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РЕСПУБЛИКИ КАЗАХСТАН

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OPTIMIZATION OF THE TECHNOLOGY OF MASS BREEDING OF CEREAL APHIDS (*Schizaphis graminum*) USING AN AEROPONIC CULTIVATION AND THE BREEDING OF THE APHIDIUS BIOAGENT (*Aphidius matricariae*)

Abstract. The results of research on the cultivation of fodder plants of barley and infection of plants with cereal aphids in the conditions of an aeroponics installation are given. The germination parameters are determined depending on the periodicity of the water supply of its volume and the mass of the seeds grown in the plant. In the conditions of the aeroponic plant, the reproduction of aphids is considered optimal if 5 individuals of phytophagous are released per barley plant. After 7 days, the number of aphids increased to 42.5 individuals, while its high concentration was noted. When carrying out the infection of aphids propagated under the conditions of the aphids, the optimal parasite ratio: host = 1:60. The degree of infection of aphids (mummified) was 84.2% on this variant.

Keywords: Aerial cultivation; bioagents; bioconveyor; cereal aphids; cuvettes; mummification of aphids.

Introduction. It is common knowledge that hydroponic systems are used to grow plants such as wheat, barley, vegetable crops, berries, fruits, and others (Terentyev et al. 2015). This method is widely used in Israel, Holland, USA, Canada, Japan, and Russia. It is believed that growing plants with hydroponic systems is the future of agricultural production. Recently, such installations have appeared in Southern Kazakhstan, where the company LLP "KAZAGROGREEN" uses for the cultivation of cereals to provide animals with a high calorie food in winter. Having studied the technical characteristics of the installation, which was considered to be hydroponic in the company, we purchased one copy, since by all parameters the device worked like an aeronautic system. Moreover, this corresponds to the truth, since classical aeroponics is one of the variants of the method of hydroponics, that is, plants are periodically sprayed with a nutrient suspension, while with pure hydroponics, and plant roots are found, for example, in a vessel with nutrient solution. The installation was purchased by our scientists in order to adapt it for more intensive cultivation of barley or wheat, thus ensure the mass breeding of aphids that are food for the production of the aphidius bioagent. When using aeroponics on plants, pests and diseases are absent and they grow much faster than those grown in the soil. In addition, 100% access to oxygen and carbon dioxide contributes to accelerated plant growth.

The aim of this work is to study the possibilities of accelerated cultivation of a forage plant for cereal aphids and the mass reproduction of a phytophagous using an aeroponics plant.

All the methodological issues related to the preparation and cultivation of barley seeds, the improvement of the parameters of the aeroponics, the counts of the number of aphids and aphids, and the determination of the parasite-host ratio were carried out according to the methods generally accepted in the literature (Hydroponics and aeroponics 2016; Gorban 2007; Biological protection 1990; Methodical recommendations 1988; Methodical instructions 2015; Popov et al. 1986).

After some of the design improvements in the technology of growing plants, the pilot experiment showed that the propagation rate of aphids was ten times higher than the conventional methods. The method of aeroponics is environmentally safe and highly efficient at a considerably low cost of water, electricity, human labor. These advantages, against the backdrop of the supposed high efficiency of propagation of cereal aphids, ultimately contributed to the acquisition of the plant in order to further ensure the mass production of bioagent for hothouse farms.

Materials and Methodsof research. The bioconveyor for the cultivation of barley and the propagation of aphids on the plant is distributed in three boxes, and the breeding of the aphidiosis continues in a separate biological laboratory. In the first box, the electrical part of the installation, the time relay, the high pressure ozonizer for water supply, the 200-liter water tank with the inside of the heating element are concentrated (Shiiko 1986).

