

RELATIONSHIP BETWEEN HERBICIDE APPLICATION AND MINERAL NUTRITION OF SUNFLOWER

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ABSTRACT

Soil herbicides can influence directly the emergence and physiological processes of cultivated plants and weeds. These chemicals can also change processes of nutrient transformation, so can indirectly effect on mineral nutrition of plants. The aim of our experiment was to study the effect of different pre-emergence herbicides on mineral nutrition of two sunflower hybrids in a pot experiment. Experiment was set up in greenhouse. We examined changes of nitrogen, phosphorus, potassium and calcium content of Itanol and Rigasol PR sunflower hybrids. The applied herbicides were Afalon Dispersion (linuron), Galigan 240 EC (oxyfluorfen), Pledge 50 WP (flumioxazin), Proponit 720 EC (propisochlor) and Stomp 330 (pendimethalin) with the highest field suggested doses. Plants were grown for four weeks. Thereafter fresh- and dry weights, as well as N-, P-, K- and Ca concentration of shoot samples were measured. We established that fertilizers increased biomass and nutrient content of shoots in every treatment. Herbicides decreased fresh- and dry weight of four weeks age sunflower shoots in different extent, moreover influenced mineral nutrition of two hybrids unequally.

Key words: biomass-production, herbicides, nutrient content, pot experiment, sunflower

IZVLEČEK

POVEZAVA MED APLIKACIJO HERBICIDOV IN MINERALNIH GNOJIL PRI SONČNICAH

Varstvo pred pleveli ima pomembno vlogo pri gojenju sončnic. Rastline sončnic, stare od 4 do 6 tednov so namreč zelo občutljive na tekmovalnost plevelov. Kmetje herbicide navadno uporabljajo pred setvijo ali pred vznikom, za uporabo po vzniku pa na Madžarskem praktično nimajo registriranih herbicidov, ki bi jih lahko uporabljali pri gojenju sončnic. Talni herbicidi lahko neposredno vplivajo na vznik in fiziološke procese gojenih rastlin in plevelov. Te kemične snovi lahko spremenijo procese premeščanja hranil in tako posredno vplivajo na mineralno prehrano rastlin. Cilj naše raziskave je bil preučiti vpliv različnih herbicidov za uporabo pred vznikom, na učinkovitost gnojenja z mineralnimi gnojili pri dveh hibridih sončnic v lončnem poskusu. Raziskava je potekala v rastlinjaku v štirih ponovitvah. Preučevali smo spremembe vsebnosti dušika, fosforja, kalija in kalcija na dveh hibridih sončnic, Itanol in Rigasol PR. Herbicidi, ki smo jih uporabili v najvišji predlagani koncentraciji, so bili Afalon Dispersion (linuron), Galigan 240 EC (oxyfluorfen), Pledge 50 WP (flumioxazin), Proponit 720 EC (propisochlor) in Stomp 330 (pendimethalin). Rastline so rasle štiri tedne. Nato smo stehali maso svežih in posušenih rastlin in izmerili koncentracijo posameznih elementov, N-, P-, K- in Ca. Ugotovili smo, da so mineralna gnojila povečala biomaso in vsebnost hranil v poganjkih v vsakem

¹ PhD., Deák Ferenc str. 16, H-8360 Keszthely

² DSc., ibid.

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obravnavanju. Uporaba herbicidov je vplivala na zmanjšanje mase svežih in posušenih sončnic starih štiri tedne, a različno pri obeh hibridih. Hibrid Rigasol PR je bil bolj toleranten na herbicide kot hibrid Itanol. Herbicid Stomp 330 je najmočnejše zaviral dvig hranil v sončnicah, medtem ko je herbicid Afalon Dispersal povečal koncentracijo N-, P-, K- in Ca- v poganjkih.

