UDC 632.51:93

Mechanical Factors of Influence on Biological Efficiency of *Solanum Nigrum L.*

O. O. Ivashchenko, O. O. Ivashchenko

Institute of Bioenergy Crops and Sugar Beet NAAS
25, Klinichna Str., Kyiv, Ukraine, 03141

e-mail: o_ivashchenko@ukr.net

Received on June 16, 2014

Aim. Studying of black nightshade young plants' response to the induced mechanical stresses. **Methods.** Researches conducted in small plot field experiments. **Results.** Change of sensitivity level of *Solanum nigrum L.* plants depending on phases of their development at the moment of damage of elevated parts has been proven. Owing to loss of the surface capable to photosynthesis, there is an essential decrease in volumes of photosynthesis at plants of weed survived and their possibilities of ontogeny passage. The deep induced dis-stresses reduce biological efficiency of plants, their ability to accumulate weight and to form seeds and even lead them to death. **Conclusions.** The defined principles of response of weed plants to the induced mechanical dis-stresses are can be used for working out and ecological receptions of crops protection from weeds.

Keywords: weed plants, sensitivity, development phase, dis-stress, dying off, biological efficiency.

INTRODUCTION

The role of each green plant in the phytocenosis, first of all, determines the part of its mass in the overall mass of such plant system components. The value of plants mass accumulation is directly proportional to the volume of products of photosynthesis effected by their overground parts. Consequently, negative influence of the weeds presence in sowings of agricultural crops causes the value of their mass accumulation, duration of joint vegetation, sharpness of competing for light energy, water, mineral nourishment, *etc*. [1, 2].

The part of mineral substances in the organic mass of cultural plants and Angiospermae weeds the (flowering plants) comprises from 3.5 up to 7.0 % on the average. The photosynthesis products in the organic mass of plants compose 93.0−96.5 % of their overall mass [3]. Specifically, volumes and productivity of the photosynthesis process are the major factors that determine the competitory ability of weeds in sowings of agricultural crops. Therefore, the basic directions of contemporary herbicides development provide also the opportunity of chemical blocking photosynthesis processes in the chlorenchyma cells. For example, blocking the acetolactate synthase ferment (ALS) [4−7].

The use of herbicides as the major factor of controlling the quantity of weeds is currently urgent in wide practice of agrarian production. However, the experience of constant use of herbicides, especially in contemporary technologies of cultivating cereal crops, except obvious advantages, revealed undesirable and even alarming tendencies. They include excessive atropous and, first of all, chemical load on the environment, harvest pollution with the herbicide residues, decrease in the level of protective actions effectiveness because of occurring and growing of the weeds resistance to the actions of herbicides, including broad spectrum ones [8].

The use of herbicides is limited or completely banned (prohibited) in urban areas, water-guarding zones, for green organic vegeteble production. The necessity to develop ecological and sufficiently effective systems for protecting agricultural crops without the use of manual labor grows. The creation of such crop protection systems is possible subject to knowing biological peculiarities of different forms of weeds and their reaction to the action the environment factors including induced dis-stresses [9−11]. Therefore, researching the reaction of the black nightshade stairs − *Solanum nigrum* L. − to the induced mechanical damages is urgent.

The study was made in the herbology laboratory of the Institute of Bioenergy Crops and Sugar Beet of the National Academy of Agrarian Sciences of Ukraine during 2008−2012.

MATERIALS AND METHODS

The experiments were carried out in the field divided into small sections. The area of one section was 7 m^2, the researches were made six times. The study aimed to cultivate weeds and contribute to them in sequential phases of stresses growth as a result of mechanical damages.

In order to research the reaction of black nightshade plants to the induced mechanical dis-stresses, in autumn at the pilot areas Nitrophoska under basic soil working calculating (112 kg/ha of N, P_2O_5 and K_2O each) was applied.

In spring black nightshade seeds were sowed into the prepared soil and turned up at a depth of 1.0−2.0 cm. After the weeds came up, the plants, were manually weeded and left 20 plants of one species on each square meter of the registered sections.

