Ukrainian Journal of Ecology

Ukrainian Journal of Ecology, 2021, 11(7), 93-109, doi: 10.15421/2021_246

ORIGINAL ARTICLE

Spreading and development of root rots in winter wheat and spring barley plants depending on pre-sown seed treatment with mwf of ehf and plant growth regulators

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Received: 03.08.2021. Accepted: 18.09.2021.

Throughout the research, it was found that the seed treatment with EHF MWF of EHF in the determined irradiation modes or with the additional treatment with the growth regulators Mars EL (wheat) and Radostim or Albit (barley) causes a decrease in the spread and development of root rots in the crops of these agricultural plants. In the case of winter wheat, the spreading and development of root rot in the full ripening phase when treated with MWF of EHF of 1.8 kw/kg 15 sec., MWF of EHF of 0.9 kw/kg 45 sec and MWF of EHF of 1.8 kw/kg 15 sec+Mars EL made up 4.9 and 2.1%, 5.4 and 2.0%, 4.9 and 2.1% respectively, while under control these indices were 9.7 and 4.0% respectively, and in the case with Vitavax 200 FF-6.1 and 2.4%. The pre-sown seed treatment with EHF MWF of EHF in the modes of 0.9 kw/kg, 45 s or 1.8 kw/kg, 20 sec., with Radostim and Albit growth regulators, as well as in their combination, causes a decrease in the spread and development of root rots throughout the growing season of barley varieties. The application of MWF of EHF in the modes of 0,9 kw/kg, 45 s. or 1,8 kw/kg, 20 sec. followed by treatment at a half-reduced rate of Vitavax 200 FF rate (1.25 L/ha) provided a lower degree of root rot of plants of the Aspect barley varieties in the stalk shoot phase than the application of the full rate of the treatment agent when the spread was lower by 2.4 and 2.2%, respectively, and the development by 0.3 and 0.5%.

Keywords: Pathogens, root rots, pre-sowing treatment, seeds, grain, fungicides, mwf, ehf, growth regulators, winter wheat, spring barley.

Introduction

One of the obligatory elements of the technological process of cultivating cereal crops, which affects the increase in the yield and quality of crop production, is the pre-sowing treatment of seeds with chemical and biological products of different origin. But today in Ukraine the problem of seed sanitation and selection of the most viable biotypes with high productive properties by presowing treatment with the ecologically friendly methods have not yet been solved.

The search for new alternative methods for seed disinfection in order to reduce the negative influence of agrochemicals on the environment has recently been recently carried out in Ukraine and abroad. Physical methods such as the treatment with ozone,

microwave, and ultrasonic radiation, etc., are of great interest (Tuchnyj et al., 2007; Tuchnyj, Karmazin & Levchenko, 2007; Shevchenko et al., 2007; Tuchnyj, Karmazin & Dzigovskij, 2012).
One of the most ecologically friendly and cost-effective methods of presowing seed treatment is irradiation with an Extra-High Frequency Microwave Field (MWF of EHF). Along with the physical method of seed treatment with the microwave field, the plant growth regulators and biological preparations that are used to increase the resistance of plants to adverse factors and the yield capacity of many crops have become widespread in agricultural practice (Anishin, 2002; Lihochvor, 2003).
The dependence of winter wheat yield capacity on agro-meteorological factors in the territory of Ukraine has been studied by several scientists (V.K. Dmytrenko, A.N. Krenke, etc.). (Krenke, Demyanchuk & Emelyanova, 1992; Tarariko, O.G. et al. (2013).
It is known that the rate of plant development is closely related to the weather conditions in a particular year. Analysis of the characteristics of the development of agricultural crops in interaction with meteorological factors is a major part of the agro-meteorological information. In this case, the criterion for the evaluation of agro-meteorological conditions, in which the crop is grown, is the value of the grain yield capacity and its quality (Kuperman, 1955).
The following indices were used to characterize the agro-meteorological conditions of winter wheat and spring barley cultivation during the research period: duration of interphase periods, average daily air temperature, sum of effective temperatures (above 5°C) and amount of precipitation in interaction with the elements of crop productivity elements.

Materials and Methods

Two varieties of spring barley and one variety of soft winter wheat are the research materials.
The characteristics of spring barley varieties are given below.
The Aspect variety: The originator is the Plant Production Institute named after V.Ya. Yuryev of NAAS. It has been listed in the State Register of Varieties since 2007 and is recommended for cultivation in the Forest-Steppe and Polissia regions (Nasinnya silskogospodarskih kultur sortovi ta posivni yakosti. Tehnichni umovi. DSTU 2240–94, 1994).
The distinctive feature is the nutans. The spike is tow-rowed, has a moderate wax coating; it is cylindrical, loose (11, 7 short segments of spike rachis per 4 cm), and of a medium length. The straw is medium-length (51-489, 0 cm) and very strong. The sterile spike occupies a position from parallel to slightly deflected. The floral glumes are fine-wrinkled, with a slight expression of venation and gradual transition to the awn. The grain is elliptical, yellow, and filmy. The main bristle is long-fibred. The weight of 1000 grains is 46-52 g.
Biological characteristics. The variety is semi-late; the duration of vegetation is 79–97 days. The resistance to lodging is 8.2 to 9.0 points, the average drought resistance is 6.5 to 7.0 points. The variety is a source of group resistance to the powdery mildew infection (7 marks) and reticular helminthosporiosis (7 marks). It is suitable for intensive cultivation technology.
The grain yield capacity is up to 8.5-8.0 t/ha. The grain has good brewing qualities: extraction is 81.1%, protein content is 9.0-10.0%, and seed uniformity of seeds is 98.8% (Katalog sortiv i gibridiv polovih kultur NAAN, 2013).
The Vyklyk variety: The originator is the Plant Production Institute named after V.Ya. Yuryev of NAAS. It has been listed in the State Register of Varieties since 2008 and is recommended for cultivation in the Forest-Steppe and Polissia regions (Katalog sortiv i gibridiv polovih kultur NAAN, 2013).
The distinctive feature is the nutans. The spike is tow-rowed, has a moderate wax coating; it is cylindrical, loose (12.2 short segments of spike rachis per 4 cm), and of medium length. The sterile spike occupies a position from parallel to slightly deflected. The floral glumes are fine-wrinkled, with a slight expression of venation and gradual transition to the awn. The grain is elliptical, yellow, and filmy. The main bristle is long-fibred. The weight of 1000 grains is 46–52 g. The variety has a high productive tillering capacity of 2.0 stems.
Biological characteristics. The variety is semi-early. The height of the plants is 68-76 cm. The awns are jagged. The growing season is 88 to 96 days. Resistance to lodging is very high (9.0 marks). The resistance to drought is high (9.0 marks). The variety is resistant to infection caused by the pathogen reticular helminthosporiosis pathogen (7 marks).
The grain yield capacity is up to 8.5 to 9.5 t/ha. The grain has good brewing qualities: extraction is 81.1%, protein content is 10.0–10.9%, and seed uniformity of seeds is 98.0%
The characteristics of the soft winter wheat variety are given below.
The Astet variety: The originator is the Plant Production Institute named after V.Ya. Yuryev of NAAS. It has been listed in the State Register of Varieties since 2005 and is recommended for cultivation in the forest-Steppe and Steppe Zones of Ukraine (Katalog sortiv i gibridiv polovih kultur NAAN, 2013).
Its approbation signs are of the *erythrospermum* variety. The stem has a medium wax coating on the upper internode. The spike has a slightly spindle-shaped covering of 8–9 cm long; it has medium density. The awns are long (10 cm), jagged, and after ear formation they have the anthocyanin colour. The grain is red, of medium size, oval in shape with a broad pubescent tuft. Anthers have the anthocyanin colour. The weight of 1000 grains is 39–43 g.
Biological characteristics: the variety is mid-ripening; the formation and ripening of the ears occur in the terms close to the standards; the variety has short stems (the plant height is 79–85 cm), it is resistant to lodging. The stem is thin, has good tillering capacity and can form 700 or more productive shoots per 1 m^2. The winter hardiness is quite high, 8.2 to 8.7 marks. Under field conditions, it is tolerant to the main harmful diseases. It is suitable for intensive cultivation technology.
The potential yield capacity is up to 9.5 t/ha. The grain, depending on the place and conditions of cultivation, contains 12.4-14.5% protein and 25-29.9% gluten; the strength of the flour is 280–431 alveograph units, and the volume of bread is 660 $cm^{3.}$