Ključne besede: biomasa-proizvodnja, herbicidi, vsebnost hranil, lončni poskus, sončnice

1 INTRODUCTION

Weed control has a determining role in sunflower growing, because 4-6 weeks old plants are very sensitive to weed competition (Szentey 1994). Early weed competition may cause 50 % yield loss. The weed control can be made by agrotechnical or mechanical methods or by herbicides.

The farmers use chemical weed control mainly as presowing and preemergence herbicide treatments (Hunyadi *et al.* 2000, Benécsné 2002), we have hardly any licensed post-emergence herbicides in sunflower culture. Choosing the herbicide and dose the characteristics of the soil has to be taken into consideration, mainly humus- and clay content (Radvány *et al.* 1999).

Soil herbicides can influence directly the emergence and physiological processes of cultivated plants and weeds. These chemicals effected on microbiotic nutrient transformation in the soil hereby influence the mineral nutrition of cultivated plants (Fischl 1994). The effect of herbicides onto the soil processes has been investigated by a number of scientists, and it has been found that the different herbicides hinder or stimulate the different processes of the soil. It has been proved that pendimethalin hinder the first step of the nitrification – the oxidation of ammonium-ions to nitrites (Goring and Laskowski 1982).

The herbicides have a direct effect on the nutrient uptake of crops by the fact, that they have a certain influence on the biological processes of the cultivated plants. This has an importance, since the N-uptake is intensive during the initial growing period (Frank 1999). The sunflower is very sensitive to herbicide residues, the testing for this character is especially important. Similar to other cultivated plants, herbicide sensitivity of the various hybrids and varieties strongly differs (Nádasy *et al.* 2000, Dobozy and Lehoczky 2002, Lehoczky *et al.* 2002, Nádasy and Germann 2003).

The aim of our experiment was to study the effect of different preemergence herbicides on mineral nutrition of two sunflower hybrids in a pot experiment.

2 MATERIAL AND METHOD

The pot experiment was set up in greenhouse on May 2004; using 13.6 cm diameter pots filled with 1 kg air dried soil in each pot, in four replications. The experimental soil was clay lassivated brown forest soil from Keszthely. Two early ripening sunflower hybrids has been used: Rigasol PR and Itanol. We grew 6 plants per pot.

100 mg N, 100 mg P and 200 mg K was given in each of the pots in form of ammonium nitrate, superphosphate, 40%, and in potassium chloride, except for the absolute controls without fertilizer and herbicide.

The effects of five preemergence herbicides on the nutrient content of the plants were studied. They belong to five chemical groups and have different action mechanism (Table 1). They were sprayed onto the soil surface a day prior to sowing, in the highest dose recommended for field application converted to the pot size. The herbicide control and absolute control pots were not treated. We had 56 pots altogether.

Watering were given to meet 60% of water capacity, which is optimal for the sunflower. The plants were allowed to grow for 4 weeks then harvested and measured the fresh- and dry weight of the shoots. The N-content were measured by Kjeldahl method, of the P-content with spectrophotometer and the potassium and calcium content by flame-photometer.

The statistical analysis has been made using the SPSS computer program, two-factorial variance analysis.

Table 1: Herbicide treatments in the experiment

Herbicides	Active agent	Chemical group	Suggested doses on the field
Afalon Dispersion	linuron	urea derivatives	2 l/ha
Galigan	oxyfluorfen	diphenil-ethers	1 l/ha
Pledge	flumioxazin	phtalimide	0.08 kg/ha
Proponit 840 EC	propizochlor	chloro-acetanilides	2 l/ha
Stomp 330	pendimethalin	dinitro-anilines	4 l/ha

3 RESULTS AND DISCUSSION

Figure 1 shows, that fertilizers increased the plant biomass in all treatments. The fresh weight of plants without fertilizer was the lowest and the herbicide treatments more or less decreased also the fresh weights. The hybrids reacted differently to the herbicide treatments. All herbicides used decreased the fresh weight of Itanol, mostly the photosynthesis-hindering Afalon Dispersion, and least the Pledge 50 WP, followed by Galigan 240 EC and Stomp 330. The fresh weight of Rigasol PR non-significantly increased the Pledge 50 WP and Stomp 330, the lowest fresh weight has been found at the Afalon Dispersion treatment also in case of this hybrid.

