



Relationship between barley varietal susceptibility to herbicides and aphid attack

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Abstract

The present study was conducted at the Institute of Agriculture in Karnobat, Bulgaria, in the period 2011-2014. After experiments on barley varietal susceptibility to certain herbicides it was determined that there were clear differences in the aphid population for each variant. It was reported that aphids prefer barley varieties treated with certain herbicides and doses. No aphids were found in barley varieties, not treated with herbicides. Dependence was established between the values of chlorophyll a+b and chlorophyll a / chlorophyll b and aphid attack. At higher values of these indexes the aphid attack was greater.

Key words: aphids, herbicide, barley

Introduction

Barley (*Hordeum sativum* J.) is a major feed crop, but its grain is widely used in brewing, food, confectionary, distillery, leather and other industries (Граматииков и кол., 2004).

Cereal crops of flat sowing are high-risk crops considering the losses from weeds and pests. Pooled data from many studies indicates that winter cereals of flat sowing and of average weed infestation decreased its yield by 15-25 %. According to Gospodinov (Господинов, 1987) the yield of winter barley decreases by up to 35 % at average weed infestation (381 *weeds/m²* and fresh weed biomass of 885 *g/m²*) and up to 15 % at relatively average level (78 *weeds/m²* and 339 *g/m²* fresh biomass). To obtain a stable yield in the conventional agriculture, weed control is realized through application of various herbicides. Kubines (1990), Arends, Pegg (1990), Lancikova (1992) established varietal susceptibility of barley to herbicides. It is therefore considered that to study how herbicides affect the crop is a necessary condition before it is introduced in agriculture (Uresei, 1969; Beck, 1970; Stefanic, 1970; Paeschke, 1976).

The quality and quantity of yield can be also significantly reduced by a good number of insects (Григоров, 1963; Chiang, 1978), among which are the economically significant aphids (Homoptera: Aphidinea). While feeding, they injure the plant tissues by sucking juice from them and thus adversely affect vital functions, cause twisting and drying of leaves and the growing tip, delay plant growth and development (Григоров, 1980). These

insects also have great significance as vectors of a great number of plant viruses (Bujaki and Szalay-Marzso, 1995; Bujaki, 1996; Darwish, 1989; Hand and Carrillo, 1982; Serini and Lozzia, 1996; Ковачевски и кол. 1999; Chapin, et al., 2001). In Bulgaria barley is mainly attacked by *Rhopalosiphum padi* L., *Rhopalosiphum maidis* Fitch., *Schizaphis graminum* Rond. and *Sitobion avenae* F. (Григоров, 1980; Манева, 2010). It is possible to change the distribution dynamics of their populations through the use of some herbicide groups. Studies suggest that the use of herbicide 2,4-D increases the density of aphids, while combined use of Malathion and 2,4-D shows no clear results (Cauad, Y. Zool, 1969).

The scarcity of studies on the impact of herbicides on the population dynamics of barley aphids in Bulgaria necessitated this investigation.

Material and Methods

The study was conducted at the Institute of Agriculture in Karnobat, Bulgaria, over the period 2011-2014. In order to test the selectivity of various herbicides to new barley varieties was conducted a field trial of a 2-level factorial design. According to the methodology of the European and Mediterranean Plant Protection Organization (PP 1/93 (2)) with single and double doses of 4 herbicides (with active substances: 25 g/l Iodosulfuron + 106 g/l Amydosulfuron - **B1**; 150,2 g/kg Florasulam + 300,5 g/kg Aminopyralid acid - **B2**; 250 g/kg Tribenuron methyl + 250 g/kg Thifensulfuron methyl - **B3**; 45g/kg pinoxaden + 5 g/kg florasulam - **B4**) were treated 9 barley varieties (Emon, Lardeia, Orfei, Vanesa, Kristi, Viki,

Krami, Kaskadior, Aheloi 2). To compare the selectivity of barley were set untreated control plots. The trial was set by the block method with size of the experimental plot of 10 m² in 4 replications. The set plots were used to study the attack of aphids. The number of aphids was determined by direct counting on 100 barley stems in each variety during the spring vegetation period in every 7-8 days. The taxonomic analysis of aphids was carried out according to Emden (1972) and Blackman & Eastop (1984).