The data on the factors regarding the pre-sowing seed treatment are as follows.
Seed treatment agents:
Vitavax 200 FF, manufactured by Crompton/Universal Chemical. It is a compound preparation, a factory mechanical mixture of two fungicidal active substances: carboxin, 200 g/L+thiram, 200 g/L. Vitavax 200 FF; It is a contact and systemic fungicide with protective and therapeutic action. It is designed for the destruction of fungal pathogens on the surface and inside the seeds; it prevents infection of the seedlings on which it is applied. The preparation is characterized by a wide range of fungicidal actions. It inhibits the development of pathogens of all kinds of smut, root and stem rots, seed snow mould, anthracnose, and some other phytopathogenic fungi. The preparation is included in the List of pesticides and agrochemicals authorised for use in Ukraine.
The seeds of cereal crops were treated with preparation at a consumption rate recommended by the producer, that is 2.5 to 3.0 L dissolved in 10 L of water per 1 ton of seeds. Reduced rates were also examined in the experimental cases.
The sowing qualities of the seeds before and after treatment were determined according to the current State Standards of Ukraine 4138–2002 (Nasinnya silskogospodarskih kultur sortovi ta posivni yakosti. Tehnichni umovi. DSTU 2240–94, 1994; Nasinnya silskogospodarskih kultur sortovi ta posivni yakosti. Metodi viznachennya yakosti. DSTU 4138–2002, 2003).
In the Laboratory of Seed Production and Seed Science of the Plant Production Institute named after V.Ya. Yuryev. For this purpose, 100 seed samples were selected in quadruplicate recurrence for each treatment case. Germination was carried out on a thermostat at a temperature of +20°C on moistened filter paper. The sprouting energy was calculated in 4 days and the laboratory germinating power was calculated in 7 days.
Field experiments were carried out in crop rotation at the laboratory of Seed Production and Seed Science Laboratory. The predecessor of spring barley was peas for grain, and the predecessor of winter wheat was fallow. The acreage of the examined plot during the experiments was 20 m^2, quadruple recurrence was used, and the plots were placed in a systematic character (Nasinnya silskogospodarskih kultur sortovi ta posivni yakosti. Tehnichni umovi. DSTU 2240–94, 1994).

Agro-meteorological conditions for winter wheat cultivation

Winter wheat sowing during the research period was carried out in optimum terms optimum for the Eastern Forest-Steppe Zone, namely in the second decade of September.
Characteristic of this zone, a sharp change in weather conditions according to the seasons of the year influenced the duration of the winter wheat growing season, both over the years and over the interphase periods of plant growth and development.
The vegetation period of the Astet variety ranged from 153 days in 2011 to 148 days in 2013, with a minimum period of 115 days in 2012 (Table 1).
The autumn period, which conditions the sprouting and tilling of the plants, is an important stage of the development of winter crops development.
The duration of the interphase period of sowing and sprouting did not change significantly over the years and was 6 to 7 days. Insignificant fluctuations in the average daily air temperature were 15-17°C and sum of the effective temperatures was 86-99°C in 2011 and in 2012. The distribution of precipitation as a source of water replenishment in the soil during this period was uneven. The maximum amount of precipitation was 25 mm in 2010 and the minimum was 5.3 mm in 2011.
The next interphase period of the ‘sprouting-tillering’ of autumn vegetation “sprouting-tillering” falls on the third decade of September and the first decade of October (Table 1). The duration of the period varied between 15 and 19 days over the years (Table 2). There was a significant decrease in the average daily temperature to 10.7°C and in the sum of effective temperatures up to 76°C against the background of maximum precipitation of 81 mm, with a long-term rate of 20 mm in 2010. Optimal conditions for vegetation were observed only in 2012.

Table 1. Phenological phases of the development of winter wheat crops in 2010-2013.

Sowing	Sprouting	Tillering	Stopping of autumn vegetation	Resumption of spring vegetation	Stalk shooting	Tillering	Full ripening
15.09.2010.	21.09.2010.	6.10.2010	25.11.2010	02.04.2011	1.05. 2011	19.05.2011	25.06.2011
16.09.2011	23.09.2011.	12.10.2011.	04.011.2011	18.04.2012	15.05.2012	28.05.2012	22.06.2012
14.09.2012	21.09.2012	5.10.2012	10.11.2012	31.03.2013	16.05.2013	23.05.2013	28.06.2013

However, the agrometeorological conditions for winter wheat cultivation varied significantly over the research period, leading to different duration of interphase periods of plant growth and development and ultimately to different levels of crop yield capacity over the years.
Thus, in 2010–2011 the vegetation period of the Astet winter wheat variety lasted 156 days (from the date of sowing date to full ripeness). At the same time, during the growing season the sum of effective temperatures was 1302°C, and the amount of precipitation was 452,6 mm (Table 2).
Table 2. Duration of interphase periods of winter wheat development depending on agro-meteorological conditions during the years of research, 2010–2013.

S.No.	Indices	Interphase period	Sum of	Yield

		Sowing-sprouting	Sowing-tillering	Tillering stopping of vegetation	RSV–stalk shooting	Stalk shooting-ear formation	Ear formation full ripening	days. vegetation period	capacity. t/ha
				2010–2011					
1	Duration of the interphase period (days)	6	15	51	25	18	38	153	4.44
2	Average daily air temperature °C	15.0	10.7	7.0	11.2	17.5	20.6	12.9	
3	Sum of effective temperatures above 5°C	93.0	76.0	–	174.0	238.0	721.0	1302.0	
4	Amount of precipitation. mm	25.0	80.6	56.0	64.0	20.0	207.0	452.6	
				2011–2012					
1	Duration of the interphase period (days)	7	19	23	27	13	26	115	5.09
2	Average daily air temperature °C	15.7	12.8	4.9	20.0	19.5	22.0	19.7	
3	Sum of effective temperatures above 5°C	86.0	148.0	–	405	189	408	1236	
4	Amount of precipitation. mm	0.0	12.2	20.0	0.3	25.0	29.0	86.5	
				2012–2013					
1	Duration of interphase period (days)	7	15	36	46	7	37	148	6.63
2	Average daily air temperature °C	16.9	15.6	9.4	16.6	22.1	22.7	15.1	
3	Sum of effective temperatures above 5°C	99.0	151.0	180.0	455.0	123.0	631.0	1639	
4	Amount of precipitation mm	5.3	13.1	115.0	10.3	15.4	75.8	234.9	

A characteristic feature of winter wheat vegetation in 2010–2011 was the absence of effective temperatures during the interphase period of "tillering-stopping of autumn vegetation", which lasted 51 days, as well as their lack in the periods of "sprouting-tillering" and "spring vegetation resumption-stalk shooting"; the period lasted 25 days and the total sum of temperature was 76 and 174.0°C respectively. The resumption of vegetation was noted on April 2, 2011.

Another characteristic of 2010–2011 was 46% (207 mm) of the annual amount of precipitation during the interphase period of "ear formation-full ripening".

Under such conditions, the winter wheat yield capacity of the Astet variety in 2011 was 4,44 t/ha on average.

In 2011-2012, the winter wheat vegetation period of winter wheat lasted 115 days at the sum of effective temperatures of 1236°C. This period was the driest during the research; the amount of precipitation during the wheat vegetation period of wheat was 86.5 mm. At the same time, 62% (54 mm) of precipitation has been evenly distributed evenly during the interphase period of "stalk shooting-full ripening".

It should be noted that winter wheat vegetation in the interphase periods of 'sprouting-tillering' and 'spring resumption of vegetation-stalk shooting" took place at the high average daily air temperatures; as a result the sums of the effective temperatures during these periods were 148.0 and 405°C at the duration of the periods of 19 and 27 days, respectively. The resumption of vegetation was observed on April 18, 2012.

The period of 'stalk shooting ear formation' lasted 13 days under favorable conditions; the average daily air temperature was 19.5°C, the sum of effective temperatures was 189°C and the amount of precipitation was 25 mm.

Therefore, in the 2011-2012 period, the agro-meteorological conditions of the winter wheat vegetation were more favorable than in the previous period, which made it possible to obtain the yield capacity at the level of 5.09 t/ha.

