ellen
agriscience

Growth Innovations for the Growing World.

This report comprises of results obtained in 2023-2024, and preliminary results from ongoing experiments.

January 2025

Ellen is a Swiss-based biotechnology research company specialising in the study of low molecular weight protein compounds and their effects on plants. The company's research provides a scientific foundation for the development of natural, eco-friendly fertilisers and protectants.

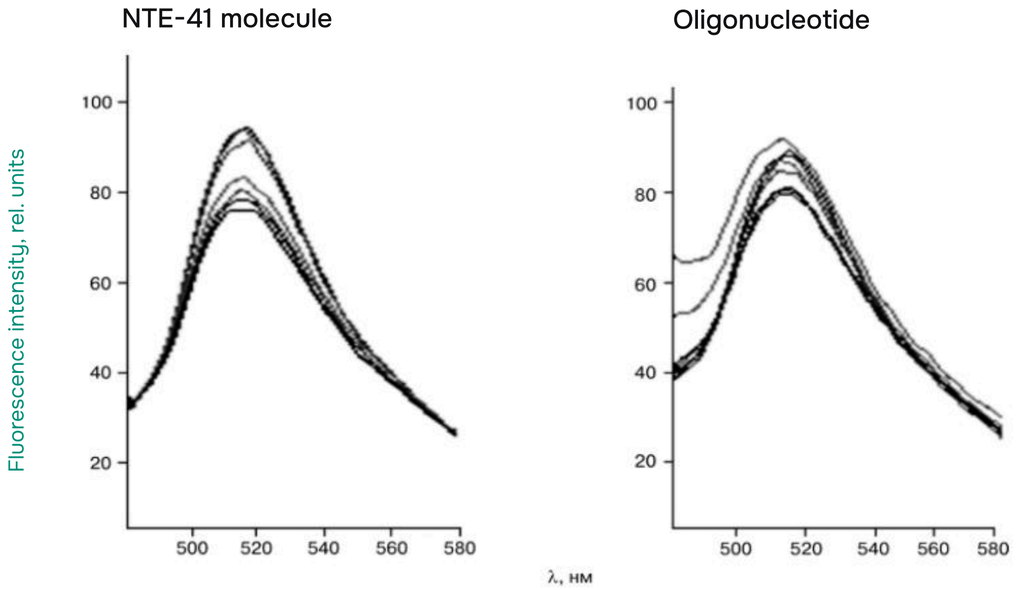
The company's objective is to introduce new generation products into the agro-industrial complex with the aim of increasing yields, reducing production costs and minimising the impact of harmful factors.

The agro-laboratory functions in collaboration with prominent research institutes, undertaking joint studies and conducting large-scale field experiments on pivotal crops.

Study of the mechanism of interaction of the molecules with wheat DNA (previously published)

Using fluorescence quenching, it was revealed that the NTE-41 molecule binds to FITC-labeled wheat histones H1, H2b, H3 and H4.

Site-specific interactions of the molecules with histones in chromatin serve as a control epigenetic mechanism for regulating gene activity and synthesis of proteins responsible for the growth, proliferation and differentiation of plant cells.

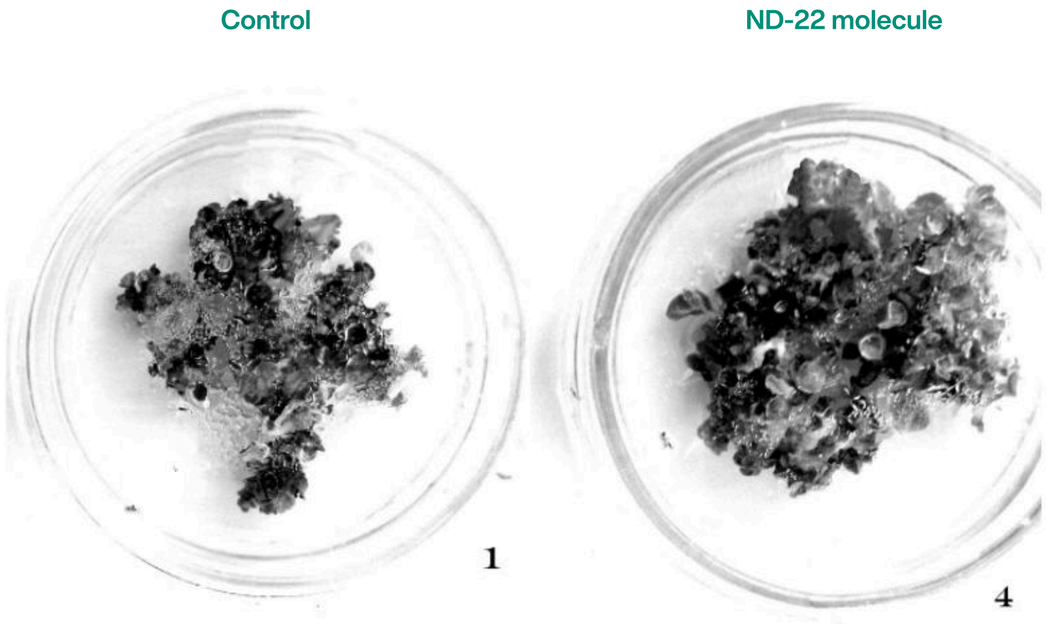


Fluorescence spectra of FITC-labeled wheat histone H1/1 upon excitation with light of 413 nm wavelength.