In order to evaluate the reaction of plants to the induced mechanical dis-stresses, (by cutting) from them overground parts were removed being in the initial stages of organogenesis (at a height 1.0−1.5 cm). The number of weeds seedlings was calculated before mechanical damages and in 10 days after them. The plants of black nightshade that survived after the induced stresses and went on their vegetation to the end of the vegetal period. Were cut on the soil surface and weighted to determine the value of the plants mass accumulation. We made calculations in the third decade of July. After the seeds ripened and at each re-applying we selected 10 plants of black nightshade and evaluated their seed productivity. The generalized results were processed statistically. All works in the experimental sections were carried out in accordance with the requirements of the Methodology of testing and applying pesticides dated 2001 [12].

RESULTS AND DISCUSSION

The black nightshade plants are typical annual late highly toxic form of weed that multiplies by seeds. The temperature of 8−10 °C is enough for its seeds to germinate. That is why, its massive seedlings traditionally coincide with the seedlings of warm-season crops: corn, sorghum, sunflower, soya, etc. In our country the black nightshade is the most extended in the zone of wooded plain and steppe, especially on the watered lands and

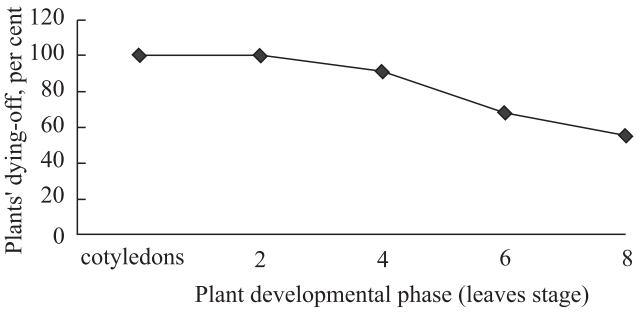

Fig. 1. Effect of the black nightshade plants' developmental phases' on the deepness of the stimulated mechanical dis-stresses (2008–2012)

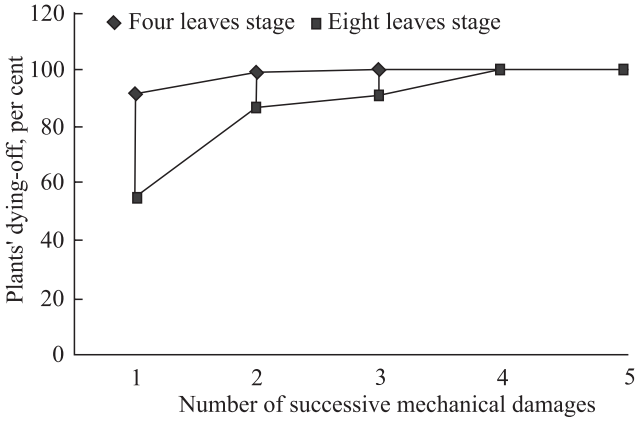

Fig. 2. Effect of the number of the successive mechanical damages (starting from four leaves stage) on the deepness of the dis-stresses with the black nightshade plants (2008–2012)

those situated along channels. Like other green autotrophic plants, for its successful growth and development, and in addition to the other factors of the environment like warmth, moisture, mineral substances, the black nightshade requires the availability of rather intensive energy flow of physiologically active solar radiation.

Above all, the research of the influence of mechanical damaging overground parts of black nightshade young plants provided the deprivation of their opportunity to take up and use light energy for the needs of photosynthesis. In the ontogenesis in the cavities of leaves young weed plants form collateral kidneys from the meristems, these collateral kidneys can be used in the process of vegetation for stems branching. This specific character of the anatomical structure of young black nightshade plants indicates the need of mechanical damages during the period when collateral kidneys have not yet been formed, or only starts.

During different growth and development phases one mechanical damage made to young black nightshade plants induced the unequal depth of dis-stresses in ex-

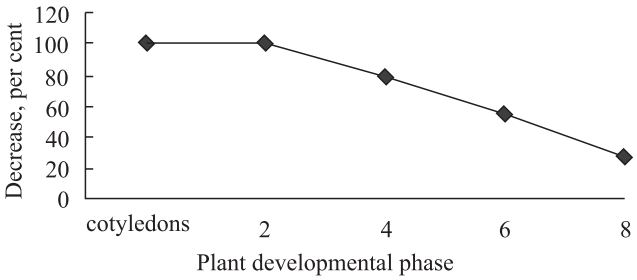

Fig. 3. Effect of the black nightshade plants' developmental phases on the weight elaboration at the moment of mechanical damaging (g/plant) (2008–2012)
The average weight of the black nightshade plants without any mechanical damages is 117 g/plant.

