UDK 632.51:93
MAKUKH Ya.P., Candidate of Agricultural Sciences,
IVASHCHENKO O.O., Candidate of Agricultural Sciences,
REMENIUK S.O., Candidate of Agricultural Sciences
Institute of Bioenergy Crops and Sugar Beet NAAS of Ukraine

EXPERIMENTAL USE OF A NEW THERMAL MEANS FOR WEEDS CONTROL

Experimental works were carried out to assess the possibility of use of new thermal means enabling more effective use of warmth energy of the heat barrier and achieve the necessary biological effect on weeds seedlings. The evaluation of weeds sensitivity to the effect of warmth factor during different phases of its development and grows was completed.
Key words: *weeds, stress, phase of development, the thermal method*

Introduction. The mass weeds contamination of the wide-row crops sowings is considered to be one of the fundamental obstacles to heavy yields. The weeds dissemination control involves considerable labor costs and systematic treatment by herbicides. Meanwhile the application of chemical means for weed germination control, despite the main advantages has numerous disadvantages. Thus, the imperfect system of herbicide application to the plants during the most vulnerable stages of their development leads to enormous losses of working substance and preparations, which normally amount to 92 - 97 % of the standard dose for liquid consumption per one sowing. As a result the major part of the herbicide pollutes the environment. In most cases the application of chemical means of the protection from weeds is impossible: growing of plants used for the production of infant food, green vegetable crops, etc [1, 2, 3].

The fire thermal method of weed control is a well-known alternative, which enables the plant destruction by means of fire and high temperature of combustion products obtained from burning out the natural gas or oil derivatives. It might be a prototype of the suggested method. Using the fire method, the destruction of plants has happened as a result of the effect of hot gases on the living tissues.

There are disadvantages to this method, such as the absence of electability, as well as the huge consumption of energy producing materials and the ineffective result, as for most plant species the living tissue is protected by cover tissue so that for their destruction, the long term influence of hot gases is required.

Thus the research of biological peculiarities of weeds and their reaction on induced stress with the purpose of the investigation and development of alternative means for its control in the wide-row crops sowings is up-to-date.

The purpose of the research was the assessment of the weeds reaction on induced stresses.

Materials and methods. With the purpose of parameters specification required for physical and biochemical effect of the thermal means of sowing protection from weeds the complex laboratory analysis were completed by the Institute of bioenergy crops and sugar beet of the National academy of agrarian sciences of Ukraine.

A new means of the thermal method is based on the possibility to use a deeper and more effective heating of plant tissues using the 25 times better conduction of warmth energy by the substance drops in comparison with the hot air steams.

To assess the plant receptivity during different phases of its development the plants were treated by hot steam with the temperature of 100 $^{\circ}$C. The motion speed of the steam flow is 5 m/sec. Duration of action on plant germination 0,5-0,8 sec. The analysis were model vegetative. Sugar beet seed was sown in vegetation containers in the soil. The containers were put on the vegetation ground and were watered regularly. After appearance of seedlings the plants were grown till the phases in accordance with the plot design (see Table 1). The containers were put into the soil with certain intervals (7 days) to ensure different stages of plant development at the moment of steam treatment. The plants steam treatment was carried out on all replications on the same day. In replications 50 plants of each species were used. Replications variation – 7 times. In each variant 350 weeds units of each species were used.

The hot steam effect was applied to seedlings of such species of weeds: *Chenopodium album L.*, *Amaranthus retroflexus L.*, *Sinapis arvensis L.*, *Ambrosia artemisiifolia L.*

To obtain the hot water steam the portable steam generator Vl2000 is used. The temperature of steam flow and plant temperature were evaluating with the laser touch-free thermometer Sirius.

The evaluation of the depth of induced temperature stresses was carried out visually. The records on the effectiveness of the protection effect of the thermal method were completed in compliance with the requirements of the Guidelines for analysis and administration of pesticides 2001 (edited by S.O. Trybel).

Results and discussion. The treatment of weeds with hot water steam leads to the air flow and its phased transfer to water drops. The high quality of water drops contact (liquid stage) which are quickly formed in the steam floe on the relatively colder surface of the top part of plants leads to the release of the hidden warmth energy (gas phase) and its transfer to the plant leaves enables the fast and deep heating of tissues namely the meristem located deep in the tissue.