Study of the influence of the molecules on growth, development and differentiation of tobacco crops (previously published)

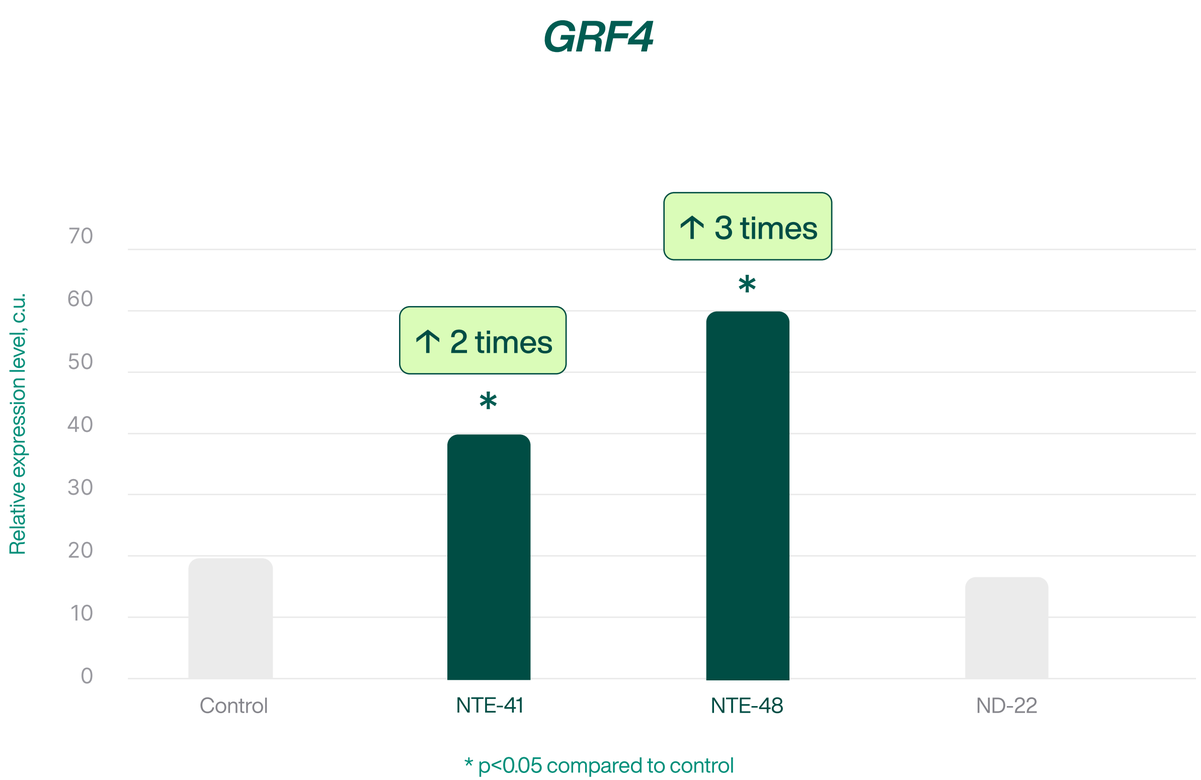
ND-22 and NTE-41 molecules influenced the growth, development and differentiation of callus culture of tobacco plants Nicotiana tabacum. They contributed to an increase in the growth of callus mass, stimulated the formation and growth of leaves in regenerants.

The molecules modulated the expression of genes of the *CLE* family, encoding endogenous regulatory molecules responsible for the proliferation and functional activity of plant cells; genes of the *KNOX* family (transcription factor genes) and *GRF* (growth factor regulator genes encoding the corresponding DNA-binding proteins, such as topoisomerases, nucleases, and others).



The effect of ND-22 molecule at a concentration of 10−8 M on the growth of tobacco callus culture.

Effect of the molecules on the expression of *GRF4* growth factor in *Nicotiana tabacum* plants (previously published)



* p<0.05 compared to control

GRF4 is a transcription factor that stimulates the activity of other genes – genes that themselves promote nitrogen uptake and assimilation.

GRF4 coordinates plant incorporation of nitrogen from the soil with the incorporation of carbon from the atmosphere.

Nicotiana tabacum plants

Field experiment on the influence of short molecules on the growth, development and yield of soybeans (previously published)

Field research was conducted on heavy loam soil according to the "Methodology of field experiment". Handicraft and industrial research were conducted.

Before planting, the seeds were treated with molecules at a concentration of 0.01 g/l. Sowing was carried out on an area of 10 hectares for each variant.

Effect of ND-22 and NTE-41 molecules on soybean yield (previously published)

Studied group	Yield, c/ha	Increase in yield, %
Control	16.1	-
ND-22 molecule	21.0	**30.5%***
NTE-41 molecule	19.0	**18.4%***

* p<0.05 compared to control

The use of molecules contributed to an increase in the number of beans by **68.8– 87.5%** compared to the control

Effect of a combination of molecules on plant growth and development under stress (freezing)

- On average, in the control groups, after frosts all **10 cuttings** of mother bushes of coleus (Pinata variety) died. Under the action of a combination of the molecules out of **5 cuttings 3 died, and 2 took root**. The development of the root system and green leaves of the plant are clearly visible (see photo on the right).

- Petunia cuttings also root poorly after frosts. Under the influence of a combination of the molecules, their ability to root **increased by 75%**. After 1.5 months of rooting and spraying with the molecules, petunia flowering was activated.

Coleus

Petunia

Effect of the molecules on plant growth and development (controlled soil, laboratory research)

Effects of NTR-31, NTR-32, NTR-34, NTR-35 molecules were studied on plant growth and development.