Electromagnetic valves provide periodic activation and shutdown of the water supply for spraying plants. In this box, barley seeds are soaked in a 5-liter container with the addition of 4 to 5 grams of slaked lime to disinfect the seeds. Soaked seeds are left here for 15 to 16 hours to drink water. After 15 hours, the seeds of barley are placed in cuvettes. Weight of barley seeds with full filling of the cuvette is 500 grams. Cuvets filled with seeds are installed on the shelves in the second box (figure 1). In the box, there is a 4-tier shelving with installed jets for supplying water under high pressure and forming a water mist.

a b

Figure 1 – Cells with barley seeds located on the shelves (a),
a nozzle that provides the formation of water mist under high pressure (b)

The time from seed placement in the second box to an increase of 2 cm is 85 to 90 hours. Therefore, in order to exclude the infection of plants with fungal diseases (mold) in this box, emitters of 30 W each are supplied. The on/off frequency is controlled by the time switch (Krasavina 2007).

Results and Discussion. Observations carried out after the development of plants and the appearance of signs of disease (mold) showed that the optimal time for periodic quartz during the entire growing period was 3 hours, including in the morning from 7:00 to 8:00, at noon from 13:00 to 14:00, in the evening from 18:00 to 19:00 hours. It was found that the symptoms of diseases (molds) during quartz formation were manifested in 24 hours after 24 hours, and the seeds died, when quartzes for 2 hours, the mold appeared after 42.5 hours and the shoots also died, the mold did not appear on quartz for 3 hours, and the germination Seed was 98%. The air temperature in this box was maintained at 20-210C, which is optimal for germination of seeds. In order to establish the intensity of seed germination, depending on their mass, as well as the time of water supply, experiments were performed. The volumes of water used to create the fog were tested in the amount of 2 liters, 4 liters and 6 liters, and the periodicity of the water supply was 60 and 90 minutes (table 1).

It is established that when water is supplied at a frequency of 60 and 90 minutes, shoots of barley appear after 65-72 hours. At the same time, when the water was supplied every 60 minutes in a volume of 2 liters and every 90 minutes in a volume of 4 liters, the seed germination was practically at the same level and amounted to 97.6% and 97.7%, respectively. It turned out that the germination capacity also depends on the weight of seeds in the cuvette. In this connection, an experiment was carried out to

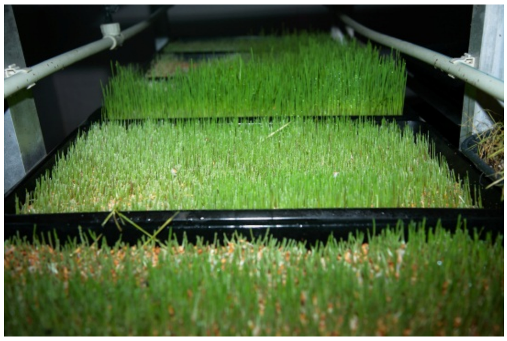
Table 1 – Germination of barley seeds, %, depending on the time of water supply and its volume

Variants of the experiment (volume of water, l)	Periodicity of water supply through, min	Germination of seeds on average, %
2 l	60	97,6 ± 0,2
	90	83,7 ± 0,5
4 l	60	90,0 ± 0,4
	90	97,7 ± 0,2
6 l	60	79,7 ± 0,5
	90	80,0 ± 1,1

determine the dependence of germination on the number of seeds laid for germination of 100, 200, 400 and 500 grams. The results of the studies showed that the weight of the seeds in 200 g was optimal and the germination was high and amounted to 97.7%. At a mass of 100 grams, the germination is high, but the cuvettes are filled only by a third. At a mass of 400 and 500 g, germination was relatively low and amounted to 80.0 and 66.5%, respectively, and therefore are unacceptable in view of low efficiency (Krasavina 2009).

The next cycle in the technology of growing barley is the transfer of cuvettes with sprouted seeds into the third box (figure 2), where the plants are infected with cereal aphids. To do this, a grid with a cell diameter of 8 mm is placed on the fresh sprouts, and the cut off barley plants infected with aphids are placed on top of the grid. For infection, aphids were released from an average of 5 individuals per plant. With a duration of 7 days on one plant, there were 42.5 individuals on average.

a



b

Figure 2 – Barley seedlings ready for infection with cereal aphids (a), Barley plants infected with cereal aphids (b)

The degree of colonization of barley by gramineous aphids depends, as a rule, on the number of pests released for infection and the duration of its development. In our experience, the degree of colonization was, on average, on one plant in the range of 22.7 to 62.7 individuals (table 2).

