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TECHNICAL EFFICIENCY

of funcicides in maize growing

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Goal. *To determine the technical efficiency of fungicidal treatments against helminthosporiosis, rust and fusarium ear rot in the conditions of the western forest-steppe of Ukraine.* ***Methods.*** *Field. The research scheme included 13 variants with different amounts of fungicidal treatments. The following fungicides were used in the experiments: Abacus e.c. (epoxiconazole 62.5 l/ha + pyraclostrobin 62.5 l/ha), Coronet 300 SC (trifloxystrobin 100 g/l + tebuconazole 200 g /l), Custodia CS (tebuconazole 200 g/l + azoxystrobin 120 g/l), Acanto KS (picoxystrobin — 250 g/l. Records of diseases were performed according to generally accepted methods in the phase of wax ripeness.* ***Results.*** *Studies have shown that fungicidal treatments reduce the development of helminthosporiosis by 14.9—25.9%, rust — by 4.0—19.4% and fusarium ear rot by 3.2—6.3%. The weighted average development of maize diseases depended on the period of application and the amount of fungicidal sprays. Among the one-time treatments, the lowest level of disease development was when spraying in the phase of panicle ejection, among double treatments — 10 leaves and panicle ejection. Three uses of fungicides in the phase of 10 leaves, shedding of panicles and after flowering reduced the development of helminthosporiosis to 4.4%, rust — to 3.5%, fusarium ear rot — to 1.2%. The highest level of protection was obtained in the variant of four preparations in the phase of 10 leaves, ejection of panicles, after flowering and grain filling, where the development of helminthosporiosis was 4.4%, rust — 2.9%, fusarium ear rot — 1.1%. The technical efficiency of the studied drugs increased with increasing number of fungicidal treatments and was the highest in the variant of four applications of fungicides, which is 86.6% against helminthosporiosis, 87.0% against rust and 85.5% against fusarium ear rot.* ***Conclusions****. The technical effectiveness of fungicides depends on the period of application of the drug and increases with an increase in the number of treatments. High technical efficiency was noted in the variant of the three-time introduction of fungicides in the phase of 10 leaves, throwing out the panicle and after flowering. The highest efficiency is in the variant of the four-time introduction of fungicides in the phase of 10 leaves, throwing out the panicle, after flowering and filling the grain.*

efficiency; diseases; rust; helminthosporium; fusarium

Maize is less affected by disease than other cereals, but it can cause significant damage to crops. Shortages and crop losses due to the development of diseases can reach 30—50%. In addition, there is a deterioration in crop quality [1].

Further growth of maize production is closely related to the reduction of losses due to diseases through a set of organizational and agronomic measures that will maximize the genetic potential of a variety or hybrid [2].

The most common and harmful diseases of corn in Ukraine are blistering and volatile soot, helminthiasis, fusarium ear rot, rust. Depending on the area of corn cultivation, root and stem rot, seed mold, bacteriosis, cob pain, etc. are also manifested. [3].

Harmfulness of helminthosporiosis or brown spot and rust is pre-

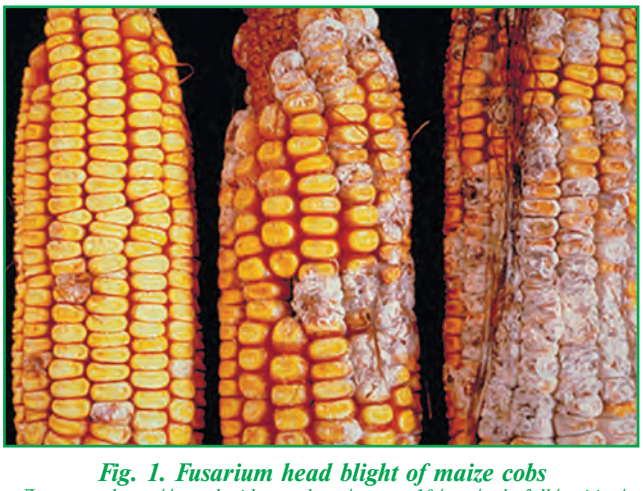

Fig. 1. Fusarium head blight of maize cobs
Джерело: https://apps.lucidcentral.org/pppw_v10/text/web_full/entities/maize_fusarium_kernel_rot_224.htm

Fig. 2. Helminthosporium of maize
Джерело: https://www.ipmimages.org/browse/detail.cfm?imgnum=5585605#javascript:fullscreen()

mature death of leaves and, consequently, reduced grain productivity of corn plants.