Studied crops:

Barley, variety Vladimir
Hordeum vulgare L.

a major cereal grain growing in temperate climate globally

Common wheat, variety Radmira
Triticum aestivum L.

it is the most widely grown of all crops and the cereal with the highest monetary yield

Lupin, variety Ladny
Lupinus angustifolius

the earliest ripening type of Lupine, which is cultivated as a fodder crop

Flax, variety Tverskoy
Linum usitatissimum

cultivated for fiber

Effect of NTR-34 molecule on morphometric parameters of wheat:

Molecule	Crop	Parameter	Reliable effect (compared to control)
NTR-34	Common wheat, variety Radmira 	germination and germination energy of seeds	↑ 24% and ↑ 26%, respectively (10^{-12} and 10^{-11} g/L)
		wet biomass of sprouts	↑ 35% (10^{-12} g/L)
		wet biomass of roots	↑ 25% (10^{-12} g/L)
		dry biomass of sprouts	↑ 45% (10^{-12} g/L)
		dry biomass of roots	↑ 29% (10^{-12} g/L)
		sprout length	↑ 43% (10^{-12} g/L)
		root length	↑ 32% (10^{-12} g/L)

(The most effective concentrations are given in brackets)

Effect of NTR-31 molecule on morphometric parameters of flax:

Molecule	Crop	Parameter	Reliable effect (compared to control)
NTR-31	Flax, variety Tverskoy 	germination and germination energy of seeds	↑ 33% and ↑ 48%, respectively (10^{-15} и 10^{-9} g/L)
		wet biomass of sprouts	↑ 46% (10^{-15} g/L)
		dry biomass of sprouts	↑ 53% (10^{-15} g/L)
		sprout length	↑ 44% (10^{-15} g/L)
		root length	↑ 43% (10^{-15} g/L)

(The most effective concentrations are given in brackets)

Effect of NTR-32 molecule on morphometric parameters of barley:

Molecule	Crop	Parameter	Reliable effect (compared to control)
NTR-32	Barley, variety Vladimir 	germination and germination energy of seeds	↑ 21% and ↑ 34%, respectively (10^{-12} и 10^{-13} g/L)
		wet biomass of sprouts	↑ 45% (10^{-13} g/L)
		wet biomass of roots	↑ 39% (10^{-13} g/L)
		dry biomass of sprouts	↑ 37% (10^{-13} g/L)
		dry biomass of roots	↑ 45% (10^{-13} g/L)
		sprout length	↑ 33% (10^{-13} g/L)
		root length	↑ 45% (10^{-13} g/L)

(The most effective concentrations are given in brackets)

Effect of NTR-32 molecule on barley composition:

Molecule	Crop	Parameter	Reliable effect (compared to control)
NTR-32	Barley, variety Vladimir	root calcium	↑ 41.3%
		root phosphorus	↑ 24%
		root fat	↑ 13%
		root ash	↑ 15%
		root fiber	↑ 9.7%
		root protein	↑ 45%
		root starch	↑ 35%

Effect of NTR-35 molecule on morphometric parameters of lupin:

Molecule	Crop	Parameter	Reliable effect (compared to control)
NTR-35	Lupin, variety Ladny 	germination energy of seeds	↑ 30% (10^{-15} и 10^{-9} g/L)
		dry biomass of sprouts	↑ 39% (10^{-15} g/L)
		wet biomass of sprouts	↑ 14% (10^{-15} g/L)
		sprout length	↑ 40% (10^{-15} g/L)
		root length	↑ 24% (10^{-15}g/L)

(The most effective concentrations are given in brackets)

Conclusion:

- NTR-31, NTR-32, NTR-34, NTR-35 molecules in various concentration stimulate stimulated germination of crop seeds;
- Specific effect of molecules depends on a type of crop;
- NTR-32 molecule has effect to the chemical composition of barley (*Hordeum vulgare L.*) seedlings, that could allow to control the process of obtaining agricultural products with improved nutritional molecules.

Effect of the molecules drugs on the morphogenetic and biosynthetic potential of holy basil (laboratory research)