Similar to the fresh weight also the dry weight changed both by nutrient and by herbicide treatments in relation to the controls (Fig. 2). The tendency of changes is the same than that of fresh weights. The Afalon Dispersion treatment considerably decreased also dry weight of the plants.

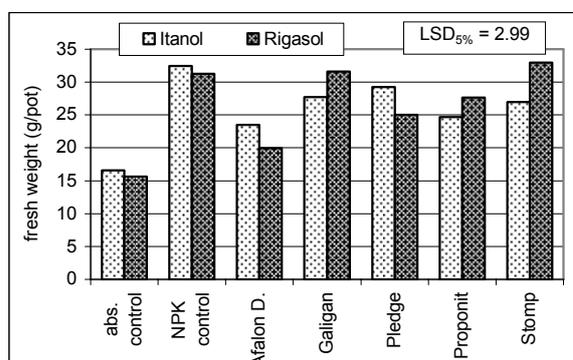


Fig. 1: Fresh weight of sunflower effect on herbicide treatments

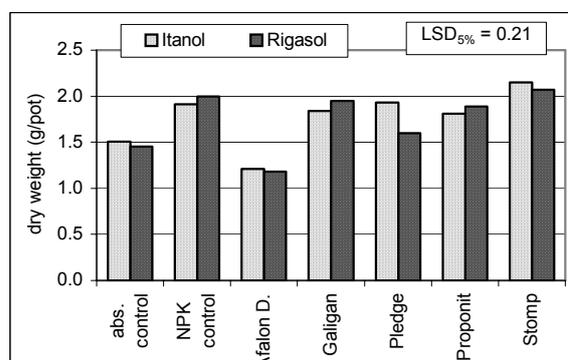


Fig. 2: Dry weight of sunflower effect on herbicide treatments

The plants without fertilization had the lowest N-content (Fig. 3). The mineral nutrition increased the N-concentration near to the double in case of the cultivar Itanol, and more

than double in case of Rigasol PR. The Rigasol PR took up more N that means, this hybrid needs more N, than Itanol. Interesting, that at both hybrid the herbicide Afalon Dispersion caused the highest N-concentration, probably because there was the lowest biomass production. In case of the hybrid Itanol the Stomp 330, while in case of Rigasol PR the Proponit 840 EC decreased mainly the N-content, but its value was statistically not significant.

The Figure 4 shows that the hybrid Rigasol PR utilized P better. As an effect, P-concentration of the shoots were statistically increased. It was surprising, that in the herbicide treatments the P-content did not decrease in relation to the NPK controls, moreover in case of Rigasol PR it increased significantly in the treatments with Afalon Dispersion and Galigan 240 EC. The highest P-content has been found using Afalon Dispersion, the lowest at Stomp 330, similar to that of N-concentrations.

The sunflower has a high potassium demand, this explains the high K-concentration and the considerably good effectivity of the fertilizers (Figure 5). The K-concentration of the shoots increased 30 % in relation to the non-fertilized absolute control plants. The herbicide treatments did not influence significantly the K-content, except for Afalon Dispersion treatment, which increased the K-concentration as a consequence of biomass decrease.

The role and uptake of Ca is antagonistic with that of K. In our experiment the Ca supply was the same for all pots, still we have found, that the Ca-content of control plants was much lower (Fig. 6). It can be explained by the fact, that the increasing NPK nutrient supply inspire the uptake of other nutrients, too, since the plant wants keeping the desirable rate of nutrients in the plant parts (Rajkainé 1999). The Ca-concentration of the shoots was about the half of that of K. The fertilized Rigasol PR had a higher Ca concentration than of Itanol, and this situation did not change significantly by the herbicide treatment.