The winter wheat vegetation period in 2012–2013 should be noted as the most favorable during the field researches. Its duration was 145 days at the highest sum of effective temperatures of 639°C and the precipitation amount of 234.9 mm.

The duration of the interphase period of 'sprouting-tillering' at high average daily air temperatures (15.6°C on average in comparison with 10.7 and 12.8°C in the previous periods) was 15 days. In the 2010-2011 and 2011-2012 periods, the duration was 15 and 19 days and the sum of the effective temperatures was 151.0°C.

It should be noted that winter wheat tilling was carried out under favourable conditions and lasted almost until autumn vegetation; the average daily air temperature was 9.4°C and the sum of effective temperatures was 180°C. During this period, there was 115 mm of precipitation or 49% of the total precipitation for the crop vegetation period.

The period of 'resumption of vegetation-stalk shooting" was also favorable for the growth, development, and formation of the generative organs of winter wheat. It was comparatively the longest (46 days) and the warmest (the sum of effective temperatures was 455°C). The resumption of vegetation was observed on March 31.

The vegetation of the Astet winter wheat variety from the stalk shoot phase of stalk shooting to full ripeness took place at high average daily air temperatures. At the same time the sum of the effective temperatures was 754°C, and there were 91.2 mm of precipitation.

One of the critical vegetation periods of winter cereals is the 'tiller' phase. During this period, the lateral shoots and a secondary root system are formed from the underground stem nodes, that is, the setting of organs that determine the crop yield takes place. The indices of productive tillering depend on the conditions of the autumn and winter periods. Water reserve is a major factor when it is quite warm (at an air temperature of 15–18°C) (Ulanova, 1975; Vrkach, 1984; Lihochvor & Petrichenko, 2006).

During the years of research, the interphase period of 'sprouting-tillering' occurred in the third decade of September and the first decade of October. According to the data (Table 2) the duration of the period varied over the years from 15, 19, and 13 days, respectively. That period was characterised by a lowering of temperatures in 2010 and 2011; the temperatures were 10,7 and 12.8°C respectively, whereas in 2012 the lowering in temperature compared to the previous period was insignificant-15.6 versus 16.9°C. In 2010, the sum of effective temperatures was minimum (76°C) against a background of maximum precipitation of 81 mm at an average long-term precipitation of 20 mm. In the following 2011 and 2012, the same period was drier, the sum of the effective temperatures was 148-151°C with a minimum amount of precipitation of 12.2-13.1 mm. As a consequence, the sharp fluctuations in heat and humidity were not optimal for the intensive tillering during the vegetation period. It is known that the tillering phase of winter cereals continues until the vegetation that is until a steady increase in the average daily temperature above 5°C (Lichhochvor & Petrichenko, 2010; Lihochvor et al., 2003).

The duration of the 'tillering stop of vegetation" period varied significantly depending on the meteorological conditions of the fall growing season. If the beginning of the 'tillering' phase was noted almost simultaneously (the first decade of October), then the date of stoppage of the autumn vegetation of winter wheat ranged between 15 and 20 days. The longest interphase period of vegetation tilling stoppage (49 days) was observed in 2010 and was accompanied by a decrease in the average daily air temperature to 7°C, the sum of effective temperatures was 96°C and the precipitation amount was 72 mm. Such weather conditions were in accordance with the climatic norm.

The minimum duration of this period (24 days) was observed in 2011. The temperature factor was crucial for the intensive growth and development of plants. The lowering of air temperature to 5°C and below in the absence of effective temperatures and at a minimum precipitation of 20 mm (60% of the average long-term rate) influenced the shortening of the vegetation period.

The most favorable conditions were observed during the period in 2012; the period lasted up to 36 days with a slower decrease in air temperature up to 9.4°C and the maximum sum of effective temperatures of 180°C, which is 20% higher than in the previous period of 'sprouting-tillering'. The amount of precipitation was also above the long-term rate.

The periods of autumn vegetation considered showed that winter wheat responds significantly responds to the changes in weather conditions. The corresponding reaction of the plants influenced field germination and tilling as the main elements of the yield structure.

Stopping of the autumn wheat vegetation varied from the first to the third decade of November and depended on the temperature regime.

In the case of winter wheat, the role of autumn and winter periods is also important for the formation of water reserve in the soil in early spring. Well-developed crops are intensively developing, forming the leaf tube and spikelets in the ear using mainly spring water reserves.

During the research period, the most favourable conditions of water supply were observed at the beginning of spring in 2013. The amount of precipitation in the period of November to March was 211 mm, which exceeded the average long-term rate by 15%. In 2011 and 2012 the amount of precipitation was significantly low and was 149 and 122 mm, respectively, or 81% and 67% of the rate.

The terms of the Spring Vegetation Resumption (SVR) of winter wheat, especially their extreme values, significantly influence the further development of plants up to the ear formation phase (Lihochvor et al., 2003). The main cause of spring crop losses is the late date of vegetation resumption, when plants were unable to adapt quickly to sudden temperature changes. According to our research (Table 1), the earliest date of the vegetation resumption was observed on 31 March 31, 2013 with a further maximum duration of the interphase period of 'vegetation resumption-stalk shooting' of 46 days.

The date of early winter wheat vegetation (April 2) was also observed in 2011. However, the duration of the interphase period from the vegetation resumption to the stalk-shooting phase was 21 days shorter than in 2013. Shortening of the active vegetation period, when the main biomass is accumulated, influences the shortage of productivity.

The critical conditions of the period under consideration were observed in 2012, the date of vegetation resumption fell on April 18, that is, 15 days later than the earlier terms. The shortening of the interphase period of the 'vegetation resumption shoot' up to 27 days was due to the increase in the temperature regime. The sum of the effective temperatures of 405-455°C exceeded the average long-term norm almost twice, and the amount of precipitation was twice as low.

The duration of the interphase period of 'stalk shooting ear formation' (Table 2) ranged from 7 to 19 days in the background of the temperature rise. The average daily temperature was within the range of 17-22°C, the sum of effective temperatures was 120–240°C, and the amount of precipitation was 15–25 mm, which corresponded to the average long-term rate.

A significant factor in the formation of the winter wheat yield capacity is the duration of the period from ear formation to full ripening. During the years of research, this period was minimum in 2012-26 days and maximum up to 37 days in 2011 and 2013 at an optimal temperature of 20–23°C. However, an uneven distribution of precipitation from 29 mm in 2012 to 207 mm in 2011 and its intensity led to a shortage in yields up to 4.44 and 5.09 t/ha in 2011 and 2012, while in 2013 the yield capacity was 6.63 t/ha.

Such agrometeorological conditions during the vegetation period provided the highest winter wheat yield capacity in our research, it was 6.63 t/ha in 2013.

Agro-meteorological conditions for spring barley cultivation

The spring barley crop by its biological characteristics is not frugal in heat. The minimum temperature of seed sprouting is +1…2°C; the seedlings can withstand short-term light frosts up to -3. to -4°C. Such characteristics determine the early terms of barley sowing (Cherenkov et al., 2010).

In recent years, the spring rise in the air temperature above 0°C during 20–25 days and more has fluctuated sharply. Therefore, the sowing dates of the early ripening spring cereal crops need annual adjustments taking into account air temperature and water accumulation in the soil (Kuperman, 1984; Yizhik, 2001). Early sowing dates facilitate a more efficient use of the water accumulated in early spring; the plants are less damaged by diseases and pests. It is very important that early sowing delays the transition to the generative phase of development and has a positive influence on the density of productive stems and the yield capacity (Nasinnya silskogospodarskih kultur sortovi ta posivni yakosti. Tehnichni umovi. DSTU 2240–94, 1994).

Brewing barley is especially sensitive to late sowing, which leads to a deterioration of grain quality-the huskiness increases, the size of grain and the starch content are reduced (Lichhochvor & Petrichenko, 2010).

In the agrometeorological conditions of 2011, barley sowing of barley was carried out on April 24. The period of spring barley vegetation irrespective of a variety lasted 91 days. The sum of the effective temperatures was 1308°C and the average daily temperature was 19.4°C with a precipitation amount of precipitation of 292 mm (Table 2).