After the barley was treated with herbicides the photosynthetic pigments were recorded, through extraction with 85 % acetone, their extinctions were established by Spekol 221, and their content was estimated according to McKinney (1941).

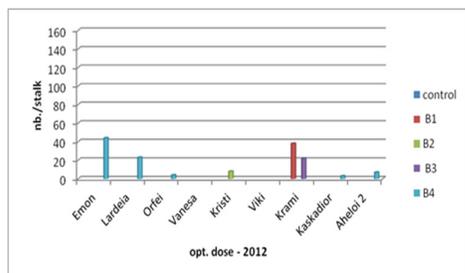


Figure 1(a) . Population dynamics of aphids in barley varieties treated with herbicides

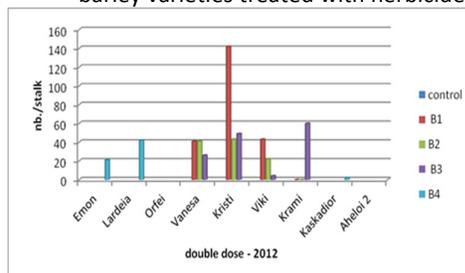


Figure 1(b). Population dynamics of aphids in barley varieties treated with herbicides

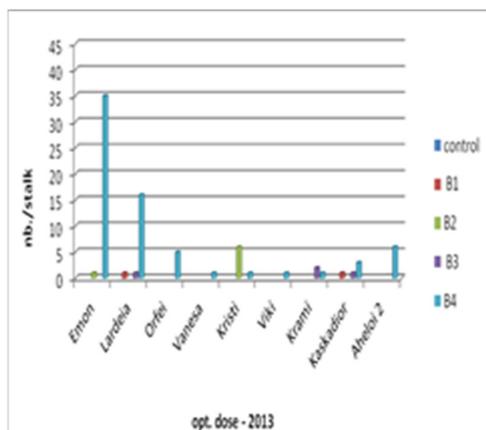


Figure 1(c). Population dynamics of aphids in barley varieties treated with herbicides

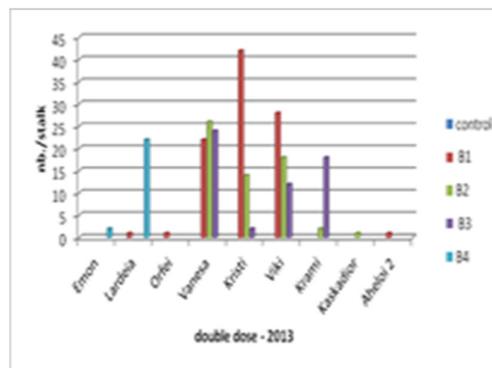


Figure 1(d). Population dynamics of aphids in barley varieties treated with herbicides

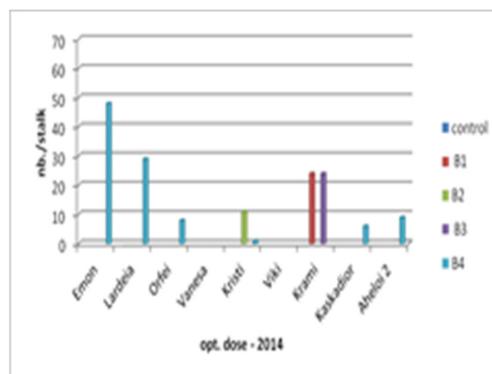


Figure 1(e). Population dynamics of aphids in barley varieties treated with herbicides

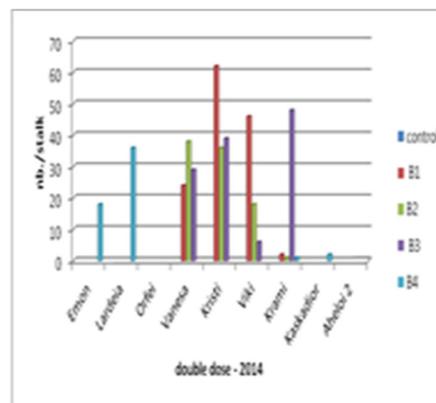


Figure 1(f). Population dynamics of aphids in barley varieties treated with herbicides

