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REGULATION OF STRESS PROCESSES DURING THE DISTILLATION OF TULIPS IN CLOSED GROUND CONDITIONS

Abstract

This article presents the results of regulating processes under stressful conditions during the distillation of tulips in an enclosed greenhouse of the Botanical Garden of the International Kazakh-Turkish University named after H. A. Yasavi. In order to evaluate the effectiveness of antistressants against stress factors affecting the decorative, economic and biological indicators of tulips, a 0.2% mixture of the immunomodulatory drug Megafol was used. 15 Dutch cultivars belonging to three classes were selected: triumph (*Curry, Royal Virgin, Sweet Rosy, Novi Sun, Montezuma, Aomory, Panenka, Dutch Design*), fringed (*San Christina, San Luiz, Indiana*), peony tulips (*Akebono, Columbus, Purpule Sky, Icoone*). The database of conditions of influence on the quality indicators of tulips is summarized with the determination of the ratio of greenhouse conditions and outdoor temperature conditions during the growing season according to the conditions of 9- and 5-degree cultivation technology. The effectiveness of 1.5-2% antistressant solution under stressful conditions has been experimentally proven.

The effect of megafol on the production of finished products with high market value was 82-96% according to variety specificity. The effectiveness of the antistressant was manifested in the uniform growth of plants of tulip varieties, in a neutral peat substrate with optimal water-physical properties, an intensive growth of tulips in height was observed, and the plant also meets high consumer requirements for such decorative properties as the volume and height of the perianth and the multicoloration of the corolla.

Key words: tulip variety, germination, graded technology, antistersant, bulb.

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BIOLOGICAL AND ECOLOGICAL STATE OF COMMON SMUT (*USTILAGO ZEAE*) IN CORN SILAGE FIELDS IN THE KYZYLORDA REGION AND MEASURES TO COMBAT IT

Abstract

Corn, as one of the most important grain feed crops, is of great importance in increasing gross grain yields. Corn smut (*Ustilago zeae*) can also cause large economic losses in susceptible sweet corn hybrids. Protection against this pathogen is mainly based on prevention. To date, many corn

smut control methods have been recommended or evaluated, including crop rotation, sanitation, seed treatments, fertility modification, and biological control. Despite these frequently cited control strategies, host resistance appears to be the only effective control method for common smut in areas where *Ustilago zeae* is common. The purpose of the study is to study the resistance to smut against a natural infectious background of samples from a collection of corn from breeding nurseries in Kazakhstan. Based on the results of a study of the resistance of a corn collection to bladder smut against a natural infectious background, varieties were identified on whose plants symptoms of the disease were not detected: Altay 250 MV, Budan 237 MV, Tatty-2012 and Tayelsizdik-20 SV. The identified samples also had high productivity and grain yield. A high level of heritability (Hb2 – 0.85) of the disease susceptibility index among the studied samples was revealed.

***Key words**: corn, bunt, 1000 grain weight, grain yield, descriptive statistics*

Introduction

Sustainable growth in the production of grain crops, including corn, and the creation on this basis of a balanced feed supply is one of the main priorities for ensuring food security both throughout the world and in Kazakhstan. The economic importance of corn as a fodder crop and a number of its biological features determine the high intensity of breeding research over a long period of time. At the same time, the use of a limited set of source material with valuable traits in long-term breeding programs creates the prerequisites for the genetic narrowing of the species *Zea mays* L [1].

In 2023, according to the regional department of agriculture of the Kyzylorda region, in the Kazalinsky district corn was cultivated on 615 hectares, in Zhanakorgansky - on 1111 hectares, in Shielisky - on 174 hectares, in Zhalagashsky - on 700 hectares, in Karmakshinsky - on 39 hectares. It was not planted in the Syrdarya, Aral regions and Kyzylorda.

At present, it is quite obvious that a rational strategy for breeding agricultural crops for resistance to diseases and pests should include expanding the genetic diversity of cultivated varieties and hybrids. The implementation of breeding research programs is based primarily on identifying genetic sources of valuable traits, studying the inheritance of resistance and creating new highly resistant source material [2].