A characteristic feature of 2011 was 165,3 mm or 57% precipitation (mainly heavy showers) during the interphase period of 'ear formation-full ripening". In such conditions, there was a significant lodging of spring barley plants on the experimental plots, which worsened the conditions of ripening and harvesting.

Another feature of spring barley vegetation in 2011 was the slow development of plants at the beginning of the vegetation period due to a decrease in air temperature. For example, the 'sowing-stalk shooting' period lasted 50 days, while the "stalk shooting-ear formation" period was shorter for the entire research period of the research and lasted 14 days.

In such conditions in 2011 the Aspect variety produced a yield of 2,95 t/ha.

The agro-meteorological conditions in 2012 can generally be generally described as the most favorable for spring barley cultivation during the research period. The sowing was carried out on April 18. The vegetation period of barley regardless of a variety was the shortest and lasted 83 days from sowing to full ripening. Thus, the interphase periods "sowing-sprouting" and 'sprouting-tillering' were the shortest – 8 and 19 days, respectively. In general, the development of plants from sowing to stalk shooting lasted 35 days, which is 15 days less than in 2011.

The average daily temperature of the vegetation period in 2012 was 21.1°C, which is 1.7°C higher than in 2011, and the sum of effective temperatures was 1335°C.

In 2012, the amount of precipitation was 79 mm, the lowest during the entire period of the research period, while in the interphase period of "sowing-tillering" there was no precipitation at all.

However, the development of spring barley plants during the period from tilling to full ripening occurred under the favourable conditions in terms of temperature and moisture, which made it possible to form the highest level of the yield capacity of barley varieties in our research. Aspect-4.72 t/ha and Vyklyk-4.83 t/ha.

An earlier spring was observed in 2013, when the increase in air temperature above 0 and 5° took place almost at the same time and fell in the middle of the third decade of March. Under such conditions, the spring barley was carried out earlier, namely on April 17.

In the agro-meteorological conditions of 2013, the vegetation period of spring barley lasted 87 days. The sum of the effective temperatures was 1390°C and the average daily temperature was 21.8°C with a precipitation amount of precipitation of 95 mm (Table 3). At the same time, the interphase periods 'sowing-sprouting' and "sprouting-tillering" were the shortest-9 and 12 days, respectively. In general, the development of plants from sowing to stalk shooting lasted 30 days, which is 5 days less than in 2012.

During the period of formation of the mass ear formation of barley the temperature factor significantly influences the final crop yield. The closest feedback between yield capacity and average daily air temperature during this phase of development is observed in areas where the temperature exceeds 20°C (Vrkach, 1984; Nasinnya silskogospodarskih kultur sortovi ta posivni yakosti. Tehnichni umovi. DSTU 2240–93, 1994).

According to the results of the observations carried out in 2013, the yield capacity of spring barley was influenced by the high average daily temperature in the phase of "ear formation" phase (21.8°C), the uneven distribution of precipitation during the vegetation period and the lowest sum of effective temperatures in the phase of "tillering-stalk shooting" (197.0°C) (Table 3).

Table 3. Duration of interphase periods of spring barley development depending on agro-meteorological conditions, 2011-2013.

S.No	Index	Interphase period					Sum for vegetation period	Yield capacity.t/ha	
		Sowing	Sprouting	Tillering-	Stalk	Ear-		Aspect	Vyklyk

		sprouting	**tillering**	**stalk shooting**	**shooting-ear formation**	**formation full ripening**			
					2011				
1	Duration of interphase period (days)	10	20	20	14	27	91		
2	Average daily air temperature, °C	14.4	16.1	21.0	20.7	21.8	19.4	2.95	-
3	Sum of effective temperatures above 5 °C	94.0	222.0	320.0	220.0	452.0	1308		
4	Amount of precipitation. mm	2	32.0	15.2	77.2	165.3	292		
					2012				
1	Duration of interphase period (days)	8	8	19	20	28	83		
2	Average daily air temperature, °C	15.6	19.4	22.5	19.5	23. 3	2 1.1	4.72	4.83
3	Sum of effective temperatures above 5 °C	85.0	116.0	332.0	289.0	513.0	1335		
4	Amount of precipitation, mm	0	0	15.2	32.4	31.0	79.0		
					2013				
1	Duration of interphase period (days)	9	9	12	33	24	87		
2	Average daily air temperature, °C	14.1	18.0	21.4	21.8	23.4	20.9	2.69	2.6
3	Sum of effective temperature above 5°C	82.0	116.0	197.0	554	441.3	1390		
4	Amount of precipitation, mm	0	0	4	58.0	33	95		

Results

According to FAO, the potential crop losses from the diseases. pests and weeds constitute 25–30%. and during years of epiphytoty they can reach 60%. Therefore. Current cultivation technologies should be based on a comprehensive approach as to the pest control (Petrenkova. Zvyaginceva & Chugayev. 2016).

Cereal spike crops are infected with many diseases. such as root rot. ear blight. loose smut. covered smut and others. The yield shortage of these crops caused by a disease complex of the diseases is up to 20% on the average (Reid. 1968; Ulonska & Baumer. 1976).

It is known that about 60% of all plant diseases are communicated through seeds. Therefore, in many countries the pre-sowing seed treatment with the plant protection products is not only a necessary but also a legally obligatory way of protecting the basic agricultural crops from the harmful organisms (Dolzhenko. Kotikova & Zdrazhevskaya. 2001; Dindorogo & Klimenko. 2007; Fadeev. 2012; Markov. 2016).

A constraint factor in increasing the yield capacity of cereal crops are also the diseases caused by fungi. among which root rots are especially harmful. The fungus *Cochliobolus sativus* Drechslera. ex Dastur (anamorph: *Drechslera. sorokiniana* Subram & Jain) is a pathogen of wheat common root rot (Markov. 2016).

A thin. delicate. Fine-haired mycelium. which grows rapidly. appears on the caryopsis and radicles infected by fusarial root rot; at first it is snow white or bright crimson in colour with the veins. Radicles decay at the base. become brown or glassy transparent. The tanning of coleptile and stem. the deformation of the rolling of the stem. and the radicle deformation are observed (Cehmejstruk. Kuzmenko. Litvinov. 2015; Markov. 2016).

Infection by fusarium root rot leads to the appearance of a black bloom on the caryopses. tanning and decay of the roots. which are covered with a black bloom from the base. The underdevelopments of radicles. tanning of stems and coleoptile. and deformation of seedlings are noted (Cehmejstruk. Kuzmenko & Litvinov. 2015; Markov. 2016).

Seeds with a bloom in caryopsis also belong to the damaged ones; the infected shoots are those that have signs of the root rot: the decayed radicles. streak mosaic and stem tanning (Markov. 2016).

Linear dark strips and elongated brown spots appear on the radicles and leaves of wheat seedlings. The tanning and decay of the coleoptile. Yellowing and moulding of leaves are observed. The shortage of wheat yield caused by common root rot can reach 5%-10% (Bublik & Vasechko. 2011).

Barley root rot pathogens are fungi of the genera *Fusarium* Link and Drechslera. ito (Markov, 2016). The disease is more intense in the dry years.

The world and domestic experience shows that when introducing into production the varieties resistant to harmful organisms. The relationships in the pathogen-plant-feeder system do not always meet the expected results. This is especially true for root rot pathogens. that belong to necrotrophs according to the type of nutrition; their manifestation and development are highly dependent on many factors. including environmental conditions. nutritional background. predecessor. tillage. timing and sowing methods, etc. (Ozkan & Preskot. 1972; Dmitrenko. 1980; Ilchenko. N.A. et al. 1988; Lejertam. 1973; Petrovskijet al. 2010)

The problem of plant protection from root rot of the main grain crops due to the application of not only chemical but also biological preparations and plant growth regulators that have the fungicidal properties is also relevant from the point of view of current environmental problems (Mikrohvilova pich zamist protrujnika. 2013).

In the course of our research, winter wheat and spring barley root rot have been recorded in the tillering phases. stalk shooting. and full ripening of the plants.

At the same time, it has been found out that the pre-sowing seed treatment with MWF of EHF in the proper modes of irradiation causes a decrease in the spreading and development of root rot on the crops of these agricultural plants.