Results and Discussion

After a trial was set to test the varietal susceptibility of barley to some herbicides, clear differences were established in the aphid population dynamics in the different variants. During the three years of observation no aphids were found in the controls (untreated with herbicides) of all the variants (Fig.1). After application of optimal and double doses of B4

were seen the following results: in 2012 at the Emon variety aphids reached 44 aphids/stem after an optimal dose and 21 aphids/stem after a double. In 2013 and 2014 the tendency remained the same – respectively 35 and 48 aphids/stem after an optimal dose and 2 and 18 aphids/stem after a double dose. With the Orfei variety the aphid fecundity was lower, but the tendency remained the same – after an optimal dose in each of the three years aphids were reported to be with density of 4 aphids/stem - 2012, 5 aphids/stem – 2013 and 8 aphids/stem – 2014. After application of double doses no aphids were found (Fig.1). With the Kaskadior variety in 2012 the difference in aphid population numbers after the two B4 treatment doses was insignificant – 3 aphids/stem after an optimal and 2 aphids/stem after a double dose. In 2013 and 2014 aphids were only found after the optimal dose –3 and 6 aphids/stem respectively (Fig.1). The Aheloi 2 variety was treated with B4 in two doses and aphids were only found in the optimal dose – 7 aphids/stem– 2012, 6 aphids/stem– 2013 and 9 aphids/stem– 2014 (Fig.1). After a two-dose treatment with B4, the Lardeia variety showed a higher number of aphids in the double dose. In 2012 aphids were counted in the optimal dose – 23 aphids/stem, and in the double – 42 aphids/stem. In 2013 and 2014 the tendency remained the same – 16 and 29 aphids/stem in the optimal dose and 22, 36 aphids/stem in the double dose respectively (Fig.1). With Emon, Orfei, Kaskadior and Aheloi 2 was observed higher aphid population dynamics after their treatment with optimal dose B4 (Fig.1). With Lardeia the tendency was the opposite – the aphid population was higher after the double dose of B4 (Fig.1). With the other barley varieties were found no aphids at all or just single aphids (Fig.1). Different aphid population dynamics of the B4-treated varieties provided evidence for the different response of barley varieties to herbicide.

The used herbicide with active substances B4 is combined – for gramineous and broadleaf weeds.

The quantity and relations of the photosynthetic pigments may have limited impact on the net photosynthetic rate (Василев и Лечева, 2003). Although there is no linear relationship between the absorption of light energy from the leaves and the amount of pigments (Terry, 1980), the sharp decrease of the latter may limit the net photosynthesis rate to a certain extent (Василев и Лечева, 2003).

An analysis was carried out on the photosynthetic pigments of the varieties after B4 treatment (Fig. 2a). There was an apparent difference in the content of chlorophyll a+b, carotenoids, chlorophyll a / chlorophyll b, chlorophyll a+b / carotenoids. With the four varieties - Emon, Orfei, Kaskadior and Aheloi 2, the amount of chlorophyll a+b and chlorophyll a / chlorophyll b was higher in the optimal dose. While with the Lardeia variety the indexes were higher in the double dose. The amount of carotenoids and chlorophyll a+b / carotenoids in the five investigated varieties was higher (Fig. 2a). A dependency was observed between the values of chlorophyll a+b and chlorophyll a / chlorophyll b and aphid attack. At higher values of these indexes the aphid attack is also greater. Probably it is due to the increase of net photosynthesis and the synthesis of more nutrients for aphids.

After nine barley varieties were treated with herbicides with active substances – B1, B2 and B3 (all for broadleaf weeds) in single and double doses, only four of the varieties (Vanesa, Kristi, Viki and Krami) showed clear differences in aphid attack (Fig. 1). Over the three years of observation the Vanesa variety was not attacked by aphids in the variants treated with optimal doses B1, B2 and B3 (Fig. 1).