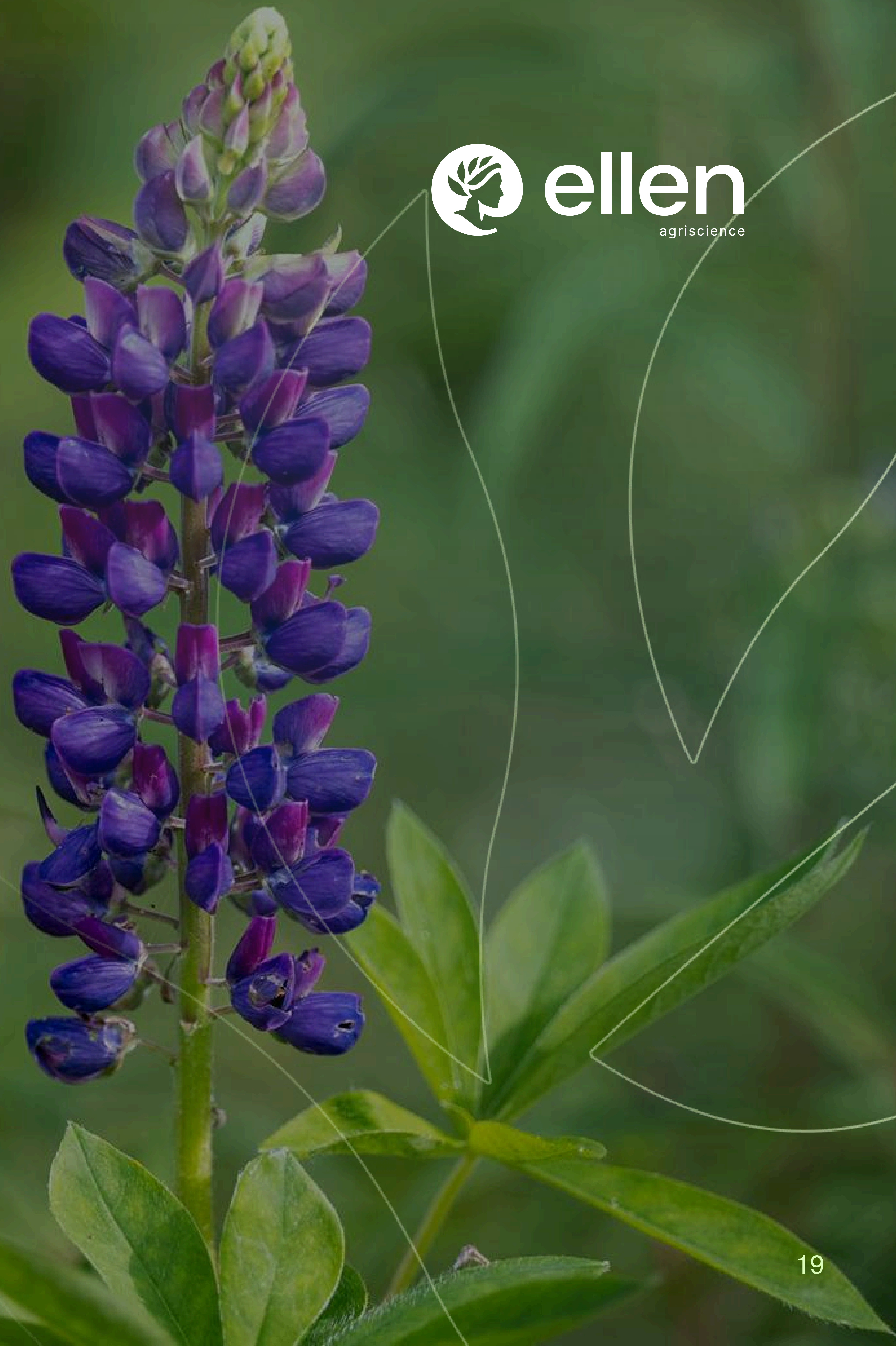
Effects of NTR-31, NTR-33, NTE-41 molecules to holy basil were studied:

Molecule	Parameter	Reliable effect (comparing to control)
NTE-41	main root length	↑ 22%
	above-ground parts	↑ 2.7 times
NTR-33	above-ground parts	↑ 2 times
NTR-31	above-ground parts	↑ 2.8 times

Ocimum tenuiflorum

cultivated for religious and traditional medicine purposes, and also for its essential oil.

Additionally, NTE-41 molecule induces formation of buds and flowers in holy basil microplants.



Effect of ND-22 and NTE-41 molecules on the sowing qualities of seeds and growth indicators at the initial stages of wheat and white lupine ontogenesis (laboratory research)

Effects of ND-22 and NTE-41 molecules were studied on the next crops:

White lupin
Lupinus albus

high protein grain crop

Common wheat
Triticum aestivum L.

he most widely grown of all crops and the cereal with the highest monetary yield

Studied parameters:

- Sowing qualities of seeds: germination energy, germination;
- Weight of sprouts and roots, height of sprouts, number and length of roots.

Results:

Molecule	Crop	Parameter	Reliable effect (compared to control)
ND-22	White lupin	weight of roots	↑ 19-72%, depends on concentration
		length of roots	↑ 10-45%, depends on concentration
	Common wheat	weight of roots	↑ 1.5-2.5 times, depends on concentration
		length of roots	↑ 17%, (10^{-9} g/L)

Results:

Molecule	Crop	Parameter	Reliable effect (compared to control)
NTE-41	White lupin	weight of roots	↑ 58%, depends on concentration
	Common wheat	length of roots	↑ 20-31%, depends on concentration
		weight of roots	↑ 2.7-3.2 times, depends on concentration

Effect of NTE-48 molecule on morphometric characteristic of flax

Pre-sowing seed treatment by NTE-48 molecule led to change morphometric characteristic of fiber flax sprouts already on 7th day after germination.
Effect became more pronounced on 10th day after germination.

Control NTE-48 molecule

7 days after germination

Control NTE-48 molecule

10 days after germination

Effect of NTE-48 molecule on morphometric characteristics of flax

Parameter	Control	NTE-48 molecule	
Overall height, cm	69.4	88.7	+27%
Technical length, cm	55.9	79.5	+43%

Flax has a **general** and **technical stem length**.
The general length is the distance from the attachment point of the cotyledon leaflets to the top of the uppermost inflorescence capsule.
The technical stem length is measured by the distance from the attachment point of the cotyledon leaflets to the beginning of the inflorescence branching. This part of the stem is the most valuable.

Pre-sowing seed treatment by NTE-48 molecule led to increase of 10 morphometric parameters of fiber flax.