A stable temperature regime during the growing season of plants contributes to the realization of the productivity potential of corn. An increase in air temperature with a simultaneous change in the amount of precipitation or its uneven fall during the growing season, especially in the second half of summer, creates risks for the cultivation of corn, including due to disease. The most harmful disease of corn is smut (*Ustilago zeae* (Beckm.)). Symptoms of the disease in maize plants are very characteristic: pathological neoplasms (galls) are formed on the vegetative and reproductive organs, reaching 30 cm in diameter and representing overgrown plant tissues in which fungal spores form [3, 4].

Common smut cobs infect an average of 3–6% of corn plants each year. In some years, the number of diseased plants increases to 10–12%, and the decrease in productivity can reach 25–30%. Intensive development of the disease is favored by heavy short-term precipitation in the second half of the growing season in combination with elevated (25–30°C) air temperatures [5].

The causative agent of common smut is a heat-loving species; the germination temperature and duration of teliospores are from 0 to +35°C, the optimal is 20–30°C. Spores can persist in the soil for 1–3 years, depending on environmental factors [6, 7]. The harmfulness of the bladder head is manifested in a sharp decrease in crop grain and green mass. By the end of the cobs, yield losses can amount to 50-100%, vegetative organs - 25-50% [8, 9].

In this regard, the purpose of this study is to study the resistance to smut against a natural infectious background of samples of a collection of corn from breeding nurseries in Kazakhstan.

Material and methods

The research was carried out in the conditions of the Kyzylorda region, in 2023, in the field of scientific crop rotation of RZA Agro LLP to study and maintain samples of the corn collection for resistance to *Ustilago zeae*.

The climate of the research region is moderately warm and characterized by instability of all climatic elements. Meteorological conditions during the research contributed to the infection of corn plants by the pathogen. The climatic regime of the Kyzylorda region is determined by the location of the region inside the Eurasian continent, its southern position, the characteristics of atmospheric circulation, the nature of the underlying surface and other factors. The continental climate is manifested in large fluctuations in meteorological elements, in their daily, monthly and annual cycles. There are no sharp differences in temperatures during this period. Everywhere the average July temperature is 26-29°C. The absolute maximum temperature in the predominant part of the region is 44-48°C. The period with an average daily air temperature above 0° C lasts 240-280 days. The average annual precipitation does not exceed 100-190 mm and is distributed unevenly across the seasons: 60% of all precipitation occurs in the winter-spring period. Rainfall and changes in daily temperatures caused intensive development of diseases; cases of high susceptibility of the collection samples were noted (score 9, damage to more than 50% of plants within the plot).

We used generally accepted agricultural technology to maintain the germination of collection samples. The sowing of the studied samples was carried out manually at the optimal time in the third ten days of April, the predecessor being winter wheat. The sowing depth is 5-6 cm, the area of the registration plot is 4.9 m2. The plant density according to the experimental scheme (50-55 thousand plants/ha) was determined by manual breaking in the 4-5 leaf phase.

On a natural infectious background, the degree of damage by the causative agent of bladder smut was assessed in 12 samples of the main subspecies *Zea mays* L adapted in the Kyzylorda and Zhambyl regions. Subspecies of corn differ both in the morphological characteristics of the endosperm and in biological properties (cold resistance, heat resistance, disease resistance), as well as in the chemical composition and technological parameters of the grain. When studying collection samples, the following standards were used: variety Celinnyi 160 SV, self-pollinated lines F2.

Field assessment of the degree of damage to corn by common smut was carried out 15 days after the start of mass flowering of the samples and during harvesting of the cobs. The number of affected plants and the number of affected ears, the percentage of affected plants were taken into account, the degree of damage to collection samples was assessed in points according to the scale of the international classifier SEV *Z. mays* [10,11], where: point 1 – very weak damage (less than 1% affected plants); score 3 – mild damage (1–10%); score 5 – moderate damage (11–25%); score 7 – severe damage (26–50%); score 9 – very severe damage (more than 50%). An additional point (score 0) to the main damage scale was given to samples within the plots of which there was no pathogen damage to the plant at all.