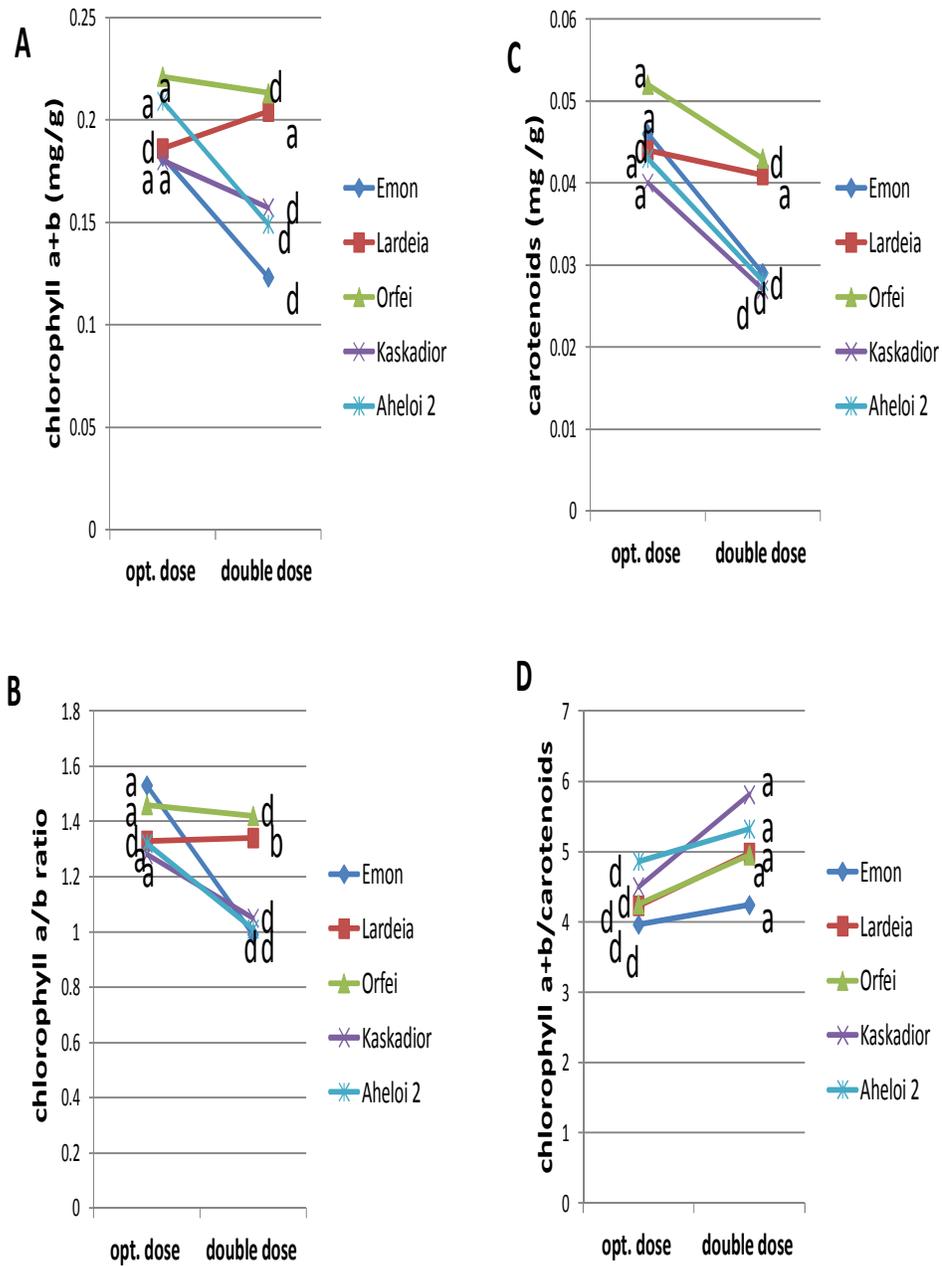


Figure 2 (a). Influence of different herbicides on both content (A, C) of and ratios between (B, D) photosynthetic pigments in the leaves of barley cultivars. In the figure, different letters (a, b, c, d) express significant differences between treatments ($P=95\%$), with „a” representing the highest value