Treatment by NTE-48 molecule led to increase of **technical length of flax stems by 43% compared to control.**

Effect of NTE-48 molecule on morphometric characteristics of flax

Parameter	Control	NTE-48 molecule	
Weight of 1 plant, g of dry matter	0.354	0.675	↑ by 2 times
Capsules per plant, pcs.	3.07	3.82	+24%
Seeds in 1 capsule, pcs.	5.4	6.3	+16%
Weight of seeds in 1 capsule, g	0.0314	0.047	+27%
Weight of 1000 seeds, g	3.88	4.95	+33%

Treatment by NTE-48 molecule led to **increase of number of capsules per plant by 24%** and **number of seeds in 1 capsule by 16%.** Treatment by NTE-48 molecule led to **increase weight of seeds by 27-33%** and **weight of dry matter of plant by 2 times.**

The propagation of flax is done exclusively by seeds, which are taken from the capsules after they have ripened.
This must be done every year, since flax is an annual plant.

Capsules of fiber flax

Effect of NTE-48 molecule on morphometric characteristics of flax

Parameter	Control	NTE-48 molecule
Fiber breaking load, N	212	262 +57%
Average number of straw	1.75	2.75 +57%
Total fiber yield, %	23.6	30.9 +31%

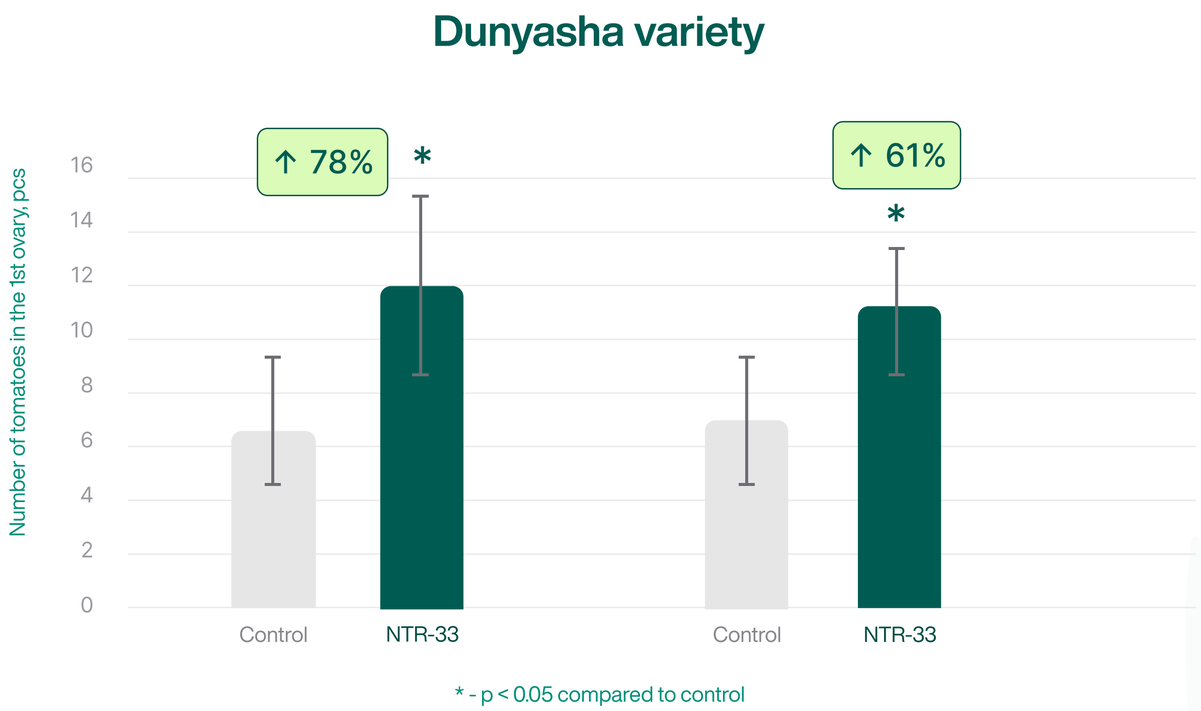
The flax straw number is determined depending on the length, bast content, strength, suitability, color and stem diameter. The higher are the listed indicators, the higher is the straw number. **Under the influence of NTE-48 molecule, the straw number increased by 57%.**

The breaking load of a fiber determines its strength. **Under the influence of NTE-48, this indicator increased by 57%.**
It is known that flax is a source of natural fiber.

Fiber yield (total) is one of the main features determining the technological value of flax straw during processing.
Under the treatment by NTE-48 molecule, **the total fiber yield increases by 31%.**

The effect of the molecules on the growth and yield of tomatoes and oats in the field

NTR-32 and NTR-33 molecules increase the number of tomatoes of the *Dunyasha* variety in the first ovary



(statistical processing was conducting using one-way ANOVA and the Dunnet post-hoc test. Here and below, the data are presented as the mean and standard deviation (SD).

The experimental design involved treating plants with molecules at different stages of their growth and development. All seeds were treated prior to planting, then some seeds were treated at the seedling stage (sprouts), some at the budding stage, and some at both the seedling (sprouts) and budding stages.

Also, 2 concentrations of molecules were tested – 0.001 g/L and 0.005 g/L.

The maximum number of treatment (at the seedling and budding stages) by NTR-32 and NTR-33 molecules led to increase of numbers of tomatoes in 1st ovary.

NTR-32 and NTR-33 molecules reduce the incidence of tomatoes diseaes (septoria, fusarium and alternaria)

Septoria leaf spot is caused by the fungus *Septoria lycopersici*. This fungus can attack tomatoes at any stage of development, but the first symptoms usually first appear on the older, lower leaves and stems when plants are setting fruit.