Results and discussion

According to ANOVA analysis ($p < 0.001$), the severity of bladder smut (Ustilago zeae) in maize silage fields varied significantly between samples. A high level of heritability (Hb2 – 0.85) of the disease susceptibility index among samples in 2022 was shown (Table 1).

Table 1 – Analysis of variance (ANOVA) of field assessment for *Ustilago zeae* on a corn collection

Experiment	Factor	SS	df	MS	F-value	p-value	H_b^2, %
Field assessment for *Ustilago zeae*	Genotype	11061.7	11	10827.9	4.249	5,261E-08	0.85
	Year	18103.0	1	35363.3	13.88	0.000438	
	Residuals	72974.4	47	2548.08			
Notes: Notes: SS – a sum of squares; df – degree of freedom; MS – mean squares; H_b^2 – broad-sense heritability index. *** Significant difference at $p < 0.001$.							

Table 2 presents results for plant height, productivity traits, and field assessment for corn bunt (Ustilago zeae). Based on plant height, the samples ranged from 170 to 305 cm. 3 samples showed the tallest: Kazakhstanskii 700 SV (300 cm), Kazakhstanskii 705 SV (305 cm) and Turan 480 SV (305 cm).

Table 2 – The results of research on the signs of productivity and field resistance to common smut *Ustilago zeae*

#	Name of samples	Plant height, cm	Weight of 1000 grains, g	Grain yield, %	Field assessment for *Ustilago zeae*, point
1	Altay 250 MV	250	328	80	1
2	Budan 237 MV	245	320	83	1
3	Kazakhstanskii 587 SV	265	288	81	3
4	Kazakhstanskii 700 SV	300	285	80	3
5	Kazakhstanskii 705 SV	305	290	82	3
6	Tatty-2012	195	260	80	1
7	Tayelsizdik-20 SV	290	300	80	1
8	Turan 480 SV	305	290	83	3
9	Turan 559 SV	280	290	80	3
10	Turan 680 SV	286	300	80	3
11	Bereke -2017	170	215	82	3
12	Celinnyi 160 SV	250	310	80	3

According to the results of a field assessment of the degree of damage to corn by common smut, twelve corn samples were divided into two groups. Four samples (36.3%) with very weak lesions (less than 1% of affected plants) were assigned to the first group: Altay 250 MM, Igvft 237 MM, Tatty-2012 and Nayelsizdik-20 SV. The second group included seven maize samples (63.7%) with a weak lesion (1-10%), they included varieties Kazakhstanskii 587 SV, Kazakhstanskii 700 SV, Kazakhstanskii 705 SV, Tigap 480 SV, Tigap 559 SV, Tigap 680 SV and Celinnyi 160 SV. Figure 1 shows a potential lesion of the common smut of corn by the causative agent *Ustilago zeae*.

Figure 1 – The causative agent of the common smut disease of corn *Ustilago zeae*

According to the trait, the weight of 1000 corn grains varied from 215 g to 320 g. The following samples distinguished themselves as having the highest yield: Turan 559 SV (290 g), Turan 480 SV (290 g), Kazakhstanskii 705 SV (290 g), Turan 680 SV (300 g), Tayelsizdik-20 SV (300 g), Budan 237 MV (320 g) and Altay 250 MV (328 g). The grain yield of the studied corn samples was from 80% to 83%.

Table 3 and Figure 2 present Boxplots analysis of quantitative data (descriptive statistics) based on plant height, 1000 grain weight, grain yield, and field assessment of resistance to corn smut pathogen *Ustilago zeae*. The results are presented using graphical data analysis, in which the box itself contains the middle 50% of the data, the top edge (hinge) of the box indicates the 75th percentile

of the data set, and the bottom hinge indicates the 25th percentile. The average yield is indicated by a horizontal line in the box. The top and bottom lines of the chart represent yields between the 10th and 90th percentiles. The points behind the lines correspond to outliers.