Thus. when recorded, the root rots in the tillering phase. Their spread in the Astet winter wheat varieties plants in the cases of MWF of EHF was 0.2-0.4%. and the development was 0.1-0.2% on the average for 2010-2012. while under the control these values were 1.9 and 0.6%, respectively. It is noteworthy that when treating the seeds with Vitavax 200 FF. 2.5 L/ha. the spreading and development of root rot were 0.7 and 0.2%. respectively (Table 4).

In general, the spread and development of root rots on winter wheat plants in the stalk shooting phase have increased significantly. In the control case, they were 16.7 and 8.0% respectively on the average for the years 2011-2013. while in the case with different methods of applying the MWF of EHF the indices were 7.9–12.1 and 3.8-6.7%, respectively. and when treated with Vitavax 200 FF the indices were 10.3 and 4.0%.

It should be noted that the presown seed irradiation only with MWF of EHF in the mode of 1.8 kw/kg. 15 sec. or in combination with Mars EL preparation treatment provided a lower level of root rot spreading in the stalk shooting phase than Vitavax 200 FF-0.6 and 2.4%, respectively; whereas in the cases of EHF treatment with MWF of EHF of 0.9 kw/kg. 45 s. the level was higher by 1.8 and 1.7% respectively. The development of root rots in winter wheat plants in the stalk shoot phase when applied only EHF MWF mode of the irradiation with MWF of EHF or in combination with Mars EL preparation was also higher than in the standard case-by 2.7 and 2.6%, respectively.

Pre-sown seed irradiation with MWF of EHF in modes of 1.8 kw/kg. 15 s. and 0.9 kw/kg. 45 sec. both separately and as an additional treatment of seeds by the growth regulator Mars EL. provided a lower level of spreading and development of root rots on winter wheat plants compared to the case without treatment until the end of the growing season. i.e. in the phase of full ripening; these indices were 4.9 to 6.8 and 2.0–2.7% respectively as compared to 9.7 and 4.0%.

Table 4. Spreading and development of the root rots of Astet winter wheat variety depending on the method of pre-sowing seed treatment with EHF% MWF of EHF % 2010-2013.

S.No	Methods of pre-sowing seed treatment	Tillering (autumn)		Stalk shooting (spring)		Full ripening	
		Spreading	Development	Spreading	Development	Spreading	Development
1	Control. without treatment	1.9	0.6	16.7	8.0	9.7	4.0
2	Vitavax 200 FF. 2.5 L/t	0.7	0.2[1)]	10.3[1)]	4.0[1)]	6.1[1)]	2.4[1)]
3	MWF of EHF. 1.8 kw/kg. 15 sec.	0.3[1)]	0.1[1)]	9.7[1)]	4.3[1)]	4.9[1)]	2.1[1)]
4	MWF of EHF. 1.8 kw/kg. 15 sec.+Mars EL	0.4[1)]	0.1[1)]	7.9[1)]	3.8[1)]	4.9[1)]	2.1[1)]
5	MWF of EHF. 0.9 kw/kg. 45 sec.	0.2[1)]	0.1[1)]	12.1[1)]	6.7	5.4[1)]	2.0[1)]
6	MWF of EHF. 0.9 kw/kg. 45 sec+Mars EL	0.3[1)]	0.2[1)]	12.0[1)]	6.6	6.8[1)]	2.7[1)]
	SSD_{05}	1.4	0.2	4.44	2.36	2.37	1.18

Note: [1)]-Significant difference.

In most cases of MWF of EHF application (except for MWF of EHF. 0.9 kw/kg, 15 sec.+Mars EL), the spreading and development of root rots in the full ripening phase were lower than in the case with Vitavax 200 FF seed treatment-4.9-5.4 and 2.0-2.1% respectively compared to 6.1 and 2.4%.

It should be noted that the level of spreading and development of root rots of winter wheat varied significantly depending on agrometeorological conditions during the research year (Table 5, 6, 7).

Table 5. Spreading and development of root rots in Astet winter wheat variety plants in the fall tillering phase of autumn tillering depending on the method of presowing seed treatment % 2010–2012.

S.No	Methods of pre-sowing seed treatment	Spreading				Development			
		2010	2011	2012	average	2010	2011	2012	average
1	Control. without treatment	0.7	0	5.1	1.9	0.2	0	1.5	0.4
2	Vitavax 200 FF. 2.5 L/t	1.1[1)]	0	1.1[1)]	0.7	0.4	0	0.3[1)]	0.3
3	MWF of EHF 1.8 kw/kg. 15 sec.	0.4	0	0.4[1)]	0.3[1)]	0.1	0	0.1[1)]	0.2
4	MWF of EHF 1.8 kw/kg. 15 sec+Mars EL	0[1)]	0	1.3[1)]	0.4[1)]	0	0	0.3[1)]	0.2
5	MWF of EHF 0.9 kw/kg. 45 sec.	0.7	0	0.0[1)]	0.2[1)]	0.2	0	0.0[1)]	0.3
6	MWF of EHF 0.9 kw/kg. 45 sec.+Mars EL	0.7	0	0.3[1)]	0.3[1)]	0.5[1)]	0	0.1[1)]	0.4
	SSD_{05}	0.6	0	1.2	1.4	0.2	0	0.4	0.2

Note: [1)]-Significant difference.

Table 6. Spreading and development of root rots on Astet winter wheat variety plants in the phase of stalk shooting depending on the method of pre-sowing seed treatment % 2011-2013.

S.No.	Methods of pre-sowing seed treatment	Spreading				Development			
		2011	2012	2013	Average	2011	2012	2013	Average

1	Control. without treatment	13.7	20.6	15.8	16.7	8.3	10.5	5.1	8.0
2	Vitavax 200 FF. 2.5 L/t	11.4	5.6[1)]	14.0	10.3[1)]	5.6	2.4[1)]	4.1	4.0[1)]
3	MWF of EHF 1.8 kw/kg. 15 sec.	13.5	8.2[1)]	7.4[1)]	9.7[1)]	6.6	4.2[1)]	2.0[1)]	4.3[1)]
4	MWF of EHF 1.8 kw/kg. 15 sec+Mars EL	6.4[1)]	4.9[1)]	12.5[1)]	7.9[1)]	5.0[1)]	2.7[1)]	3.6[1)]	3.8[1)]
5	MWF of EHF 0.9 kw/kg. 45 sec.	17.7	11.8[1)]	16.1	15.2	11.5[1)]	5.8[1)]	5.6	7.6
6	MWF of EHF 0.9 kw/kg. 45 sec.+Mars EL	19.1	4.5[1)]	12.5[1)]	12.0	12.3[1)]	2.7[1)]	4.9	6.6
	SSD_{05}	5.9	3.8	2.8	5.1	3.0	2.0	1.2	2.7

Note: [1)]-Significant difference.

Table 7. Spreading and development of root rots on Astet winter wheat variety plants in the phase of full ripening depending on the method of pre-sowing seed treatment % 2011-2013.

S.No.	Cases of pre-sowing seed treatment	Spreading.%				Development.%			
		2011	2012	2013	average	2011	2012	2013	average
1	Control. without treatment	18.7	6.8	3.8	9.8	9.4	1.8	0.9	4.0
2	Vitavax 200 FF. 2.5 L/t	9.7[1)]	7.4	1.4[1)]	6.2[1)]	4.9[1)]	2.0	0.4[1)]	2.4[1)]
3	MWF of EHF 1.8 kw/kg. 15 sec.	9.9[1)]	3.4[1)]	1.6[1)]	5.0[1)]	4.9[1)]	1.1[1)]	0.4[1)]	2.1[1)]
4	MWF of EHF 1.8 kw/kg. 15 sec+Mars EL	9.7[1)]	3.4[1)]	1.6[1)]	4.9[1)]	5.1[1)]	0.8[1)]	0.5[1)]	2.1[1)]
5	MWF of EHF 0.9 kw/kg. 45 sec.	10.6[1)]	2.5[1)]	3.2	5.4[1)]	4.9[1)]	0.7[1)]	0.6[1)]	2.1[1)]
6	MWF of EHF 0.9 kw/kg. 45 sec.+Mars EL	12.5[1)]	4.8	3.1	6.8[1)]	6.3	1.2[1)]	0.7	2.7
	SSD_{05}	5.8	2.2	0.8	2.4	3.1	0.6	0.2	1.2

Note: [1)]-Significant difference.