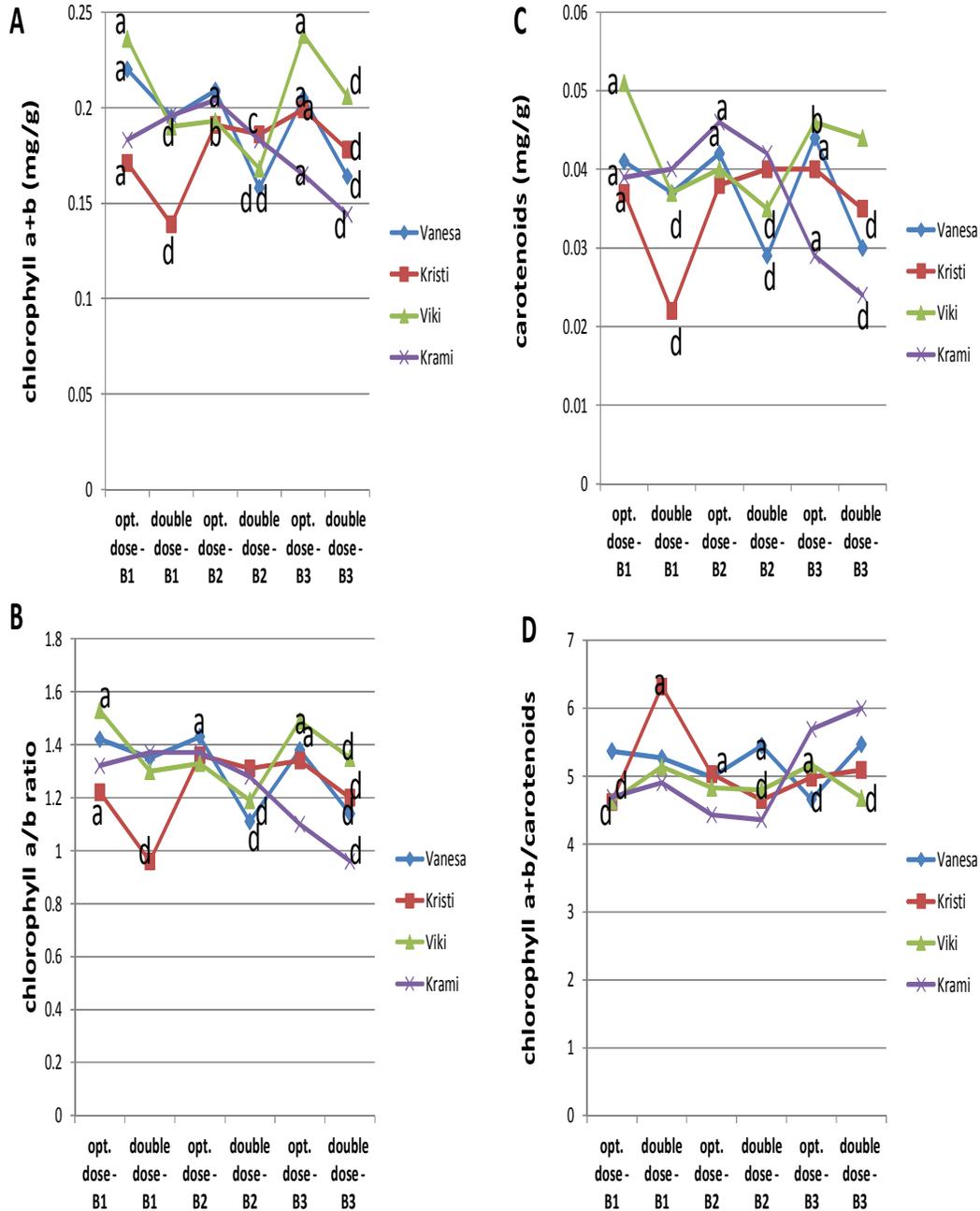


Figure 2 (b). Influence of different herbicides on both content (A, C) of and ratios between (B, D) photosynthetic pigments in the leaves of barley cultivars. In the figure, different letters (a, b, c, d) express significant differences between treatments (P=95%), with „a” representing the highest value