Table 2 – Degree of colonization of barley by cereal aphids, individuals, depending on the duration of development and the number of phytophagous released for infection

Variant of experience (duration of development, days)	Number of produced phytophagous individuals per plant	The degree of occupancy of aphids on average per plant, individuals
5 days	3	21,5 ± 0,6
	5	31,5 ± 0,6
	7	43,5 ± 0,8
7 days	3	31,7 ± 0,8
	5	40,7 ± 0,4
	7	61 ± 0,9
10 days	3	40,5 ± 0,6
	5	10,0 ± 10
	7	0

From the data obtained, it can be concluded that the optimal population is planting aphids in the number of 5 individuals per plant, with a development time of 7 days. The number of aphids on one plant on this variant was 42.5 individuals, with a high concentration of phytophagous. In other cases, after 10 days of aphid development, either an insufficient concentration was observed, or the plants were aging and decaying, and therefore the aphids did not stop leaving the plants in search of a new food. In this experiment, in order to avoid the formation of large droplets of water on the leaves with aphids and negatively influence the development of the pest, and to exclude their flooding, the volume of water for spraying was reduced by a factor of 1.5 (Kozlova and Krasavina 2010).

The next stage in the technology of development of aphidius is the transfer of cuvettes with plants infected by aphids to the laboratory where the aphids infect the aphids with the bioagent. The cuvettes are placed on the shelves where there is illumination with an intensity of illumination of 2500 lux; the temperature is maintained within 24-25 °C, humidity of air is at the level of 70-75%. Aphidius dilution was carried out in special cages measuring 65*30*30 cm, made of stainless steel wire 4 mm in diameter and closed with a capron mesh with a mesh size of 0.1 mm.

It is known that the maximum realization of the fertility of the bioagent of aphidius in the infection of aphids is largely determined by the selection of parasite and host density [9-11]. In our experiment, the parasite: the host was determined in the ratio 1:10; 1:20; 1:40; 1:60. The beginning of mummification of aphids was noted 5-6 days after infection with aphids, and after 8-10 days, the mummification process was completed. Analysis of the obtained data shows that the maximum number of mummies was obtained in the variant where the parasite: host ratio was 1:60 (Figure 3). Insignificant share of mummified aphids was noted at a ratio of 1:10. The average position is 1:20; 1:40, accounting for 40.2% and 54.5%, respectively. With such ratios, the number of mummified aphids was lower than at a ratio of 1:60, respectively, by 35 and 53% (figure 3).

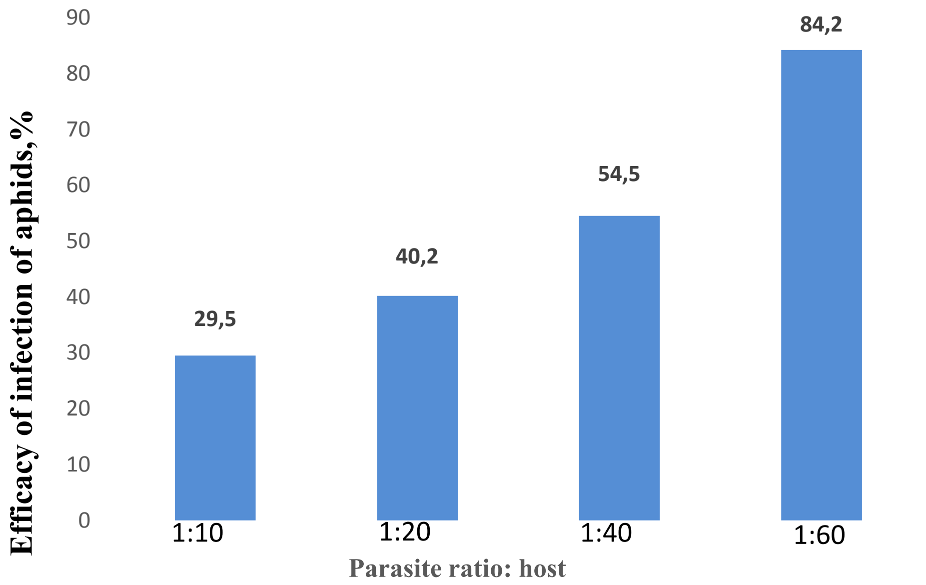


Figure 3 – Change in the number of mummified aphids as a function of parasite ratio: host