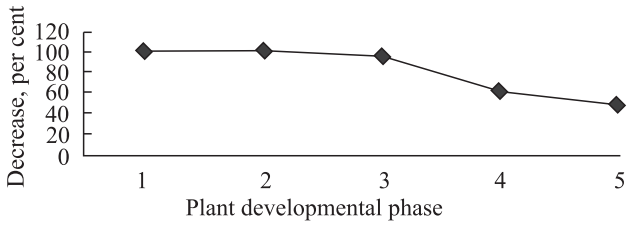

Fig. 4. Effect of the developmental phases at the moment of mechanical damaging on the seed productivity of the black nightshade plants (g/plant) (2008–2012)
The average seed productivity of the black nightshade plants without any mechanical damages is 0.88 thousand of seeds/plant.

perimental plants. Damaging plants overground parts during the phase of seed lobe leads to their subsequent complete extinction. For the losses of overground parts during the phase of two leaves the level of their extinction reaches 100 per cent (Fig. 1). As researched plants grow and develop their ability to overcome the induced dis-stresses rises. During the phase of eight leaves as a result of induced dis-stresses 55.4 per cent of their initial quantity dies off.

Sequential mechanical damages made to research plants strengthens the effect of the suppression of their growth and limitation of the volumes of photosynthesis products. Phases of of black nightshade plants development are of vital importance at the beginning of dis-stresses induction period. If in the phase of four leaves two sequential mechanical damages lead to extinction of 98.5 per cent of researched plants, in the phase of eight leaves it is only 86.4 per cent (Fig. 2). The following mechanical damages strengthen the effect of weeds oppression. After five sequential damages researched plants die off completely notwithstanding the phase of their development at present of the beginning of dis-stresses induction.

After obtaining deep dis-stress, black nightshade plants that survived underwent long oppression. New sheet plates were gradually formed from the surface part of stems and existing collateral kidneys after mechanical damages due to plastic substances the existing in the cloths. The plants that at the moment of mechanical damages have not yet formed collateral kidneys, died off. The increase in the area of the plants assimilation surface after their preliminary loss made it possible to gradually restore the synthesis of organic substances with the use of light energy. The volumes of photosynthesis products were not numerous; however, they ensured the survival of the researched plants parts. The biological productivity of researched plants in comparison with the ones under control that did not experience mechanical damages, decreased. The induced deep mechanical dis-stress limits the ability of weed plants to accumulate foliage.

As a result of inducing one mechanical dis-stress with black nightshade plants in the phase of two leaves, the ability to form mass was reduced to 100 per cent (Fig. 3) in the average, to 78.6 per cent, in the phase of four leaves, and respectively to 27.3 per cent in the phase of eight leaves.

Black nightshade plants that vegetated to the senile period of ontogenesis without any mechanical damages formed seeds in the amount of 0.880 pcs/plant in average, *i. e.*, such plants manifested maximum biological productivity that was achieved in the experiment (Fig. 4).

Mechanical dis-stresses suppressed the ability of the researched black nightshade plants to form seeds. The plants experienced damages in the phase of seedings coming out (seed lobes) died off and there was no subsequent growth and development. Mechanical dis-stress inducing in the phase of four leaves led to the reduction of the ability to form seeds on the average to 95.0 per cent, and only to 47.1 per cent during the phase of eight leaves.

Conclusions. It is determined that black nightshade plants are the most sensitive to induced dis-stresses in the earliest stages of organogenesis (cotyledon – two leaves). As the growth and development phases progress, the plants sensitivity to external factors and depth of dis-stresses formation gradually weakens.

Single mechanical damage of overground parts of young black nightshade plants induces dis-stresses and leads to considerable oppression of their vital activity and biological productivity. The substantial part of the plants under research cannot overcome induced deep dis-stresses and dies off. The plants that survived, de-

crease in the ability to form mass by 27.3−100 per cent and weaken their competitory ability.

One mechanical damage at the moment it is made induces deep dis-stress depending on the phase of the plants development and ensures reduction in the ability of black nightshade plants to form seeds up to 47.1–100 per cent of the level of controlled weed productivity.

Механічні фактори впливу на біологічну продуктивність *Solanum nigrum L*.

