UDC 633.15:631.527:632.9
KHOLOD S., KHARCHENKO L., scientists
Ustymivka Experimental Station of Plant Production
Yuryev Plant Production Institute of NAAS of Ukraine
e-mail: udsr@ukr.net

SOURCE MATERIAL RESISTANCE TO MAIZE SMUT DISEASES

The characteristic of introduced genotypes of maize for resistance to smut diseases. An analysis of defeat 48 samples of maize different groups of ripeness. Confirmed by the data, that the main influence on the development of maize smut disease had abiotic factors, particularly temperature and precipitation. The structural analysis of the harvest on the parameters: weight of grain with cob, grain number, weight of 1000 grains. Substantial grain losses were observed in damage of 5% of plants, and in damage of 40% harvest practically non formed. Allocated the samples, which are sources of resistance to common smut, which can be used in breeding maize for resistance to the disease.

Keywords: *maize, common smut, a source of resistance, damage, harmfulness*

Introduction. Production of maize is an important component of total grain production in Ukraine. Its modern economic importance and, in particular, to ensure reliable grain-fodder balance – has no alternative. Among the cereal cultures maize occupies a place of honor as an indispensable source of raw materials used in livestock industry as well as in the industrial sector for the production of oil and fuel [8]. In Ukraine area of maize takes third place after winter wheat and spring barley, accounting for almost 15% of the gross grain yield [5]. Involvement in production of high-productive maize hybrids and its concentration in the area of specialized agricultural organization is accompanied not only increase yield capacity, but also a number of problems. Of particular anxiety is the deterioration of the general phytosanitary condition of crops, accompanied by a strengthening of the harmful effects of diseases and pests of crops [7]. In the economic situation which has developed, the value of disease-resistant varieties and hybrids, as one of the components improvement of ecological situation and factor resource saving technologies, growing.

In recent years Ukraine has seen a deterioration in the phytosanitary condition agrocenoses, caused by the influence of environmental and economic factors, that led to a sharp increase of the number and extension zones of harmfulness of main diseases and pests. The concentration sown area of maize in specialized farms and short rotational crop rotation leads to accumulation in soil pathogens, among which deserve special attention smut disease (common and head). If a strong degree of defeat them, grain harvest shortfall in the farms of Ukraine may be 15-20% due to affection of cobs, as well as through the hidden costs, associated with the loss of some of shoots, low height of plants and underdeveloped cobs [13]. Negative activity of pests and pathogens, causes not only reduced harvest of grain or silage, but the deterioration of their quality.

Of the most harmful diseases of maize in Ukraine is a head and common smut. The causative agent of maize common smut – basidiomycetes *Ustilago zeae* (Beckm) Unger. The disease is spread over, where growing maize: Europe, Asia, America, Africa and Australia. In Ukraine the disease is widespread, but has the most damage in semi-dry central areas of the Steppe, especially when growing the susceptible hybrids, existing disease 10-25% of plants. Harmfulness of the disease is a significant shortfall of the crop due to damage of different plant organs, sterility of cobs under conditions of early infection, also in the death of infected young plants. In the value of yield losses affect the number, size and location of blisters on the individual plant. The blisters of large sizes cause losses of about 60% or more, medium size – 25%, smaller – 10% [11].

In appearance volatile smut differs from common smut, so that in the first – accumulation of spore dry and do not have shell, while the other swellings covered with fleshy, shiny, wet from mid the shell. In Ukraine volatile smut is much less common than the maize smut, found mostly in regions with enough moisture.

The ebsence of biological resistance to pathogens smut diseases in hybrids causes the need study resistance of material to detection of sources of perseverance and put them in the selection process [12]. Some authors argue, that resistance to the maize smut disease depends largely on the origin. M.I. Vavilov in their studies pointed out to Mexico and Central America, which are the main centers of the introduction of maize plants in culture [2]. Thanks to variability, adaptability and high yield of maize considerably spread in the countries of Old World. Complicated evolutionary process of creating contributed to the emergence diversity characteristic and formation of various types of variability. In each zone selection on immunity to conducted to those diseases, that are most common and harmful [12].

Steadiness to pathogens of smut diseases are very complex traits, which determined as the morphological and biological characteristics of plants and their genetic structure. The same varieties, lines, hybrids in different environments, different level of steadiness [3].

The aim of this work was envisaged complex the study and evaluation of the different origin introduced varieties and populations of maize for resistance to common smut and head smut in conditions of natural infection.

Materials and methods. Field and laboratory experiments were conducted in a introduction-quarantine nursery, and in the collection nursery department of maize crop from Ustymivka Experimental Station of Plant Production of Yuryev Plant Production Institute of NAAS Ukraine during 2008-2010. Farming equipment consistent with the adopted to the Forest Steppe of Ukraine the technology of growing maize. Materials of researches were 48 maize samples, including 16 varieties and 27 populations from Spain and Mexico.