Table 3 – Descriptive statistics (Quantitative data) according to the studied characteristics of corn samples

Statistic	Plant height, cm	Weight of 1000 grains, g	Grain yield, %	Field assessment for *Ustilago zeae*, point
Minimum	170,000	220,000	80,000	1,000
Maximum	305,000	328,000	83,000	3,000
Freq. of minimum	1	1	7	4
Freq. of maximum	2	1	2	8
Range	135,000	108,000	3,000	2,000
1st Quartile	248,750	287,250	82,000	1,000
Median	272,500	290,000	80,000	3,000
3rd Quartile	292,500	302,500	83,000	3,000
Sum	3141,000	3481,000	971,000	28,000
Mean	261,750	290,083	80,917	2,333
Variance (n)	1697,021	731,076	1,410	0,889
Variance (n-1)	1851,295	797,538	1,538	0,970
Standard deviation (n)	41,195	27,038	1,187	0,943

The general variable showed that the distribution of samples between groups was within the following range: for plant height – Min – 170.0; 1st Qu –248.750 and median – 272.500; Mean – 261.750; 3rd Qu – 292,500; Max – 305,000, variance(n-1) – 1851,295, St. deviation – 41.195; by weight of 1000 grains – Min – 220.0; 1st Qu –287.250 and median – 290.000; Mean – 290.083; 3rd Qu – 302,500; Max – 328,000, variance(n-1) – 797,538, St. deviation – 27.038; based on grain yield – Min – 80.0; 1st Qu –82.0 and median – 80.0; Mean – 80.917; 3rd Qu – 83.0; Max – 83.0, variance(n-1) – 1.538, St. deviation – 1.187; for field resistance to bladder smut Ustilago zeae – Min – 1.0; 1st Qu –1.0 and median – 3.0; Mean – 2.333; 3rd Qu – 3.0; Max – 83.0, variance(n-1) – 1.538, St. deviation – 1.187.

Effective measures to corn common smut are optimal sowing dates, compliance with crop rotation, seed treatment and high-quality soil tillage, and incorporation of plant residues. The economic importance of corn as a fodder crop and a number of its biological features determine the high intensity of breeding research over a long period of time.

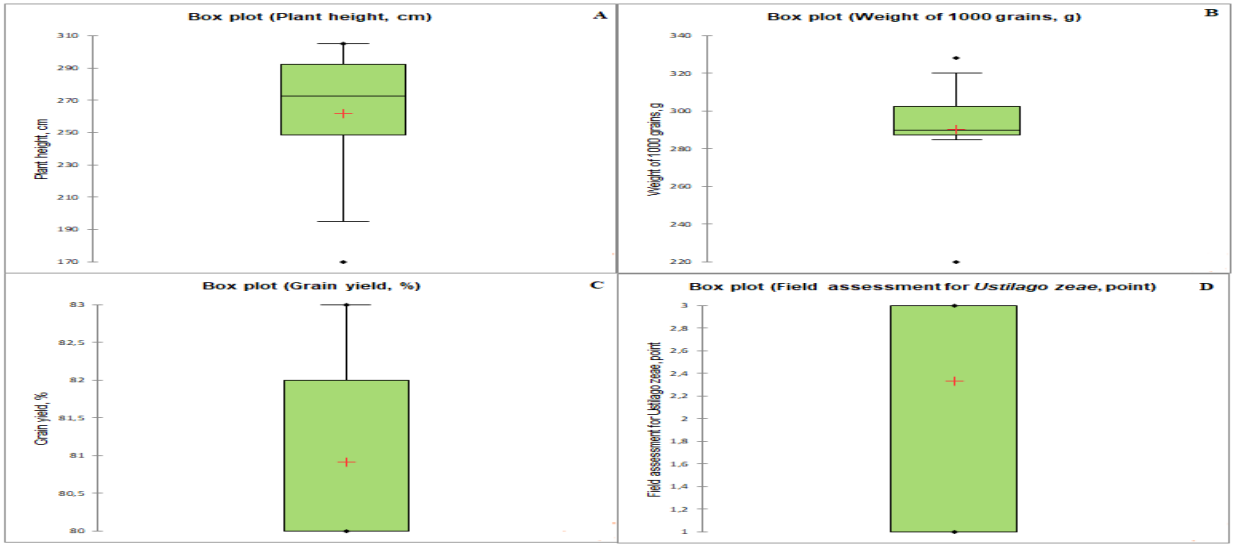

Figure 2 – Boxplots of plant height (A), weight of 1000 grains (B), grain yield (C) and of field assessment for disease (D)