О. О. Іващенко, О. О. Іващенко

e-mail: o_ivashchenko@ukr.net

Інститут біоенергетичних культур
і цукрових буряків НААН України
Вул. Клінічна, 25, Київ, Україна, 03141

Мета. Вивчення реакції молодих рослин пасльону чорного на індуковані механічні стреси. **Методи.** Дослідження проводили в дрібноділянкових польових дослідах. **Результати.** Доведено зміни рівня чутливості рослин пасльону чорного залежно від фаз їхнього розвитку на момент пошкодження надземних частин. Внаслідок втрати поверхні, здатної до фотосинтезу, відбувається значне зниження обсягів фотосинтезу у рослин бур'яну, які виживали, і їхньої спроможності до проходження органогенезу. Глибокі індуковані дис-стреси знижують біологічну продуктивність рослин, їхню здатність накопичувати масу і формувати насіння та навіть призводять до їхньої загибелі. **Висновки.** Визначені закономірності реакції рослин бур'яну на індуковані механічні дис-стреси можуть бути використані для розробки екологічних прийомів захисту посівів від бур'янів.

Ключові слова: рослини**,** чутливість, фаза розвитку, дис-стрес, загибель, біологічна продуктивність.

Механические факторы влияния на биологическую продуктивность *Solanum nigrum* L.

А. А. Иващенко, А. А. Иващенко

e-mail: o_ivashchenko@ukr.net

Институт биоэнергетических культур
и сахарной свеклы НААН
Ул. Клиническая, 25, Киев, Украина, 03141

Цель. Изучение реакции молодых растений паслена черного на индуцированные механические стрессы. **Методы.** Исследования проводили в мелкоделяночных полевых опытах. **Результаты.** Доказано изменение уровня чувствительности растений паслена черного в зависимости от фаз их развития на момент повреждения надземных частей. Вследствие потери поверхности, способной к фотосинтезу, происходит существенное снижение объемов фотосинтеза у выживающих растений сорняка и их способности к прохождению органогенеза. Глубокие индуцированные дис-стрессы снижают биологическую продуктивность растений, их способность накапливать массу и формировать семена и даже приводят к их гибели. **Выводы.** Определенные закономерности реакции растений сорняка на индуцированные механические дис-стрессы могут быть использованы для разработки и экологических приемов защиты посевов от сорняков.

Ключевые слова: растения, чувствительность, фаза развития, дис-стресс, гибель, биологическая продуктивность.

REFERENCES

1. Veselovskyi I. V., Lysenko A. K., Manko Yu. P. Atlas determinant weeds. – Kyiv : Vrozhay, 1988. − 69 p.
2. Barbarych A. I., Visiulina O. D., Vorobyov M. Ye. et al. Weeds of Ukraine.−Kyiv: Naukova Dumka, 1970.− 506 p.
3. Etenboro D. Life on Earth. – Moscow : Mir, 1984. − 176 p.
4. Mirkin B. M. On types of ecological and coenotic strategies in plants // Zh. Obshch. Biol. – 1983. − **44**, N 5. − P. 603−613.
5. Ivashchenko O. O., Kunak V. D. Weeds. Why growing potential debris fields // Захист рослин. − Kyiv, 1998. − N 7. − P. 25−26.
6. Morderer Ye. Yu. Physiological basis of integrated application of herbicides: Author. Thesis. ... Dr. biol. sci. / Institute of Plant Physiology and Genetics, NAS of Ukraine. – Kyiv, 2002. – 38 p.
7. Schwartau V. V., Trach V. V. Detection of herbicides content in the environment by determining the activity acetolactate synthase // Pytannya bioindykatsiyi ta ekolohiyi. − Kyiv, 2005. − P. 104−107.
8. Ivashchenko O. O. Green neighbors. – Kyiv : Feniks, 2013. − 479 p.
9. Shikarova F. M. Nonspecific plants resistance to stress factors and its regulation.–Ufa: Gilem, 2001.−160 p.
10. Fogelberg F., Dock Gustavsson A. M. Mechanical damage to annual weeds and carrots by in-row brunch weeding // Weed Research. − 1999. − **39**. − P. 469−479.
11. Graglia E., Melander B., Jensen R. K. Mechanical and cultural strategies to control *Cirsium arvense* in organic arable cropping systems // Weed Research. − 2006. − **46**. − P. 304−312.
12. Tribel S. O. Methods of testing and use of pesticides / Ed. By S. O. Tribel. – Kyiv : Svit, 2001. − 447 p.