Septoria in tomato plants

Fusarium wilt is a soil-borne fungal disease of tomato throughout worldwide. The disease is caused by *Fusarium oxysporum f. sp. lycopersici* that can cause significant yield losses of tomato production. The source may be infected seeds.

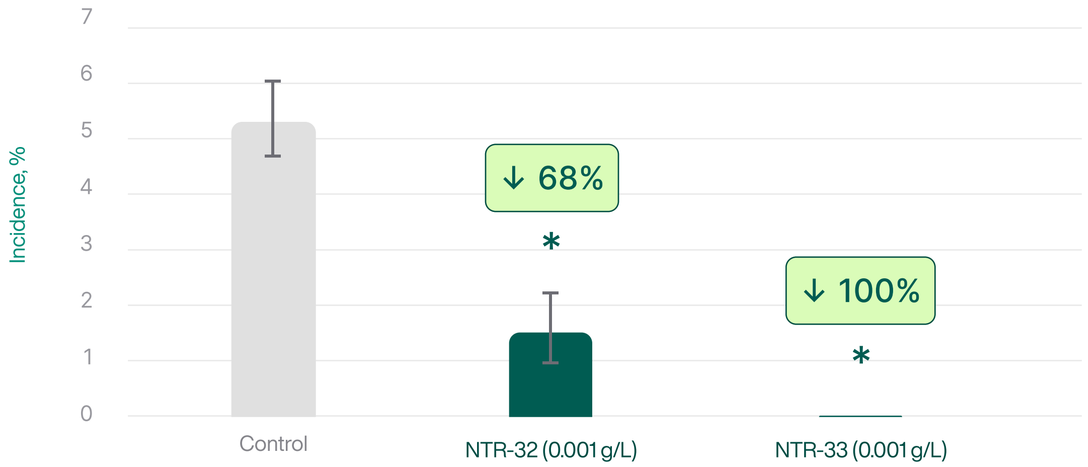
Fusarium in tomato plants

Alternaria is a fungal disease caused by *Alternaria solani Sorauer*, a member of the mold family. The pathogen can affect plants both in open and protected soil. The source may be infected seeds.

Alternaria in tomato plants

NTR-32 and NTR-33 molecules reduce the incidence of fusarium and alternaria in tomatoes of the *Dunyasha* variety

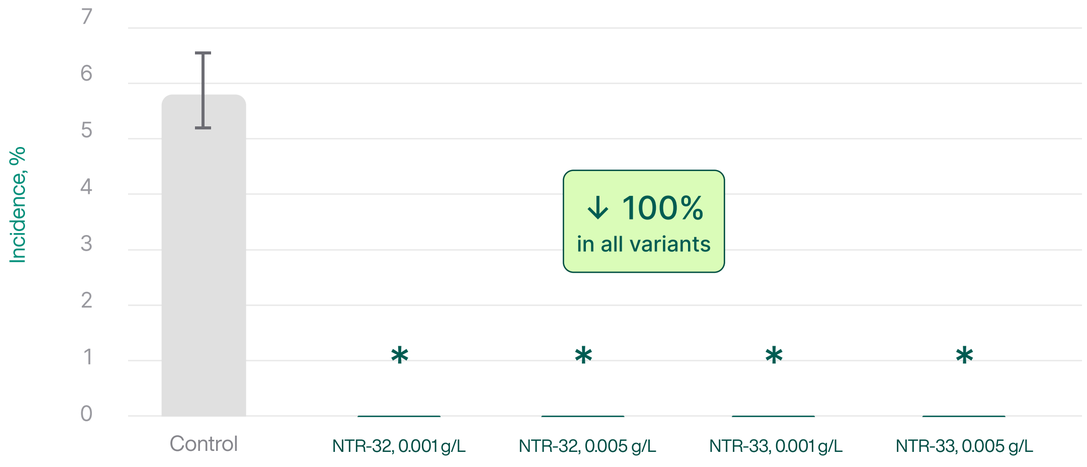
Fusaria in tomato plants



* - p < 0.05 compared to control

For Fusaria treatment, molecules were most effective at a concentration of 0.001 g/L. The NTR-33 molecule completely eliminated Fusaria incidence, reducing it **by 100%**, while the NTR-32 molecule reduced Fusaria incidence **by 68%** compared to the control group.