Weather conditions for plant growth were as follows: period "sowing-shoots" marked shortage of the sum of active temperatures in 2008 and the optimum conditions in 2010. The development of plants, filling and the formation of grain were in dry conditions 2009 and opportune - 2008, 2010 (table 1). In general the weather conditions were opportune for growing of maize.

Table 1

The weather conditions during the vegetation season of the research

Year	Sowing-shoots				Shoots-flowering panicles				Flowering panicle - wax ripeness of grain			
	sum of active temperatures, ^{0}C	% of optimum conditions	precipitation, mm	% of optimum conditions	um of active temperatures, ^{0}C	% of optimum conditions	precipitation, mm	% of optimum conditions	um of active temperatures, ^{0}C	% of optimum conditions	precipitation, mm	% of optimum conditions
2008	328,4	+9,5	65,1	-34,9	719,6	+2,8	69,2	-44,6	1394,2	+5,6	123,5	+37,2
2009	336,5	+12,2	37,5	-62,5	838,9	+19,8	31,6	-74,7	1359,7	+3,0	9,4	-89,6
2010	387,7	+29,2	22,1	-77,9	843,6	+20,5	42,6	-65,9	1611,3	+22,1	112,2	+24,7

Accounting the degree of damage of disease carried on a scale of perseverance with gradations: up to 5% damage of cobs – highly resistant, 5,1-25% – resistant, 25,1-50% – medium resistant, 50,1-75% – susceptible, an more 75% - highly susceptible.

Economically valuable traits (productivity with plant, ripeness group etc.) of the samples were determined according to "Methodological recommendations for field and laboratory studies of the genetic resources of maize" [9] and "Recommendations for the studing of foreign samples of crops in the introduction quarantine nyrsery" [10]. Morphological evaluation was performed according to " Descriptor- reference book for the Zea Mays L. species" [5].

By groups of ripeness samples distributed as follows: 9 – mild-early (18,7%), 14 – middle-ripping (29,2%), 10 – medium ripping (20,8%), 15 – late ripping (31,2%).

Samples of maize belonging to three subspecies: indurata, semidentata and indentata.

Results and discussion. On development of common smut, primarily, affecting climatic factors – high temperatures and lack of rainfall (less than ½ of normal), especially during of the period "flowering cobs - grain filling" [1].

Determine the effect of rainfall and relative humidity for resistance of maize to common smut conducted during the flowering cobs (July and I-II decade of August), when the plants are most susceptible to the disease. For the small amount of precipitation and days with relative humidity below 40% of lesions observed affection samples of maize (2009), drought alternating with a small number of rainfall in 2008, 2010 has increased the development of the disease (table 2).

Table 2

Damage to plants maize common smut, depending on rainfall and relative humidity below 40%

Years	Amount of precipitation by decade (mm)						The amount of rainfall for the period (mm)	Number of days		Average number of infected plants (%)
	July			August				with precipitation	relative humidity of 40% and below	
	I	II	III	I	II	III				
2008	73,4	27,6	3,1	0	3,0	16,0	123,1	14	3	7,5
2009	0	0	0	0	6,6	2,8	9,4	4	8	3,5
2010	79,2	16,2	0,7	0	2,7	3,4	102,2	11	2	10,7

In general the most favorable for development of disease was 2009, less favorable – 2008 and 2010. Intensive development of maize smut disease on maize was observed during July – early August, when dry periods alternated with moderate moisture, that are optimal conditions for the development of maize smut diseases.

Studies have shown, that in most samples of maize most often affects young cobs and your rudiments. They located in the leaf axils below the cob and thus their number depends on number of nodes on the stem and lay the cob height [4]. Most strongly affected samples with high laying cob and a large number reproductive rudiments (table 3).

Table 3

Affection of maize plants depending on the morphological and biological properties

Groups of samples on ripening	Number of samples	Plant height (cm)	The height of the lower cob (cm)	Number reproductive rudiments	Number of infected plants (%)
Medium early	9	168	36	2-3	4,1
Mild-ripping	14	202	48	3-4	4,9
Mild-late	10	284	55	5-6	8,7
Late ripping	15	319	78	7-8	18,0

Resistance maize samples also associated with length of growing season. Medium-early and mild-ripping forms low with laying cob, a small number of reproductive rudiments, are affected to a lesser extent. Mild-late and late ripping forms of high laying cobs and a large number reproductive rudiments affected considerably, so long as their tissues are affected by negative factors.

We have determined, that in the field plants of samples of corn, that have been studied most susceptible to the disease on the phase of 4-6 leaves prior to the milky stage – especially during panicle development. Earlier affected is rare and usually ends with death of plant. Defeat later phase of milky ripeness is negligible or is accompanied by a slight degree of the disease.

Determining the percentage of infected plants common smut during harvest showed high perseverance in some samples (table 4).