Therefore, when carrying aphids infection to obtain good results, the maximum number of aphids should be used, that is, the ratio should be 1:60. The degree of infection of aphids (mummification) by aphidius on this variant was high and amounted to 84.2%. The high fecundity of aphidius at this ratio can be explained by the fact that the aphids propagated on the aeroponic plant were somewhat larger in comparison with aphids grown on barley in the usual way and therefore probably for the bioagent, it was more attractive. It must be assumed that the presence of an excess of fodder (aphid) on this variant is of no small importance.

Aphids damage fodder plants, thereby contributing to exhaustion, a decrease in the green mass, poor fruit bearing, premature fall of leaves and the formation of galls, in some cases, the food of aphids ends with the death of the plant. In addition, aphids carry phytopathogenic viruses, bacteria and fungi, one type of insect is able to spread up to 100 pathogens of dangerous plant diseases.

Cereals are dangerous pests of grain crops. They cause the inhibition of plants and a decrease in the mass of grains. If the damage is considerable, the loss of grain is no less than 4-5 centners per hectare, and in some years the crop may be halved.

Aphids have a great breeding potential, high migratory activity, significant intrapopulation changes, which contributes to a rapid increase in numbers. In this regard, it is expedient to develop reliable and effective methods for monitoring these pests. The changed conditions of production stipulate the need to improve the methods for their accounting.

By populating cereal crops, insects are distributed in them according to their requirements to environmental conditions and under the influence of certain factors – these are intrapopulation and interspecific relationships, food selectivity of insects, egg-laying method, migration abilities.

The field size can also influence the spatial distribution of pests in crops: in small areas, insects are more numerous in the marginal zone; On large arrays they are distributed more evenly over the field. The domination in crop rotation of monoculture and increase in the number of specialized pests in crops in comparison with primary cenoses lead to a decrease in the role of the marginal effect in the distribution of insects. A noticeable role in the spatial distribution of phytophages in crops can be played by the structure of crops and the presence of weed vegetation.

Crops act as a habitat in the life of harmful insects. They are not only a source of food for pests, but also a place of their development. The crops create certain microclimatic conditions, to which the insects make demands, corresponding to the biology of each species. The settlement of pests with different plant density depends on the ecological norm of the reaction of grain crops on temperature, light and other factors. It is known that thickened crops promote rapid growth and lignification of stems, the death of plant leaves, which makes them unattractive for pests. Damaged, well-warmed crops of cereal crops are more intensively populated and damaged by light and heat-loving insects, for example Oscinella frit. This is explained by the fact that in the dense stem it creates a great shade, accelerates the growth of vaginal leaves, shoots, and coarsening them in phases, tillering and stalking occurs much faster, which allows them to escape damage from Oscinella frit. Intra-stem pests are subject to the rule of changing habitats, as a result of which insects choose habitats corresponding to their hydrothermal and light requirements. Sucking phytophages inhabit mainly thickened crops with a more stable temperature regime and relative humidity.

The study of the spatial distribution of insects is of great practical importance. Obtained information on the distribution of insects in crops is needed not only from the point of view of studying the bioecological features of insects, but also to choose the tactics of conducting agrotechnical and chemical protective measures on the whole area of sowing or only in certain areas.

The retrospective analysis of long-term biological material on population dynamics of insects and their spatial distribution in crops showed that 93 phytophagous species dwell in agrocenoses of cereals, but only 16 species have a periodically economic importance: Oscinella frit, chloropid gout fly, Meromyza nigriventris, Lema Lacombe, etc.

It was revealed that the spatial distribution of pests is predominantly random and uniform, which is confirmed by literary data. So, in general, the settlement of cereal crops was characterized by cereal flies, cicadas, bugs and grain fleas.

A number of authors indicates a uniform colonization of crops by pests, associating it with the effect of climatic factors, habitats, plant development phases and other.