Alternaria in tomato plants

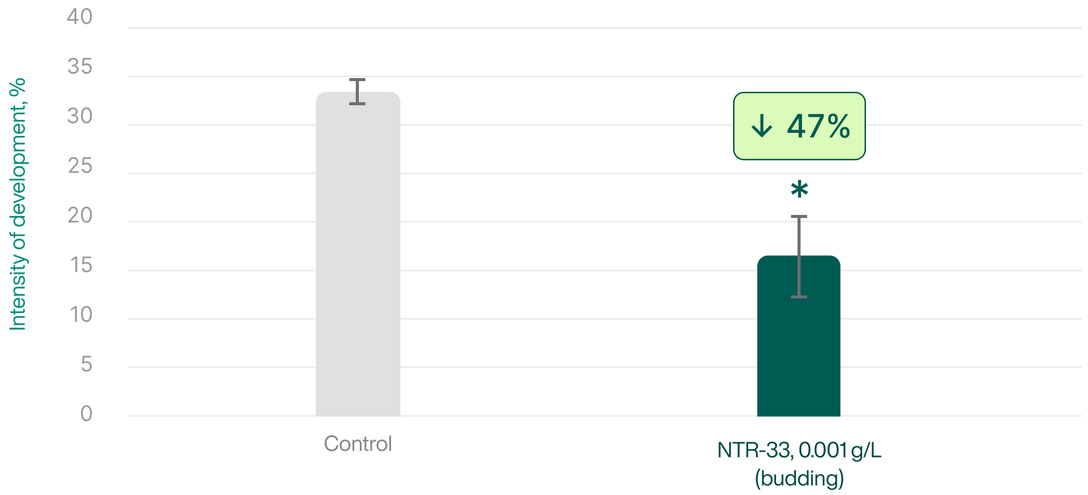


* - p < 0.05 compared to control

For Alternaria treatment, both NTR-32 and NTR-33 molecules were effective at both tested concentrations, reducing the incidence of Alternaria in tomato plants **by 100%** compared to the control.

NTR-32 and NTR-33 molecules reduce the intensity of development of septoria in tomatoes of the *Dunyasha* and *Zarya Vostoka* varieties in the budding stage

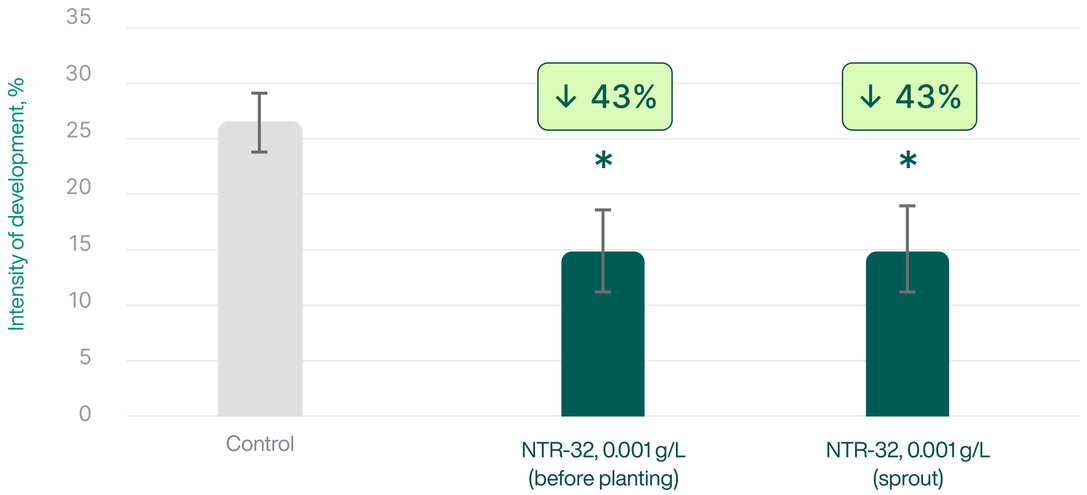
Septoria in tomato plants (*Zarya Vostoka* variety)



* - p < 0.05 compared to control

In tomatoes of Zarya Vostoka variety, NTR-33 molecules significantly decreased the intensity of development of Septoria, when applied at a concentration of 0.001 g/L at the stage of budding.
The NTR-32 molecule, at concentrations of 0.001 and 0.005 g/L, also significantly reduced disease intensity **by 37%** in various treatment options.

Septoria in tomato plants (*Dunyasha* variety)



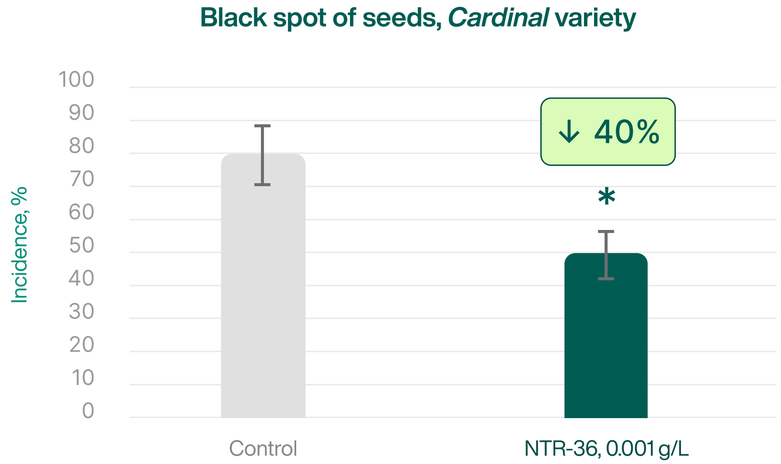
* - p < 0.05 compared to control

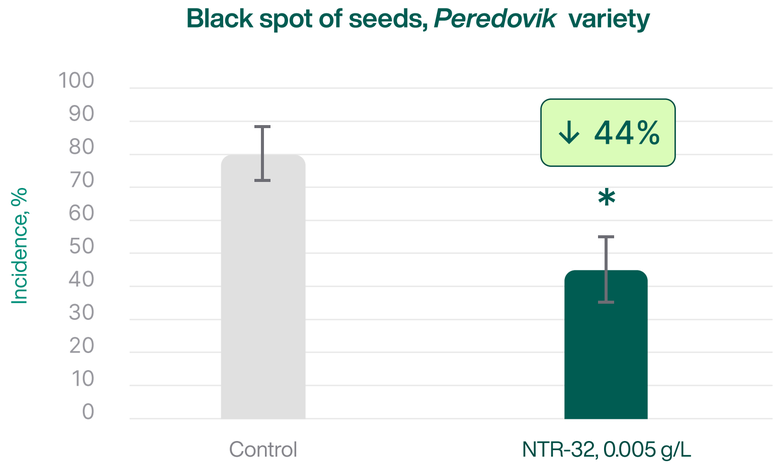
In tomatoes of the Dunyasha variety, the NTR-32 molecule at a concentration of 0.001 g/L was equally effective in the "before planting" and "sprout" treatment options.