For example: The spread and development of root rots in winter wheat plants in the autumn tillering in 2010 were insignificant and did not depend on the pre-sowing seed treatment with EHF MWF of EHF either separately or with the subsequent treatment with Mars EL.

In 2011, in the phase of autumn tillering. the diseases of the winter wheat crops were absent. and as a result, no difference found between the cases.

In the conditions of 2012, in the phase of autumn tillering. root rot decrease in the spreading and development in winter wheat plants was observed in the cases with the pre-sowing seed treatment in the mode of MWF of EHF of 0.9 kw/kg. 45 s. both separately and with the subsequent Mars EL treatment-0-0.3%. while the indices under the control were 5.1 and 1.5%, respectively.

In the full ripening phase, the highest level of spread and development of root rots on winter wheat plants in 2011 in the cases of pre-sowing treatment in the modes of EHF of 1.8 kw/kg. 15 s and EHF of 0.9 kw/kg. 45 sec+Mars EL in the range of 9.9 and 4.5% and 8.8 and 4.3% according to the control of 18.7 and 9.4% (Table 7). This fact is related to the character of the weather conditions of this year; there were 46% of the annual precipitations (207 mm) of the annual amount and the average daily temperature was 20.6°C during the interphase period of 'ear formation-full ripening".

In the conditions of 2012 in the full ripening phase, a decrease in the spreading and development of root rots of 3.4 and 3.4% and 0.7 and 1.0%. respectively, was observed in the cases with the pre-sowing seed treatment with MWF of EHF of 1.8 kw/kg. 15 sec. both separately and with subsequent treatment with Mars EL. Under the control these indices were 6.8% and 1.8%. Treatment of seeds with Vitavax 200 FF at the full consumption rate (2.5 L/t) was less effective-7.4 and 2.0%. respectively (Table 8).

Table 8. Spreading and development of root rots in spring barley in the stalk shooting phase, depending on the variety. method of presown seed treatment and phase of plant development %.

S.No.	Methods of pre-sowing seed treatment	Aspect (average for 2011–2013)				Vyklyk (average for 2012–2013)			
		Stalk Shootins		Full Ripening		Stalk Shootms		Full Ripening	
		spreading	development	spreading	development	spreading	development	spreading	development

1	Control without treatment	11.0	3.7	3.8	1.5	8.9	2.6	3.0	1.1
2	Vitavax 200 FF. 2.5 L/t (standard)	8.6	2.3[1)]	2.1[1)]	0.9[1)]	3.2[1)]	1.2[1)]	2.7	1.1
3	Radostim. 0.25 L/t	5.7[1)]	2.3[1)]	1.8[1)]	0.7[1)]	6.2[1)]	2.3	1.4[1)]	0.7[1)]
4	Albit. 30 ml/t	6.1»	2.4	2.8[1)]	1.0[1)]	5.0[1)]	1.4[1)]	1.5[1)]	0.7[1)]
5	MWF of EHF. 0.9 kw/kg. 45 sec.	7.0')	2.8	3.1	1.2[1)]	3.1[1)]	1.0[1)]	1.6[1)]	0.6[1)]
6	MWF of EHF. 0.9 kw/kg. 45 sec.+Vitavax 200 FF. 1.25 L/t	6.2[1)]	2.0[1)]	3.2	1.2[1)]	7.5	2.2	3.0	1.0
7	MWF of EHF. 0.9 kw/kg. 45 sec.+Radostim. 0.25 L/t	6.3[1)]	2.3[1)]	2.8[1)]	0.9[1)]	4.9[1)]	1.7[1)]	1.7[1)]	0.6[1)]
8	MWF of EHF. 0.9 kw/kg. 45 sec.+Albit. 30 ml/t	5.8[1)]	1.9[1)]	2.7[1)]	1.0[1)]	3.5[1)]	1.2[1)]	0.9[1)]	0.4[1)]

Note: [1)]-Significant difference.

Table 9. Spreading and development of root rots on spring barley in the stalk shooting phase depending on the variety. method of pre-sowing seed treatment and phase of plant development %.

S.No	Methods of pre-sowing seed treatment	Aspect (average for 2011–2013)				Vyklyk (average for 2012–2013)			
		stalk shootins		full ripening		stalk shootins		full ripening	
		Spreading	Development	Spreading	Development	Spreading	Development	Spreading	Development
1	Control. without treatment	11.0	3.7	3.8	1.5	8.9	2.6	3.0	1.1
2	Vitavax 200 FF. 2.5 L/t (standard)	8.6	2.3[1)]	2.1[1)]	0.9[1)]	3.2[1)]	1.2[1)]	2.7	1.1
3	Radostim. 0.25 L/t	5.7[1)]	2.3[1)]	1.8[1)]	0.7[1)]	6.2[1)]	2.3	1.4[1)]	0.7[1)]
4	Albit. 30 ml t	6.1[1)]	2.4	2.8[1)]	1.0[1)]	5.0[1)]	1.4[1)]	1.5[1)]	0.7[1)]
5	MWF of EHF. 0.9 kw/kg. 45 sec.	7.0[1)]	2.8	3.1	1.2[1)]	3.1[1)]	1.0[1)]	1.6[1)]	0.6»
6	MWF of EHF. 0.9 kw/kg. 45 sec.+Vitavax 200 FF. 1.25 Lt	6.2[1)]	2.0[1)]	3.2	1.2[1)]	7.5	2.2	3.0	1.0
7	MWTofEHF. 0.9 kw/kg. 45 sec. 45 sec.+Radostim. 0.25 L/t	6.3[1)]	2.3[1)]	2.8[1)]	0.9[1)]	4.9[1)]	1.7[1)]	1.7[1)]	0.6[1)]
8	MWTofEHF. 0.9 kw/kg. 45 sec.-Albit. 30 ml/t	5.8[1)]	1.9[1)]	2.7[1)]	1.0[1)]	3.5[1)]	1.2[1)]	0.9[1)]	0.4[1)]
9	MWFofEHF. l.8 kw/kg. 20 sec.	6.8[1)]	2.1[1)]	2.4[1)]	1.0[1)]	5.7[1)]	2.3	2.0[1)]	0.7[1)]

10	MUT of EHF. 1.8 kw/kg. 20 sec.+Vitavax 200 FF. 1.25 L/t	6.4l[1)]	1.8[1)]	2.5[1)]	0.9[1)]	6.3[1)]	2.1[1)]	1.8[1)]	0.9
11	MWF of EHF. 1.8 kw/kg. 20 sec.+Radostim. 0.25 L/t	5.4[1)]	1.9[1)]	2.4[1)]	1.0[1)]	5.5[1)]	1.7[1)]	2.2	0.8[1)]
12	MWF of EHF. 1.8 kw/kg. 20 sec.+Albit. 30 ml/t	9.0	3.4	2.6[1)]	1.1[1)]	3.6[1)]	1.3[1)]	1.2[1)]	0.4[1)]
	SSD $_{05}$	3.2	1.4	0.8	0.3	2.0	0.5	0.9	0.3

Note: [1)]-Significant difference.

In the full ripening phase. in the conditions of 2013, there was a decrease in root rot spreading and development of root rots in cases with the pre-sowing seed treatment in the EHF mode of EHF of 1.8 kw/kg 15 sec, both separately and with the subsequent treatment with the plant growth regulators by 2.2 and 2.2% and 0.5 and 0.4%, respectively, at 3.8 and 0.9% under the control.

In the research carried out with spring barley of the Aspect and Vyklyk varieties. records of the spread and development of root rot have been carried out in the stalk-shooting and full ripening phases. The results received show that presown seed treatment with EHF MWF of EHF in the modes of 0.9 kw/kg. 45 sec. or 1.8 kw/kg. 20 sec.. with the growth regulators Radostim and Albit. as well as their combination causes a decrease in the spread and development of root rots throughout the whole vegetation period of barley varieties (Table 9, 10, 11).

Table 10. Spreading and development of root rots on Aspect spring barley variety plants in the stalk shooting depending on the method of presowing seed treatment % 2011–2013.