The high temperatures (above 80 $^{\circ}$C) causes inconvertible protein folding which lose its enzymatic characteristics and regulate the metabolic processes. In plant cells as a result of high temperature the metabolic process is blocked and destructed. Accordingly, such cells as well as whole plants stop its growth and development and start to die away.

The treatment of weeds (*Chenopodium album L.*, *Amaranthus retroflexus L.*, *Sinapis arvensis L.*, *Ambrosia artemisiifolia L.*) with hot water steam leaded to the full disorganization of metabolic processes in cells of young plants. The thickness of tissues of seedlings in the phase of cotyledon at the top part of plants is insufficient and they were heated very fast to the temperature of 100 $^{\circ}$C. The warmth energy transfer from the plant surface to inside was done by tissues themselves as they are overwatered during the period of organogenesis. Traditionally the content of water in cells of tissues of different weed seedlings is from 80 from 94 % from their overall weight.

Increase of weeds development phases (formation of two real leaves) enlarged the surface contact area with the hot steam flow, though the weight of plants had been increasing and resistance of plants to fast heating demonstrated the tendency to grow. Most of the representatives of different species of weed died, thus 3% (11 units of this species plants from the total amount of 350 units) of *Ambrosia artemisiifolia L.* survived (see Table 1).

Table 1

Change of weeds phase sensibility to heating with water steam, average performance for 2011-2013

Types of weeds	Phases of development of weed plants during treatment									
	Cotyledon		2^{nd} leaves		4^{th} leaves		6 leaves		8 leaves	
	Plants survived, it.	died, %	Plants survived, it.	died, %	Plants survived, it.	died, %	Plants survived, it.	died, %	Plants survived, it.	died, %
Chenopodium album L.,	0	100	0	100	11	97	53	85	102	71
Amaranthus retroflexus L.,	0	100	0	100	14	96	59	83	105	70
Sinapis arvensis L.,	0	100	0	100	0	100	28	92	74	79
Ambrosia artemisiifolia L.	0	100	11	97	39	89	95	73	154	56
HIP_{05}	9,8									

During the phase of formation of 4 leaves in weed plants of different species their sensitivity to the effect of high temperatures demonstrated the tendency to decrease in comparison with previous phases. Thus, plants of *Chenopodium album L.*, which are used in the trial during this phase of development died about 97 %, or 339 items in the trial. At the same time 11 plants or 3 % from the total amount of plants in variation survived and continued the vegetation. Average performance of plants sensibility to affect of hot steam was demonstrated by the *Amaranthus retroflexus plants.* Dying away of plants after warm stress was about 96-98 % from the total amount of plants in trials. Seedlings of *Ambrosia artemisiifolia L.* demonstrated better resistance to heating. Their dying away was about 89% that is less for 7-9% in comparison with other plant species.

During the treatment of weed seedlings with hot steam at the period of 6 leaves formation the resistance to the warmth factor increased considerably. Such effect can be explained by the bigger weight of top parts of plants to which heating more energy is requested. Accordingly the weed plants dying-away indexes were lower than the previous ones. Seedlings of *Chenopodium album L.*, at the phase of 6 leaves formation were dying away at 85%, seedlings of *Amaranthus retroflexus L.*, were dying away at 83%.

Stronger sensibility to high temperatures during the phase of 6 leaves formation *Sinapis arvensis L.*, demonstrated. The seedlings of the abovementioned plant were dying away at 92%. Seedlings of *Ambrosia artemisiifolia L.* were the most resistant to the hot steam – 73%. Among 350 plants of *Ambrosia artemisiifolia L.* 95 seedlings (or 27%) survived and continued to develop.

The increased sensibility of *Sinapis arvensis L.*, plants to the effect of high temperatures can be explained by the peculiar features of its proteins - ferments, which complex was forming in the process of genealogy of all the botanic family of *Brassicaceae.* Being a typical representative of this family the *Sinapis arvensis L.* has similar biochemical metabolic processes. Plants of *Ambrosia artemisiifolia L.* originated from subtropics of America demonstrated increased resistance to high temperatures of the environment.

The application of the tom steam to treat the weeds during the phase of 8 leaves formation was less effective in comparison with previous phases of vegetation. The plants of *Chenopodium album L.*, were dying away at 71% that means the among 350 plants used for the trial 102 survived. The average performance is similar of *Amaranthus retroflexus plants as well.* The index of dying away was 70%.