Harmfulness of fusarium wilt — in reducing the yield and quality of grain. Developing fungi in the process of life emit harmful substances — mycotoxins. Feeding animals, especially pigs, with the affected grain causes vomiting, refusal of food, pulmonary edema, reproductive disorders, etc. The presence of mycotoxins in grain can cause cancer of the human esophagus. Young children, whose diet is rich in cereals, are under special threat [4—6].

The development of helminthosporiosis from 5 to 25% on 60 — 100% of sown areas in Lviv, Khmelnytsky, Chernihiv and Chernivtsi regions was recorded [7].

In the area of western Polissya the development of dark mold, gray rot and fusarium reached 7.0%, and helminthosporiosis — 15.9% [8].

In the Khmelnytsky Institute of APV, the prevalence of helminthiaspor in corn is 11—53.3% with a development of 1.2—11.5 points, depending on the hybrid composition [9].

The use of the fungicide Optimo (200 g/l pyraclostrobin) at a rate of 0.5 l/ha at the beginning of the ejection of the panicle reduced the incidence of fusarium ear rot by 3.4—12.8%, and the drug Privent (250 g/l triadimefon) 0.6 kg/ha — by 2.0—12.3%. Efficacy against vesicular soot for treatment with Optimo 5.5—33.4%, Prevent — 3.0—29% [10]. In the conditions of artificial infection with fungi of the genus Fuzarium use Amistar Extra SC (200 g/l azoxystrobin + 80 g/l cyproconazole), Abacus Ultra, CE (62.5 g/l epoxiconazole + 62.5 g/l pyraclostrobin), Acanto Plus, KS (200 g/l cyproconazole + 80 g/l picoxystrobin) increased the weight of 1000 grains and allowed to save 5.7—7.7 c/ha of corn yield [11].

The level of protection of corn against diseases also depends on the duration of application of the fungicide. The efficiency of application of Prozaro (125 g/l prothioconazole + 125 g/l tebuconazole) 0.8 l/ha against fusarium ear rot in the phase of 4—6 leaves and at the beginning of the panicle ejection was 36.9 and 40.8%, respectively. And the efficiency of Prozaro 1.0 l/ha in combination with the insecticide was 58.6% [12].

The use of fungicides in the cultivation of corn is currently not widespread due to rising material costs. However, the size of the preserved harvest gives reason to investigate the effectiveness of their application.

The aim. To establish the technical efficiency of the studied fungicides for growing corn against helminthosporiosis, rust and fusarium wilt in the conditions of the western Forest-Steppe of Ukraine.

Methods. The field method was used. The experiments were conducted during 2018—2020 in the research field of the Research and Production Center «Podillya» Podolsk State Agrarian and Technical University. The total area of the plot is 40 m², accounting — 30 m².

The soil of the experimental site — typical chernozem is characterized by the following agrochemical indicators: humus content — 3.21—3.29%, nitrogen supply (according to Cornfield) low — 116—119 mg/kg of soil, mobile phosphorus (according to Chirikov) average — 91—97 mg/kg of soil, potassium metabolism (according to Chirikov) — 81—89 mg/kg of soil, pH — 6.5.

Predecessor — winter grains. After collecting the previous one, disking was carried out at 10—12 cm. Plowing was carried out at 26—28 cm. Mineral fertilizers in the norm of $P_{60}K_{100}$ were applied under fallow plowing. In the spring we closed the moisture, pre-sowing cultivation and application of nitrogen fertilizers — N_{120}. Hybrid LG 3258 (FAO 250).

Weed protection included the application of the herbicides Primextra TZ Gold 500 SC (DR S-metolachlor — 312.5 g/l + terbuthylazine — 187.5 g/l) — 4.0 l/ha and MySter 62 c. d. (foramsulfuron 300 g/kg + iodosulfuro 20 g/kg + isoxadifen-ethyl 300 g/kg) — 0.15 kg/ha. Fungicide consumption rate: Abacus m.e. (epoxiconazole 62.5 l/ha + pyraclostrobin 62.5 l/ha) — 1.5 l/ha), Coronet 300 sc (trifloxystrobin 100 g/l + tebuconazole 200 g/l) — 0.7 l/ha, Custody COP (tebuconazole 200 g/l + azoxystrobin 120 g/l) — 0.9 l/ha, Acanto COP (picoxystrobin — 250 g/l) —

Fig. 3. Helminthosporium of maize
Джерело: https://ag.umass.edu/vegetable/fact-sheets/corn-northern-corn-leaf-blight

Fig. 4. Corn rust
Джерело: https://www.wiscontext.org/southern-rust-rare-serious-threat-wisconsin-corn-crops

1.0 l/ha. All the above drugs are included in the state register of pesticides and agrochemicals approved for use in Ukraine [13].

