reduction in this component was one of the main reasons of the yield losses in infested plots. In these plots, a great number of plants dried without giving panicula due to initial infestation of *D. noxia* in 4-5 leaf-stage of canarygrass. A significant reduction in spike number were reported for wheat (Gray et al., 1990; Kieckheffer and Gellner, 1992) and barley (Calhoun et al., 1991; Robinson, 1993).

Grain number per panicula: The reduction in grain number per panicula was 43,97 %. The numbers averaged as 30,45 and 17,06 in sprayed and unsprayed plots, respectively.

Grain number per ear (panicula) is very important component affecting yield directly together with panicula number per square meter (Darwinkel, 1978). Decreased grain number in panicula of infested plants was partly related with the reduction of panicula length in the plots.

Grain weight per ten panicula*:* There was significant difference between sprayed and infested plots. This component was decreased in the rate of 55,43 % by the damage. It was found in grain per ten panicula as 14,15 g and 31,75 g in infested and sprayed plants, respectively. Of the seven components tested, this component was one of the three which showed the highest reduction rates due to *D. noxia* feeding.

1000 kernel weight: 1000 kernel weight was also significantly (P<0.01) affected by *D. noxia* damage. This component was 26,95 % lower in infested plots than that of the plots without aphid. The mean kernel weights in sprayed and unsprayed plots were 6,90 and 5,04 g, respectively.

Kernel weight was significantly reduced by *D. noxia* in wheat (Gray et al., 1990; Kieckheffer and Gellner, 1992). In barley, while Calhoun et al. (1991) did not find a significant effect, Robinson (1993) reported an effect on kernel weight especially in susceptible barley genotypes.

Grain yield: Of the seven components tested, the highest loss rate was measured in grain yield. The mean reduction of grain yield by *D. noxia* was 81,7 % on canarygrass. In 1998, it was 89 % due to higher population of *D. noxia*.

The mean grain yield was 40,05 kg.da $^{-1}$ in sprayed plots, whereas it decreased to 7,34 kg.da $^{-1}$ in infested plots. It was already known that the seed yield of canarygrass was lower than the other small grains (Robinson,1979). Even at low densities, *D. noxia* was able to reduce seed yield significantly (Gray et al., 1990; Kieckheffer and Gellner, 1992). Calhoun et al. (1991) determined grain yield reductions of 59 % in spring barley. Robinson (1993) obtained similar results for susceptible barley genotypes but reduction of grain yield was lower (20 %) in resistant ones.

Macronutrient levels

Of the macronutrients tested, only potassium level differred significantly beetwen sprayed and infested plots (P<0.05). The differences of nitrogen and phosphorus levels were not significant (Table 2).

Table 2. Macronutrient levels of canarygrass grains in *Diuraphis noxia* infested and sprayed canarygrass plots

Macronutrients (%)	Infested Plots			Sprayed Plots		
	1998	1999	mean	1998	1999	mean
Nitrogen	3.30 ± 0.08	2.80 ± 1.03	3.05	3.22 ± 0.08	2.72 ± 0.04	2.97
Phosphorus	0.16 ± 0	0.19 ± 0	0.18	0.18 ± 0.01	0.21 ± 0.01	0.2
Potassium	0.59 ± 0.01 *	0.64 ± 0.01 *	0.62	0.54 ± 0.01 *	0.58 ± 0.01 *	0.56

* *Significantly different (P<0.05)*

The potassium level was a little higher in infested plots in both years than of sprayed plots. The mean values were 0,56 % and 0,62 % in sprayed and infested parts, respectively.

As a result of *D. noxia* damage through removal of organic compounds and especially plant tissue damage by salivary components injected during feeding, physiological activity of plants seriously decline. These damaged plants are forced to produce grain prematurely. Grains of infested plants are weak and their corbohydrate level is low due to reduced photosynthetic efficiency. In weak grains, the rate of grain shell increases. In cereals the potassium level of shell is higher than these of other parts of grain (Kün, 1985). The increase in potassium level of grain on infested plants may be related to higher potassium content of the shell.

In conclusion, *D. noxia* damage significantly affected canarygrass productivity in terms of grain yield, panicula number per square meter, grain weight per ten panicules, grain number per panicula, plant height, 1000 kernel weight and panicula length. The potassium content of grain slightly increased in infested plants. It was concluded that to take an average yield on canarygrass in Konya province, insecticides should be weekly applied at higher doses than the recommended. Disadvantages of pesticide using both economically and environmentally are well known. In addition, canarygrass is oversummering host of RWA which may be source of a serious threat for wheat production. Finally, canarygrass cultivation is not suitable in Konya province, " the cereal store of Turkey ", in crop rotation due to the cumulative economic losses attributable to *D. noxia* and possible risks to wheat cultivations.

ACKNOWLEDGEMENTS

We thank Professor Dr. Bayram Sade, Assoc. Prof. Dr. Süleyman Soylu and Research Assistant Ahmet Şahbaz for assistance with general aspects of the work.

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