The seedlings of *Sinapis arvensis L.* according to previous results demonstrated the considerably lower sensibility to the effect of hot steam during the phase of 8 leaves formation. They were dying away at 79% less in comparison with the previous phase of development. Such changes can be explained by the considerable increase of the weight of young plants top parts, thickness of their stems and accordingly decrease of the level of heating of apical and collateral growing points with the meristem tissues.

The seedlings of *Ambrosia artemisiifolia L.* demonstrated the tendency to decrease the sensibility of plants to the effect of hot steam and accordingly the increase of the percentage of the seedlings survival after the warmth stress during the phase of 8 leaves formation. As in the variant of the trial 350 plants of this species were used 154 plants continued its vegetation that makes 44% from the overall amount. Only 56% of the treated plants died away.

Analyzing the tendencies of different species weed plants seedlings sensitivity to the effect of hot steam and their further dying away it should be mentioned that they demonstrated some certain species characteristics at the same phase of the development. The most vulnerable were the seedlings of *Sinapis arvensis L.* and the seedlings of *Ambrosia artemisiifolia L.* were the most resistant. Other representatives of species used in the trial demonstrated almost the same level of sensibility.

Practically all species of weeds changed the level of sensibility to the effect of warmth stress during the phases of ontogenesis. The most vulnerable species among all species used in the trial were seedlings are the phase of cotyledons. With the consecutive changing of phases the level of plants sensitivity to hot temperatures was decreasing and the level of their resistance was increasing considerably.

The highest level of resistance to hot steams among all weed species used in the trial had plants during the phase of 4 leaves formation. Accordingly the indexes of dying away of weed seedlings decreased from 100% (at the phase of cotyledons) to 56-76% (at the phase of 8 leaves development).

Conclusion. Weed plants of different species have high sensitivity to the effect of hot steam during the phase of cotyledons development the dying away is 100%. With the phases changing the sensitivity decreases. The most sensitive to hot steams were seedlings of *Sinapis arvensis L.*, (during the phase of 8 leaves development their dying away was 79%). The most resistant were seedlings of *Ambrosia artemisiifolia L.* during the phase of 8 leaves development their dying away was 56%.

References

1. Фотосинтез, продукционный процесс и продуктивность растений / [Б.И. Гуляев, И.И. Рожко, А.Д. Рогаченко и др.]. – К.: Наукова думка, 1989. – 152 с.

2. Іващенко О.О. Енергія Сонця і бур'яни : [монографія] / О.О. Іващенко – К.: Колобіг, 2011. – 134с.

3. Іващенко О.О. Бур'яни в агрофітоценозах / О. О. Іващенко. – К.: Світ, 2001. – 234 с.

4. Довідник з гербології / [І.Д. Примак, М.П. Косолап, П.У. Ковбасюк та ін.] ; за ред. І.Д. Примака. – К.: Кондор, 2006. – 370 с.

5. Методики випробування і застосування пестицидів / [Трибель С.О., Сігарьова Д.Д., Секун М.П. та ін.] ; за ред. С.О. Трибеля. – К.: Світ, 2001. – С. 381 – 382.

Анотація

Макух Я.П., Іващенко О.О., Ременюк С.О.

Експериментальне використання нового термічного способу контролю бур'янів

Виконано експериментальні роботи з оцінки можливостей використання нового термічного способу, що дозволяє раціональніше використовувати теплову енергію теплоносія і досягати необхідного біологічного ефекту дії на сходи бур'янів. Здійснено оцінку чутливості рослин бур'янів у різних фазах їх росту та розвитку до теплового чинника впливу.

***Ключові слова**: бур'яни, стрес, фази розвитку, термічний спосіб*

Аннотация

Макух Я.П., Иващенко А.А., Ременюк С.А.

Экспериментальное применения нового термическим способом контроля сорняков

Выполнены экспериментальные работы по оценке возможностей использования нового термического способа, позволяющего рационально использовать тепловую энергию теплоносителя и достигать необходимого биологического эффекта воздействия на всходы сорняков. Осуществлена оценка чувствительности растений сорняков в различных фазах их роста и развития до теплового фактора влияния.

***Ключевые слова:** сорняки, стресс, фазы развития, термический способ*