S.No.	Methods of pre-sowing seed treatment	Spreading				Development			
		2011	**2012**	**2013**	**average**	**2011**	**2012**	**2013**	**average**
1	Control. without treatment	14.4	7.5	11.2	11.0	5.6	2.6	3.1	3.8
2	Vitavax 200 FF. 2.5 L/t	9.7[1)]	5.8	10.3	8.6	4.0	2.2	2.9	3.0
3	Radostim. 0.25 L/t	8.1[1)]	2.7[1)]	6.3[1)]	5.7[1)]	4.0	1.1[1)]	1.9[1)]	2.3[1)]
4	Albit. 30 ml/t	6.6[1)]	6.2	5.6[1)]	6.1[1)]	2.6[1)]	2.7	1.9[1)]	2.4
5	MWF of EHF. 0.9 kw/kg. 45 sec.	4.2[1)]	4.6[1)]	12.2	7.0[1)]	3.0[1)]	1.9	3.6	2.8
6	MWF of EHF. 0.9 kw/kg. 45 sec.+Vitavax 200 FF. 1.25 L/t	4.6[1)]	3.3[1)]	10.7	6.2[1)]	2.1[1)]	1.0[1)]	2.9	2.0[1)]
7	MWF of EHF. 0.9 kw/kg. 45 sec.+Radostim. 0.25 L/t	3.6[1)]	5.6	9.7	6.3[1)]	1.5[1)]	2.6	3.0	2.4
8	MWF of EHF. 0.9 kw/kg. 45 sec.+Albit. 30 ml/t	1.9[1)]	5.8	9.7	5.8[1)]	1.1[1)]	2.2	2.4	1.9[1)]
9	MWF of EHF. 1.8 kw/kg. 20 sec.	3.2[1)]	6.9	10.4	6.8[1)]	1.4[1)]	2.3	2.6	2.1[1)]
10	MWF of EHF. 1.8 kw/kg. 20 sec.+Vitavax 200 FF. 1.25 L/t	2.7[1)]	5.4	11.1	6.4[1)]	1.0[1)]	1.8	2.6	1.8[1)]
11	MWF of EHF.1.8 kw/kg. 20 sec.+Radostim. 0.25 L/t	2.1[1)]	2.7[1)]	11.4	5.4[1)]	1.2[1)]	1.1[1)]	3.5	1.9[1)]
12	MWF of EHF. 1.8 kw/kg. 20 sec.+Albit. 30 ml/t	10.3[1)]	3.5[1)]	13.2	9.0	5.4	1.2[1)]	3.5	3.4
	SSD $_{05}$	3.0	2.8	3.4	3.2	1.7	1.1	1.1	1.4

Note: [1)]-Significant difference.

Table 11. Spreading and development of root rots on Aspect spring barley variety plants in the phase of full ripening depending on the method of pre-sowing seed treatment % 2011–2013.

S.No.	Methods of pre-	Spreading	Development

	sowing seed treatment	2011	2012	2013	average	2011	2012	2013	average
1	Control. without treatment	4.8	5.6	1.1	3.8	2.3	1.9	0.4	1.5
2	Vitavax 200 FF. 2.5 L/t	2.9$^{1)}$	3.0$^{1)}$	0.3$^{1)}$	2.1$^{1)}$	1.5$^{1)}$	1.2	0.1$^{1)}$	0.9$^{1)}$
3	Radostim. 0.25 L/t	4.0	1.4$^{1)}$	0.0$^{1)}$	1.8$^{1)}$	1.5$^{1)}$	0.6$^{1)}$	0.0$^{1)}$	0.7$^{1)}$
4	Albit. 30 ml/t	4.1	3.0$^{1)}$	0.9	2.7$^{1)}$	1.8	0.9	0.4	1.0$^{1)}$
5	MWF of EHF. 0.9 kw/kg. 45 sec.	4.0	4.1	1.2	3.1	1.7	1.4	0.5	1.2
6	MWF of EHF. 0.9 kw/kg. 45 sec.+Vitavax 200 FF. 1.25 L/t	4.4	4.1	1.0	3.2	2.0	1.4	0.3	1.2
7	MWF of EHF. 0.9 kw/kg. 45 sec.+Radostim. 0.25 L/t	3.8	4.2	0.3$^{1)}$	2.8$^{1)}$	1.2$^{1)}$	1.3	0.1$^{1)}$	0.9$^{1)}$
8	MWF of EHF. 0.9 kw/kg. 45 sec.+Albit. 30 ml/t	3.7$^{1)}$	3.1$^{1)}$	1.2	2.7$^{1)}$	1.7	1.1	0.3	1.0$^{1)}$
9	MWF of EHF. 1.8 kw/kg. 20 sec.	3.7$^{1)}$	2.5$^{1)}$	1.5	2.6$^{1)}$	1.7	0.9	0.4	1.0$^{1)}$
10	MWF of EHF. 1.8 kw/kg. 20 sec.+Vitavax 200 FF. 1.25 L/t	4.4	2.3$^{1)}$	0.9	2.5$^{1)}$	1.6$^{1)}$	0.8$^{1)}$	0.3	0.9$^{1)}$
11	MWF of EHF.1.8 kw/kg. 20 sec.+Radostim. 0.25 L/t	4.0	3.2$^{1)}$	0.0$^{1)}$	2.4$^{1)}$	1.8	1.3	0.0$^{1)}$	1.0$^{1)}$
12	MWF of EHF. 1.8 kw/kg. 20 sec.+Albit. 30 ml/t	4.4	2.8$^{1)}$	0.6	2.6$^{1)}$	1.9	1.2	0.2	1.1$^{1)}$
	SSD $_{05}$	1.0	2.1	0.7	0.8	0.6	1.0	0.2	0.3

Note: $^{1)}$-Significant difference.

Thus, on the average for 2011–2013, the spreading and development of root rot in the cases of MWF of growth regulators application in the stalk shooting phase was 5.7–7.0 and 2.1–2.8%, respectively, while under the control the indices were 11.0 and 3.7%, respectively. and in the standard case with Vitavax 200 FF they were 8.6 and 2. 3% respectively.

It is noteworthy that the application of MWF of EHF in the modes of 0.9 kw/kg 45 sec, or 1.8 kw/kg. 20 sec, followed by a half-reduced rate of Vitavax 200 FF rate (1.25 L/ha) provided a lower degree of infection caused by root rot to barley plants of the Aspect varieties in the stalk shooting phase than the application of the full rate of the treatment agent; spread was lower by 2.4 and 2.2% respectively, and the development-by 0.3 and 0.5%.

The combination of presown barley seed irradiation of barley seeds with EHF MWF of EHF with the growth regulator treatment in most cases led to a more significant reduction in root rot plant infection by root rots than microwave irradiation itself. For example, in the stalk shooting phase the spreading and development of root rots in the cases of MWF of EHF of 0.9 kw/kg 45 sec.+Radostim, 0.25 L/t and MWF of EHF of 0.9 kw/kg 45 sec.+Albit. 30 ml/t were 6.3 and 2.3% and 5.8 and 1.9%, respectively, on average for three years, while in the case of MWF of EHF of 0.9 kw/kg 45 sec, the indices were 7.0 and 2.8%, respectively.

While recorded during the phase of full ripening. It was found that the positive influence of EHFMWF on reducing the infection of plants caused by root rots have remained the barley same until the end of the vegetation period of barley of both varieties, although there were some differences (Table 12, 13).

Table 12. Spreading and development of root rots on Vyklyk spring barley variety plants in the stalk shooting depending on the method of pre-sowing seed treatment, % (2012-2013).