In general, using an aerial installation with 1 cuvette, it is possible to collect mummified aphids on an average of 160,000 specimens, and with a maximum load of 2 million 800 thousand copies. With this amount, it is possible to control the aphids in a closed ground on an area of 280 hectares.

The work was carried out with the financial support of the KN MES of the RK (grant funding: 5393/GF4 "Study of the potential for practical use of insect entomophages for biological protection of vegetable crops from arthropod pests").

Conclusion. For the first time, the results of studies of the mass reproduction of cereal aphids (Schizaphis graminum) using an advanced version of the aerial plant, allowing to provide a 10-fold increase in phytophagy in comparison with the usual method, were obtained.

The most effective and optimal for barley infestation of cereal aphids grown in conditions of high humidity using aeroponics is the option when plants were inhabited by aphids in the amount of 5 individuals per plant. The number of aphids after 7 days increased to 42.5 individuals with a high concentration level.

The technology of growing plants and mass multiplication of cereal aphids in an isolated airspace without the use of soil, while automatically regulating the optimal growth and development regime, allows for a substantial reduction in labor costs, saving energy, water, eliminating the use of soil, and preventing contamination by harmful organisms.

When the aphids were infected with the aphids (Aphidius matricariae) using aerial plant, good results were obtained with the parasite: host ratio of 1: 60, the degree of infection of aphids (mummified) in this variant was 84.2%.

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АСТЫҚ БИТТЕРІН (*Schizaphis graminum*) ЖӘНЕ АФИДИУС (*Aphidius matricariae*) БИОАГЕНТТЕРІН ЖАППАЙ КӨБЕЙТУ ТЕХНОЛОГИЯЛАРЫНА ЭРОПОНДЫ ҚОНДЫРҒЫЛАРДЫ ПАЙДАЛАНУ АРҚЫЛЫ ОҢТАЙЛАНДЫРУ

Аннотация. Аэропонды қондырғыны пайдалану арқылы астық биттерін көбейтуге үшін арпа дақылын өсіру бойынша жүргізілген зерттеулер нәтижесі келтірілген.Қондырғыдаберілетін судың реттілігіне байланысты өсірілетін тұқымдардың өнімділік көрсеткіштері анықталды. Аэропонды қондырғыда биттерді көбейту кезінде арпаның бір өсімдігіне 5 фитофагты жіберу қолайлы болып табылады. 7 күннен соң жіберілген биттердің саны 42,5 дарақты құрады. Өз кезегінде аталған қондырғыда биттерді афидиуспен залалдау кезінде тоғышар:ие арақатынасы 1:60 болғаны қолайлы. Бұл нұсқадағы биттердің зақымдалу (мумиялану) дәрежесі 84,2% құрады.

Түйін сөздер: аэропонды қондырғы, астық биті, биоагенттер, афидиус, мумияланған биттер, биоконвейер.

Б. А. Дуйсембеков, А. М. Чадинова, К. А. Алпысбаева

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ОПТИМИЗАЦИЯ ТЕХНОЛОГИИ МАССОВОГО РАЗМНОЖЕНИЯ ЗЛАКОВОЙ ТЛИ (*Schizaphis graminum*) С ИСПОЛЬЗОВАНИЕМ АЭРОПОННОЙ УСТАНОВКИ И РАЗВЕДЕНИЕ БИОАГЕНТА АФИДИУСА (*Aphidius matricariae*)

Аннотация. Приведены результаты исследований по выращиванию кормового растения ячменя и заражение растений злаковой тлей в условиях аэропонной установки. Определены показатели всхожести в зависимости от периодичности подачи воды ее объема и массы выращиваемых в установке семян. В условиях аэропонной установки размножение тли считается оптимальным, если на одно растение ячменя выпускают 5 особей фитофага. Через 7 дней количество тли увеличивалось до 42,5 особей, при этом отмечено ее высокая концентрация. При проведении заражения тли размноженной в условиях установки афидиусом, оптимальным соотношением паразит:хозяин = 1:60. Степень заражения тли (мумифицированных) составила на этом варианте 84,2%.

Ключевые слова: аэропонная установка, злаковая тля, биоагенты, афидиус, кюветы, мумификация тлей, биоконвейер.

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