Conclusions

All subspecies of corn can be affected by the disease, but starchy corn is most susceptible to the effects of blister smut. The loose and mealy endosperm of this subspecies is able to quickly absorb moisture, creating favorable conditions for the development of fungal diseases. Therefore, starchy corn, compared to popping, flint and other subspecies, is less resistant to disease and is usually cultivated in dry areas. In the process of self-pollination of corn plants, it is possible to identify lines with varying degrees of resistance to bladder smut. Incineration has such a strong effect on the genotype of the original forms that it causes the formation of lines contrasting in resistance to the disease, from resistant to susceptible. This effect of incubation manifests itself already from the first generations and continues until I5. The number of lines and the degree of their resistance to smut depend on the hereditary capabilities of the source material. The latest methods of breeding work on corn are focused on the complex resistance and adaptability of plants and provide for a comprehensive immunological study of source material of various ecological and geographical origins. The most promising method in combating the disease is the selection of resistant self-pollinated lines and hybrids. The initial stage of breeding work for disease resistance is the identification of new sources of resistance. The relevance of the search for new resistant forms is increasing over time, primarily due to the loss of effectiveness of those currently used.

Thus, field studies made it possible to identify polymorphism in the maize collection samples for resistance to *Ustilago zeae*. Disease-resistant forms can be isolated within any subspecies assortment of collection specimens, especially during periods favorable for the development of the pathogen. Popping corn grain has a relatively high protein content (up to 16%) and can be widely used in food production for the manufacture of cereals, flakes and other products.

Based on the results of studying the resistance of a corn collection to bubbly smut against a natural infectious background, samples were isolated on whose plants symptoms of the disease were not detected: Altay 250 MV, Budan 237 MV, Tatty-2012 and Tayelsizdik-20 SV. The identified samples also had high productivity and grain yield. Breeders recommend that in order to improve the soil from bladder smut infection, it is necessary to place corn crops after grain and vegetable crops, perennial grasses, soybeans, potatoes and other predecessors. Comprehensive protection of corn crops from mold fungi and smut species includes seed treatment with the combined drug Vitavax 200 FF containing carboxyl and thiram, or systemic - Maxim XL.

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ҚЫЗЫЛОРДА ОБЛЫСЫ ЖАҒДАЙЫНДАҒЫ СҮРЛЕМДІК ЖҮГЕРІ ЕГІСТІГІНДЕ КЕЗДЕСКЕН КӨПІРШІКТІ ҚАРА КҮЙЕ (*USTILAGO ZEAE*) АУРУЫНЫҢ БИОЛОГИЯЛЫҚ, ЭКОЛОГИЯЛЫҚ ЖАҒДАЙЫ ЖӘНЕ КҮРЕСУ ШАРАЛАРЫ

Аңдатпа

Жүгері маңызды дәнді-азықтық дақылдардың бірі ретінде астықтың жалпы түсімін арттыруда үлкен маңызға ие. Көпіршікті қара күйе (*Ustilago zeae*) сезімтал тәтті жүгері будандарында да үлкен экономикалық шығындарға әкелуі мүмкін. Бұл қоздырғыштан қорғау негізінен алдын алуға негізделген. Бүгінгі күні жүгері дақылымен күресудің көптеген әдістері ұсынылған немесе бағаланған, соның ішінде ауыспалы егіс, санитария, тұқымдарды өңдеу, құнарлылықты өзгерту және биологиялық бақылау. Осы жиі келтірілген бақылау стратегияларына қарамастан, иесінің қарсылығы Ustilago zeae жиі кездесетін аймақтарда жалпы иіспен күресудің жалғыз тиімді әдісі болып көрінеді. Зерттеудің мақсаты – Қазақстандағы асыл тұқымды питомниктерден жүгері коллекциясынан алынған сынамалардың табиғи инфекциялық фонында қоқыс ауруына төзімділігін зерттеу. Табиғи инфекциялық фонға жүгері коллекциясының қуық дақтарына төзімділігін зерттеу нәтижелері бойынша өсімдіктерінде ауру белгілері анықталмаған сорттар анықталды: Алтай 250 МВ, Будан 237 МВ, Татты-2012 және Тайелсіздік. -20 SV. Анықталған үлгілердің өнімділігі мен астық өнімділігі де жоғары болды. Зерттелген үлгілер арасында ауруға бейімділік индексінің тұқым қуалаушылықтың жоғары деңгейі (Hb2 – 0,85) анықталды.