S.No.	Methods of pre-sowing seed treatment	Spreading			Development		
		2012	2013	Average	2012	2013	Average
1	Control. without treatment	7.7	10.0	8.9	2.4	2.7	2.6
2	Vitavax 200 FF. 2.5 L/t (standard)	4.3	2.1$^{1)}$	3.2$^{1)}$	1.7	0.6$^{1)}$	1.2$^{1)}$
3	Radostim. 0.25 L/t	3.5$^{1)}$	8.8	6.2$^{1)}$	2.3	2.2	2.3
4	Albit. 30 ml/t	4.5	5.4$^{1)}$	5.0$^{1)}$	2.0	0.8$^{1)}$	1.4$^{1)}$

5	MWF of EHF. 0.9 kw/kg. 45 sec.	2.9[1)]	3.3[1)]	3.1[1)]	1.0[1)]	0.9[1)]	1.0[1)]
6	MWF of EHF. 0.9 kw/kg. 45 sec.+Vitavax 200 FF. 1.25 L/t	7.9	7.0	7.5	2.5	1.8	2.2
7	MWF of EHF. 0.9 kw/kg. 45 sec.+Radostim. 0.25 L/t	6.3	3.5[1)]	4.9[1)]	2.2	1.2[1)]	1.7[1)]
8	MWF of EHF. 0.9 kw/kg. 45 sec.+Albit. 30 ml/t	4.5	2.4[1)]	3.5[1)]	1.8	0.6[1)]	1.2[1)]
9	MWF of EHF. 1.8 kw/kg. 20 sec.	5.3	6.1	5.7[1)]	2.0	2.5	2.3
10	MWF of EHF. 1.8 kw/kg. 20 sec.+Vitavax 200 FF. 1.25 L/t	5.8	6.7	6.3[1)]	2.1	2.0	2.1
11	MWF of EHF.1.8 kw/kg. 20 sec.+Radostim. 0.25 L/t	5.7	5.2[1)]	5.5[1)]	2.0	1.4[1)]	1.7[1)]
12	MWF of EHF. 1.8 kw/kg. 20 sec.+Albit. 30 ml/t	2.1[1)]	5.0[1)]	3.6[1)]	1.2	1.4[1)]	1.3[1)]
	SSD_{05}	3.5	4.1	2.0	1.2	1.1	0.5

Note: [1)]-Significant difference.

Table 13. Spreading and development of root rots on Vyklyk spring barley variety plants in the phase of full ripening depending on the method of pre-sowing seed treatment % 2012–2013.

S.No.	Methods of pre-sowing seed treatment	Spreading			Development		
		2012	2013	Average	2012	2013	Average
1	Control. without treatment	5.3	0.6	3.0	1.9	0.2	1.1
2	Vitavax 200 FF. 2.5 L/t (standard)	4.6	0.8	2.7	1.8	0.3	1.1
3	Radostim. 0.25 L/t	2.5	0.3[1)]	1.4[1)]	1.2	0.2	0.7[1)]
4	Albit. 30 ml/t	2.6	0.4	1.5[1)]	1.1	0.2	0.7[1)]
5	MWF of EHF. 0.9 kw/kg. 45 sec.	2.5	0.7	1.6[1)]	0.9[1)]	0.2	0.6[1)]
6	MWF of EHF. 0.9 kw/kg. 45 sec.+Vitavax 200 FF. 1.25 L/t	5.2	0.7	3.0	1.8	0.1[1)]	1.0
7	MWF of EHF. 0.9 kw/kg. 45 sec.+Radostim. 0.25 L/t	3.0	0.4	1.7[1)]	1.0[1)]	0.1[1)]	0.6[1)]
8	MWF of EHF. 0.9 kw/kg. 45 sec.+Albit. 30 ml/t	1.6[1)]	0.2[1)]	0.9[1)]	0.6[1)]	0.1[1)]	0.4[1)]
9	MWF of EHF. 1.8 kw/kg. 20 sec.	3.7	0.3[1)]	2.0[1)]	1.3	0.1[1)]	0.7[1)]
10	MWF of EHF. 1.8 kw/kg. 20 sec.+Vitavax 200 FF. 1.25 L/t	3.2	0.3[1)]	1.8[1)]	1.6	0.1[1)]	0.9
11	MWF of EHF.1.8 kw/kg. 20 sec.+Radostim. 0.25 L/t	3.8	0.6	2.2	1.4	0.2	0.8[1)]
12	MWF of EHF. 1.8 kw/kg. 20 sec.+Albit. 30 ml/t	2.2[1)]	0.2[1)]	1.2[1)]	0.7[1)]	0.1[1)]	0.4[1)]
	SSD_{05}	3.0	0.3	0.9	0.9	0.1	0.3

Note: [1)]-Significant difference.

Thus, as for the Aspect variety. in most cases of MWF of EHF application with additional treatment with the plant growth regulators Radostim and Albit, with the treatment agent Vitavax 200 FF at half-rate. The level of spreading and development of root rot (respectively, 2.4-3.2 and 0.9-1.2%) was lower than in the control (3.8 and 1.5%), but higher than in the standard case with Vitavax 200 FF. 2.5 L/t (2.1 and 0.9%).

As for the Vyklyk variety. on average for the years 2012–2013, while recorded during the stalk shooting phase in most cases of applying MWF of EHF (except MWF of EHF in the mode of 0.9 kw/kg. 45 sec.) and plant growth regulators. the spread and development of root rots (3.5–6.2 and 1.3–2.3%, respectively) were lower than in the control (8.9 and 2.6%). but higher than in the standard case with Vitavax 200 FF (3.2 and 1.2%).

In the phase of full ripening, other tendencies have been identified. In most cases the application of EHF MWF of EHF and growth regulators as well as their combination, significantly lowered the level of spreading and development of root rots of the Vyklyk variety, it was 1.2–2.2 and 0.4–0.9% respectively. whereas under the control the level was lower by 3.0 and 1.1% respectively and in the case with the full rate of Vitavax 200 FF it was 2.7 and 1.1%. The lowest level of spreading and development of root rot was established in the cases with the combination of EHF MWF of EHF and the growth regulator Albit-0.9–1.2% and 0.4%, respectively.

It should be noted that when combined the pre-sown seed treatment with MWF of EHF with the growth regulator Albit 30 ml/t the indices of spreading and development of root rot in the plants of the Vyklyk spring barley variety in the phase of full ripening on average for 2 years were lower than when using MWF of EHF and the Albit preparation separately and were the lowest during the investigation. For example. in the MWF of the EHF case of 0.9 kw/kg. 45 s.+Albit. 30 ml/t these indices were 0.9 and 0.4%, respectively. which is 0.5 and 0.3% lower than in the case of Albit. 30 ml/t and by 0.7 and 0.2% lower than in the case of EHF MWF. 0.9 kw/kg. 45 sec. In the case of EHF MWF. 1.8 kw/kg. 20 sec.+Albit. 30 ml/t these indices were 1.2 and 0.4%, respectively. which is 0.3 and 0.3% lower than in the case of Albit. 30 ml/t and 0.4 and 0.2% lower than in the MWF of EHF case of 1.8 kw/kg. 20 sec. Such regularity has not been noticed with the Aspect barley variety.

Conclusion

Seed treatment with EHF MWF in the determined irradiation modes only or with additional treatment with the growth regulators Mars EL (wheat) and Radostim or Albit (barley) causes a decrease in the spreading and development of root rots in the crops of these agricultural plants. In the case of winter wheat, the spreading and development of root rots in the full ripening phase when treated with MWF of EHF of 1.8 kw/kg. 15 sec. The MWF of EHF of 0.9 kw/kg 45 sec, and the MWF of EHF of 1.8 kw/kg 15 sec.+Mars EL made up 4.9 and 2.1%, 5.4 and 2.0%, 4.9 and 2.1%, respectively, while under the control these indices were 9.7 and 4.0% respectively, and in the case with Vitavax 200 FF-6.1 and 2.4%. Pre-sown seed treatment with EHF MWF of EHF in the modes of 0.9 kw/kg 45 s. or 1.8 kw/kg 20 s. with the Radostim and Albit growth regulators, as well as in their combination cause a decrease in the spreading and development of root rots throughout the growing season of barley varieties. Applying the MWF of EHF in the modes of 0.9 kw/kg 45 sec. or 1.8 kw/kg 20 sec, followed by treatment at a half-reduced rate of Vitavax 200 FF rate (1.25 L/ha) provided a lower degree of root rots of plants of the Aspect barley varieties in the stalk shooting phase than the application of the full rate of the treatment agent when the spreading was lower by 2.4 and 2.2%, respectively. and the development – by 0.3 and 0.5%.

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Citation:

Stankevych, S., Zhukova, L., Horiainova, V., Bezpal'ko, V., Dolya, M., Polozhenets, V., Rozhkova, T., Batova, O., Zaiarna, O.Yu., Golosna, L., Gavryliuk, A., Furdyha, M., Kucherenko, Ye., Zviahintseva, A., Gepenko, O., Bondar, O.B. (2021). Spreading and development of root rots in winter wheat and spring barley plants depending on presowing seed treatment with mwf of ehf and plant growth regulators. Ukrainian Journal of Ecology. 11 (7), 93-109.