Table 4

The degree of damage of maize common smut, 2008-2010

Groups of resistance	Introduced samples of maize
Highly resistant (up 5,0%)	Menforte, Armariz, Xermade, Maceda, La Frangueira, Viana, Guillarey, Lalin, Coristanco, H POLL 7 C0
Resistant (5,1-25,0%)	Canicouva, Cammbre, Prodocabalos, Monfero, TAMA 125 OAXA 70, H POOL 7 C0, H POOL 29 C24, H POOL 30 C23, H POOL 31 C20, H POOL 1 C0, H POOL 2 C0, H POOL 3 C0, H POOL 4 C0, H POOL 5 C0, H POOL 8 C0, H POOL 9 C0, H POOL 0 C0, H POOL 12 C0, POLL 15 C29,H POOL 32 C26, H POOL 33 C23
Medium resistant (25,1-50,0%)	Ortigueira, Cee, Foz, NAYA 29, NAYA 54, CHIH 436, H POOL 6 C0, POLL 16 C28, H POOL 34 C23, H POOL 17 C34, H POOL 18 C30
Susceptible (over 50,1%)	–

In conducting structural analysis of samples of maize was found, that the damage 5% of plants in the cobs formed small swellings (up to 2 cm in diameter), preferably at the upper part of the cob. During maturation have increased wraps cobs under weight of mature teliospores. The damage cob grain content well, but the number of grains in them was lower than not damaged cobs. 1000 grain weight in them flush with not damaged cobs. As a result, in damage samples experienced a slight decrease mass of grain with cob.

When damage 10% of plants showed proliferation of swellings and were significant changes in comparison with healthy cobs. Length of cob less, order of the grain rows dislodged, grains of different size and lower the quantity, 1000 grain weight smaller, weight grain with cob also smaller, namely disease development by 10% of plant caused the decrease productivity by 50%.

In 20% of the plants damage, swelling considerably expanded, grains that formed during under mass teliospores – small, shrunken. Content of cob is uneven. Weight of grains with cob with this level of infestation was on average 75% lower than in healthy plants. With increasing damage intensity to 40% – cob size is twice less than healthy. Most cobs at this level of damage not form a grain. If the grains are formed they shrunken, 1000 weight of grains is very small. Because of this damage weight grain with cob decreased by 95%, that harvest practically not formed. During more intense damage (60% or more) instead grain content cob formed a solid mass spore.

Conclusions. High temperature and conditions, when periods sufficient moisture alternating with her lack of, more favorable for the development of common smut, than the conditions systematic sufficient moistening. In years, when the growing season rainfall is uneven, common smut is very much, but prolonged droughts unfavorable to its development. Infestation of plants is always higher at low (40% or less) or high (80% and above) humidity of air, than at optimum (60%). Infestation of cob of maize common smut affects to their length, number of grains cobs, grain weight with cobs, 1000 grain weight and height of plants. Specific weather conditions during years of study (2008-2010) made it possible to identify the source and install individual resistance to common smut on natural background of introduced maize samples originating from Mexico and Spain.

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Анотація

Холод С.М., Харченко Л.Я.

Вихідний матеріал кукурудзи за стійкістю до сажкових хвороб

Наведена характеристика інтродукованих генотипів кукурудзи за стійкістю до сажкових хвороб. Проведено аналіз ураження 48 зразків кукурудзи різних груп стиглості. Підтверджено даними, що основний вплив на розвиток сажкових хвороб кукурудзи мали абіотичні чинники, зокрема, температура повітря та опади. Проведено структурний аналіз врожаю за показниками: маса зерна з качана, кількості зерен, маса 1000 зерен. Істотні втрати зерна спостерігалися при враженні 5% рослини, а при враженні 40 % – урожай практично не формувався. Виділено зразки, що є джерелами стійкості до пухирчастої сажки, які можна використовувати в селекції кукурудзи на стійкість до даної хвороби.

Ключові слова: *кукурудза, пухирчаста сажка, джерело стійкості, ураженість, шкідливість*

Аннотация

Холод С.Н., Харченко Л.Я.

Исходный материал кукурузы по устойчивости к головневым болезням

Приведена характеристика интродуцированных генотипов кукурузы по устойчивости к головнёвым болезням. Проведен анализ поражения 48 образцов кукурузы различных групп спелости. Подтверждено данными, что основное влияние на развитие головневых болезней кукурузы имели абиотические факторы, в частности, температура воздуха и осадки. Проведен структурный анализ урожая по показателям: масса зерна с початка, количество зерен, масса 1000 зерен. Существенные потери зерна наблюдались при поражении 5% растений, а при поражении 40% – урожай практически не формировался.

Выделено образцы, являющиеся источниками устойчивости к пузырчатой головне, которые можно использовать в селекции кукурузы на устойчивость к данной болезни.

Ключевые слова: *кукуруза, пузырчатая головня, источник устойчивости, пораженность, вредность*