Records of diseases were performed in the phase of wax ripeness. Rust was measured on the Cobb scale, helminthosporium head blight — on a scale for spotting cereals [14]. A five-point scale was used to account for fusarium head blight [15]. Inspected 10 plants in each replicate.

The effectiveness of the drugs was determined by formula (1):

$$Ед = [(R_1 - R_2) / R_1] \times 100\%,$$

where Ed — the effectiveness of drugs,%; R_1 — disease development in the control variant,%; (1) R_2 — disease development in the study variant,%; 100 — conversion factor,%.

Research results and discussion. The evaluation of the effectiveness of the drugs shows that the fungicides used in the experimental variants provided a reduction in the development of major diseases of corn (Table).

With the increase in the number of fungicidal treatments, a decrease in the development of diseases was observed. With a single application of the drug, the weighted average development of helminthosporiosis was 13.9—18.0%, and in the control — 29.9%. In the variants of double application of fungicides, the lower development of helminthic spores was in the variants of treatment of plants in the phase of 10 leaves and ejection of panicles — 7.1%.

Triple application of drugs in the phase of 10 leaves, ejection of panicles and after flowering reduced the weighted average development of helminthosporiosis by 25.5%.

The highest efficiency against the development of helminthosporiosis was obtained in the variant of four sprays with fungicides, where the development of the disease is 4.0%.

The development of rust in the control variant was 22.3%. Among the one-time treatments, the most effective was the option of applying drugs in the phase of ejection of the panicle, where the development of the disease was 7.4%. Among double sprays, the lowest development of the disease was when treated in phases of 10 leaves and ejection of panicles. Three treatments in the phases of 10 leaves, ejection of panicles and after flowering helped reduce the development of rust to 3.5%. The highest protection against rust was in the variant of four applications of fungicides, where the development of the disease was 2.9%.

Against fusarium ear rot were effective treatments in the later phases of the growing season — the ejection of panicles, after flowering and grain filling. On control, the development of the disease was 7.6%, with a single fungicidal treatment — 3.7—4.4%, with a double — 1.7—2.8%. Three times the use of fungicides reduced the development of fusarium ear rot to 1.2%, and four times — up to 1.1%.

Application of the fungus Abacus once in the phase of 10 leaves of corn had 42.1% effectiveness against fusarium ear rot, 53.5% against helminthosporiosis and 57.4% against rust.

Spraying the drug in the phase of ejection of the panicle was the most effective among the options for a single application of fungicides, because it is during this period of ontogenesis that plants are most vulnerable to disease. Technical efficiency against helminthosporiosis was 53.5%, against rust 66.8%, against fusarium ear rot — 63.1%.

Application of fungicides after flowering and during the period of grain filling were less effective against helminthosporiosis (39.8—44.5%) and rust (17.9—21.1%), but protection against fusarium ear rot was 50.0—51.3%.

The use of fungicides in the 10 leaves and the ejection of the panicle (Abacus + Coronet) provided the best efficiency among the double application of drugs, and was 76.2% against helminthosporiosis, 73.5% against rust and 75.0% against fusarium ear rot.

Three spraying of maize crops in the 10-leaf phase, ejection of panicles and after flowering reduced the development of helminthosporium by 85.3%, rust — by 84.3%, fusarium ear rot — by 84.2%.

Technical efficiency of fungicides on corn crops, 2018—2020

Terms and fungicidal treatments	Weighted average development,%			Technical efficiency,%		
	Helmintho-sporiosis	Rust	Fusarium ear rot	Helmintho-sporiosis	Rust	Fusarium head blight
1. Control (without fungicides)	29.9	22.3	7.6	—	—	—
2. 10 leaves (Abacus)	13.9	9.5	4.4	53.5	57.4	42.1
3. Ejection of the panicle (Abacus)	14.0	7.4	2.8	53.2	66.8	63.1
4. After flowering (Abacus)	16.6	17.6	3.7	44.5	21.1	51.3
5. Pouring grain (Abacus)	18.0	18.3	3.8	39.8	17.9	50.0
6. 10 leaves + discard (Abacus + Coronet)	7.1	5.9	1.9	76.2	73.5	75.0
7. 10 leaves + after flowering (Abacus + Coronet)	8.3	7.3	2.7	72.2	68.2	64.5
8. 10 leaves + poured grain (Abacus + Coronet)	8.7	7.4	2.8	70.9	66.8	63.2
9. Ejection of panicles + after flowering (Abacus + Coronet)	14.2	7.1	1.7	52.5	68.2	77.6
10. Disposal of panicle + grain filling (Abacus + Coronet)	14.7	6.8	1.7	50.8	69.5	77.6
11. 10 leaves + shedding + after flowering (Abacus + Coronet + Custody)	4.4	3.5	1.2	85.3	84.3	84.2
12. Discarding panicles + after flowering + poured grain (Abacus + Coronet + Custody)	10.2	6.2	1.2	65.9	72.2	84.2
13. 10 leaves + shedding + after flowering + grain filling (Abacus + Coronet + Custody + Acanto)	4.0	2.9	1.1	86.6	87.0	85.5
SSD_{05}	6.6	5.7	1.7	—	—	—