Кілт сөздер: жүгері, көпіршікті қара күйе, 1000 дәннің салмағы, астық шығымы, сипаттамалық статистика

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БИОЛОГО-ЭКОЛОГИЧЕСКОЕ СОСТОЯНИЕ ПУЗЫРЧАТАЯ ЧЕРНОЙ ГОЛОВНИ (*USTILAGO ZEAE*) НА СИЛОСНЫХ ПОЛЯХ КУКУРУЗЫ КЫЗЫЛОРДИНСКОЙ ОБЛАСТИ И МЕРЫ БОРЬБЫ С НЕЙ

Abstract

Кукуруза, как одна из важнейших зернофуражных культур, имеет большое значение в увеличении валовых сборов зерна. Обыкновенная головня кукурузы (*Ustilago zeae*) также может вызвать большие экономические потери у восприимчивых гибридов сладкой кукурузы. Защита от этого патогена в основном основана на профилактике. На сегодняшний день рекомендовано или оценено множество методов борьбы с кукурузной головней, включая севооборот, санитарию, обработку семян, изменение плодородия и биологический контроль. Несмотря на эти часто упоминаемые стратегии борьбы, устойчивость хозяина, по-видимому, является единственным эффективным методом борьбы с обыкновенной головней в тех районах, где распространен *Ustilago zeae*. Целью исследования является – изучение устойчивости к пузырчатой головне на естественном инфекционном фоне образцов коллекции кукурузы из селекционных питомников Казахстана. По результатам исследования устойчивости коллекции кукурузы к пузырчатой головне на естественном инфекционном фоне выделены сорта, на растениях которых симптомы заболевания не выявлены: Altay 250 MV, Budan 237 MV, Tatty-2012 и Tayelsizdik-20 SV. Идентифицированные образцы также имели высокую продуктивность и выход зерна. Выявлен высокий уровень наследуемости (H_b^2 – 0.85) индекса восприимчивости к заболеванию среди изученных образцов.

Keywords: кукуруза, пузырчатая головня, масса 1000 зерен, выход зерна, описательная статистика

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BACILLUS THURINGIENSIS – БИОЛОГИЯЛЫҚ ҚОРҒАУ ҚҰРАЛДАРЫНЫҢ НЕГІЗІ

Аңдатпа

Алматы және Ақмола облыстарында жүргізілген маршруттық зерттеулер кезінде *Bacillus thuringiensis* изоляттарын оқшаулау үшін табиғи субстраттар (топырақ, жапырақ қалдықтары, ағаш қабығы) жиналды. Бұл ретте Алматы және Ақмола облыстарының жағдайында бактериоз белгілері бар қабыршаққанаттылар отрядынан 84 өлі жәндік табылды. Жиналған бактериоз белгілері бар жәндіктердің мәйіттерінен *Bacillus thuringiensis* бактериясының 30 табиғи изоляттары бөлініп алынды. Бүгінгі таңда изоляттар Жазкен Жиембаева атындағы Қазақ Өсімдіктерді қорғау және карантин ҒЗИ биотехнологиялық зертханасының микроорганизмдер коллекциясында сақтаулы.

Коллекция штаммдары физиологиялық және биохимиялық қасиеттері мен серологиялық идентификациясы негізінде келесі серотиптерге жатқызылды: *Bt kurstaki* түр тармағы; 3a363c, H4ab – *Bt sotto* түр тармағы және 31 *Bt toguchini* түр тармағының серотиптері Штамдардың биологиялық белсенділігін бағалау екінші және үшінші жас мөлшеріндегі алма күйе көбелегінің жұлдызқұрттарына зертханалық сынақ жүргізілді. Эксперимент вируленттілігі