was seen after the double dose of B1 – 142 aphids/stem– 2012, 42 and 62 aphids/stem– 2013 and 2014. (Fig. 1). With the Viki variety the tendency was the same – the greatest aphid attack was in the double doses, and with B1 the density was largest in the three years – 43, 28 and 46 aphids/stem (Fig. 1). With the Krami variety was seen the opposite tendency – in the optimal dose of B1 the aphid density was higher than in the double (Fig. 1). With B2 were only found single

With the double doses was observed increased density of aphids and the highest values in the three years the aphids reached at B2 – 41aphids/stem in 2012 and 26 and 38 aphids/stem in 2013 and 2014 respectively. (Fig. 1). Higher aphid population was also observed

after the double doses of treatment with B1, B2 and B3 for the Kristi variety. The largest density

was seen after the double dose of B1 – 142 aphids/stem– 2012, 42 and 62 aphids/stem– 2013 and 2014. (Fig. 1). With the Viki variety the tendency was the same – the greatest aphid attack was in the double doses, and with B1 the density was largest in the three years – 43, 28 and 46 aphids/stem (Fig. 1). With the Krami variety was seen the opposite tendency – in the optimal dose of B1 the aphid density was higher than in the double (Fig. 1). With B2 were only found single

aphids after the double dose (Fig. 1). With B3 the density was higher in the double dose, reaching up to 60 aphids/ stem in 2012, 18 in 2013 and 48 aphids/stem in 2014 (Fig. 1).

After an analysis of the photosynthetic pigments, higher values were observed for chlorophyll a+b, carotenoids, chlorophyll a / chlorophyll b at optimal doses of treatment with B1 and B2 of Vanesa, Kristi and Viki varieties (Fig. 2b). With the Krami variety the values in the optimal dose of chlorophyll a+b, carotenoids, chlorophyll a / chlorophyll b and chlorophyll a+b / carotenoids were lower than in the double (Fig. 2b). With the varieties treated with B3 in an optimal dose, Vanesa, Kristi and Krami varieties has apparently lower values of chlorophyll a+b, carotenoids, chlorophyll a / chlorophyll b and chlorophyll a+b / carotenoids, than in the double (Fig. 2b). With the Viki variety the values of the above indexes were higher after the double dose of treatment with B3 (Fig. 2b).

The difference in aphid attack in different variants of the experiment showed the varietal reaction of barley to the herbicide group. Since in none of the controls was reported significant aphid density, it can be assumed that the attack was caused by the reaction of different varieties to the group of applied herbicides after single and double doses. The herbicides with active substances – B1, B2 and B3, in double doses, held the barley growth at stage tillering-end to stage 1-2 node. It ripened later and remained green and suitable for aphid food for a longer time, which explains the largest quantity of photosynthetic pigments in the double doses of treatment, as well as the greater aphid attack. The varietal response to herbicides established the exception – the Krami variety, where the aphids had higher density after the optimal than after the double dose of B1.

Conclusions

- In the three years of study no aphids were found on barley varieties, untreated with herbicides.
- After treatment with herbicide of combined action (B4) at an optimal dose, higher aphid population dynamics was observed in the Emon, Orfei, Kaskador and Aheloi 2 varieties, and at double dose –in the Lardeia variety.
- After treatment with herbicides only against broadleaf weeds (B1, B2 and B3), aphids responded with an attack on the other four varieties – Vanesa, Kristi, Viki and Krami. After treatment with an optimal dose of B1 – the density of pests was higher with the Krami variety, and after treatment with B1, B2 and B3 in

double doses – the Vanesa, Kristi and Viki varieties.

- A dependency was observed between the values of chlorophyll a+b and chlorophyll a / chlorophyll b and aphid attack. At higher values of these indexes the aphid attack is greater.

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