Treatments in the ejection phase, after flowering and grain filling were less effective against the development of helminthosporiosis and rust (65.9% and 72.2%) compared to the previous version.

The highest technical efficiency against all studied diseases was obtained with four applications of fungicides — in the phase of 10 leaves, ejection of panicles, after flowering and grain filling, which is 86.6% — against helminthosporiosis, 87.0% — against rust and 85.5% — against fusarium ear rot on corn. Treatments in the phase of 10 leaves and ejection of the panicle contributed to the protection primarily against helminthiasis and rust. Spraying of corn plants after flowering and during the pouring of grain was mainly aimed at protection against fusarium ear rot, because it is at this time that the pathogen is affected. The use of fungicides at different times during the growing season allowed to protect plants from disease and promote full growth and development.

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CONCLUSIONS

Four times the use of fungicides best controlled the development of corn diseases. In this variant, the development of helminthosporiosis was 4.0%, which is 27.5% less than control, rust — 2.9%, which is 19.4 less than control, fusarium ear rot — 1.1%, which is 6.5% less from control. The technical efficiency of the drugs increased with increasing number of treatments and was 86.6% against helminthosporiosis, 87.0% against rust and 85.5% against fusarium ear rot.

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Технічна ефективність застосування фунгіцидів за вирощування кукурудзи

Мета. *Визначити технічну ефективність фунгіцидних обробок проти гельмінтоспоріозу, іржі та фузаріозу качанів кукурудзи в умовах Західного Лісостепу України.* **Методи.** *Польовий. Схема досліджень включала 13 варіантів з різною кількістю фунгіцидних обробок. У дослідах використовували фунгіциди: Абакус, к.е. (епоксиконазол, 62,5 л/га + піраклостробін, 62,5 л/га), Коронет 300 SC (трифлоксістробін, 100 г/л + тебуконазол, 200 г/л), Кустодія КС (тебуконазол, 200 г/л + азоксистробін, 120 г/л), Аканто КС (пікоксістробін, 250 г/л). Обліки хвороб проводили згідно із загальноприйнятими методиками у фазу воскової стиглості.* **Результати.** *Дослідженнями встановлено, що фунгіцидні обробки знижують розвиток гельмінтоспоріозу на 14,9—25,9%, іржі — на 4,0—19,4, фузаріозу качанів кукурудзи — на 3,2—6,3%. Середньозважений розвиток хвороб кукурудзи залежав від строку застосування та кількості фунгіцидних обприскувань. За одноразових обробок найнижчим рівень розвитку хвороб був при обприскуванні у фазу викидання волоті, за дворазових — 10 листків і викидання волоті. Триразове використання фунгіцидів у фази 10 листків, викидання волоті та після цвітіння знизило розвиток гельмінтоспоріозу до 4,4%, іржі — до 3,5, фузаріозу качанів — до 1,2%. Найвищий рівень захисту одержали у варіанті чотириразового внесення препаратів у фази 10 листків, викидання волоті, після цвітіння та наливу зерна, де розвиток гельмінтоспоріозу становив 4,4%, іржі — 2,9, фузаріозу качанів — 1,1%. Технічна ефективність досліджуваних препаратів зростала зі збільшенням кількості фунгіцидних обробок і була найвищою у варіанті чотириразового внесення фунгіцидів: 86,6% — проти гельмінтоспоріозу, 87,0 — проти іржі, 85,5% проти фузаріозу качанів.* **Висновки.** *Технічна ефективність фунгіцидів залежить від строку застосування препарату та зростає зі збільшенням кількості проведених обробок. Високу технічну ефективність відзначено у варіанті триразового внесення фунгіцидів у фази 10 листків, викидання волоті та після цвітіння, а найвищу — у варіанті чотириразового внесення фунгіцидів у фази 10 листків, викидання волоті, після цвітіння та наливу зерна.*

ефективність; хвороби; іржа; гельмінтоспоріоз; фузаріоз

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