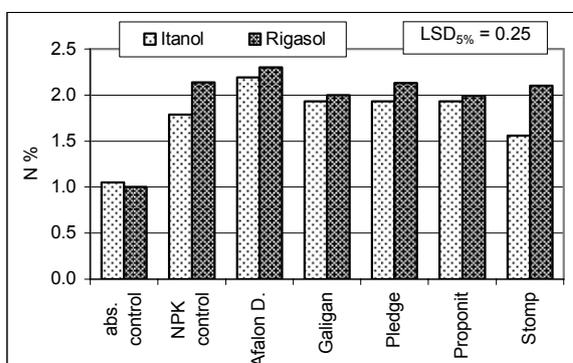


Fig. 3: N-concentration of sunflowers' shoots

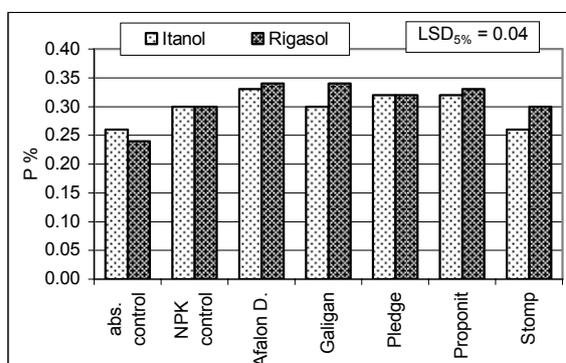


Fig. 4: P-concentration of sunflowers' shoots

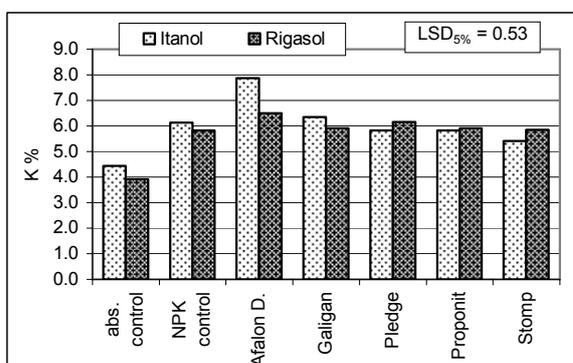


Fig. 5: K-concentration of sunflowers' shoots

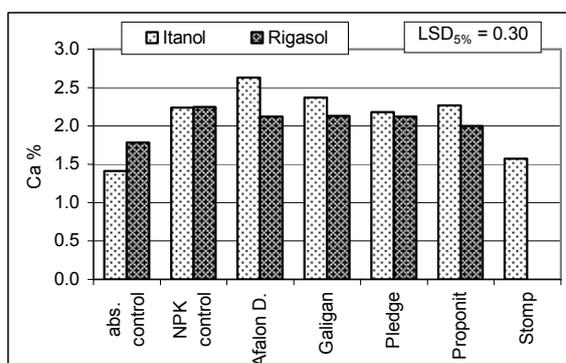


Fig. 6: Ca-concentration of sunflowers' shoots

4 CONCLUSIONS

Based on the results we can established that the fertilizers increased the biomass production and the nutrient uptake of sunflower hybrids in all herbicide treatments. The respond of Rigasol was stronger than that of Itanol.

The herbicides influenced mainly the fresh- and dry mass production. All herbicide treatment significantly decreased the fresh weight of Itanol. Both hybrids produced the lowest fresh and dry weight in the Afalon Dispersion treatment.

The macronutrient concentration was in a good correlation with the biomass production. The nutrient concentration of the plants with higher dry matter production was lower as a consequence of dilution of the nutrients. With this can be explained that in the Stomp 330 treatment the N-, P-, K-concentration of shoots of more sensitive Itanol decreased, while in case of Afalon Dispersion increased. The Galigan 240 EC, Pledge 50 WP and Proponit 720 EC had a lower influence on the macronutrient content. That means, that the hybrids decreased mainly the biomass production because of the herbicide treatments, and this influenced also the macronutrient concentrations.

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