NTR-32, NTR-33, NTR-35 and NTR-36 molecules reduce incidence of black spot in oat seeds

Black spot (black point) is a disease of cereal seeds caused by several species of fungi (*Alternaria tenuissima, A. alternata, A. arborescens, Cladosporium spp, Bipolaris sorokiniana Sacc*).

Black spots of seeds





NTR-32, NTR-33, NTR-35 and NTR-36 molecules at concentrations of 0.001 and 0.005 g/L reduced the incidence of black spot in *Cardinal* oat seeds by an average of **35%**, and in *Peredovik* oat seeds by **37%**, compared to the control. The diagrams illustrate data on the most noticeable reduction in the under the molecules treatment.

* - $p < 0.05$ compared to control

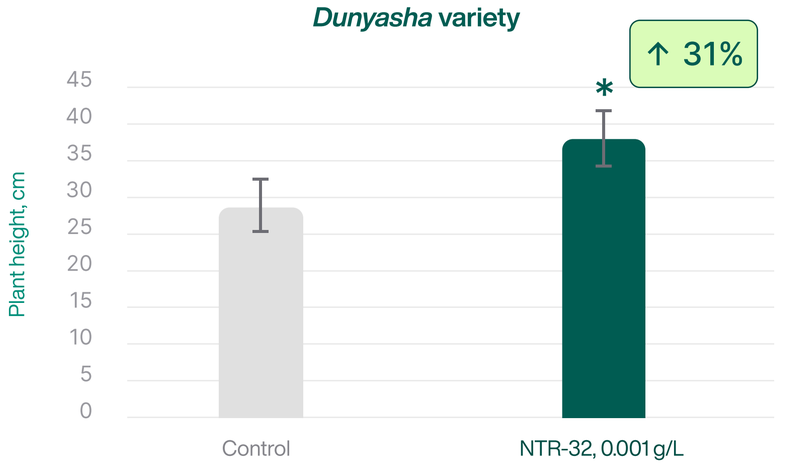
NTR-32 molecule stimulates the growth of tomato plants

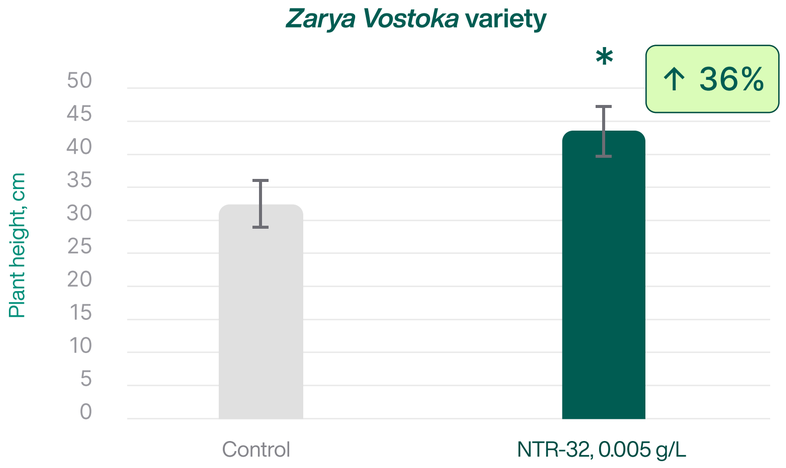
The NTR-32 molecule stimulated the growth of tomato plants in both varieties during the budding phase. For the *Dunyasha* variety, a concentration of 0.001 g/L was more effective, while for the *Zarya Vostoka* variety, 0.005 g/L was optimal. The most significant growth promotion was observed in the treatments with the highest number of applications.

Control

NTR-32, 0.005 g/L

In *Zarya Vostoka* tomatoes, the height of plants treated with NTR-32 molecule was over 40 cm, and the plants had developed fruits, whereas in the control group, the plants were shorter (31.4 cm in average) and only had buds.

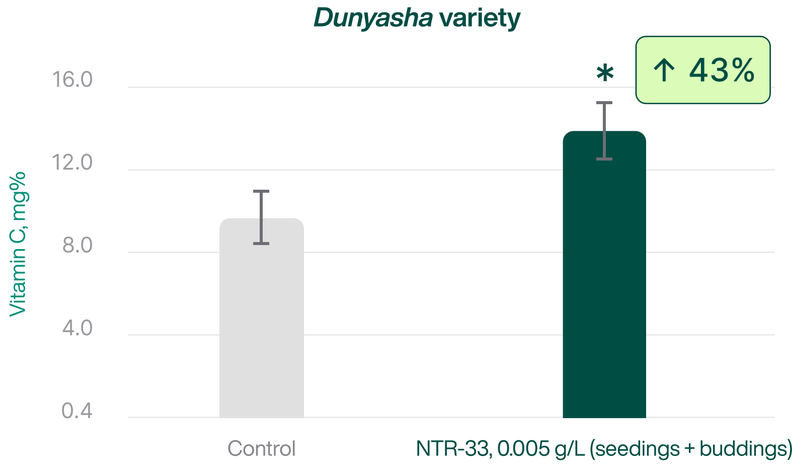




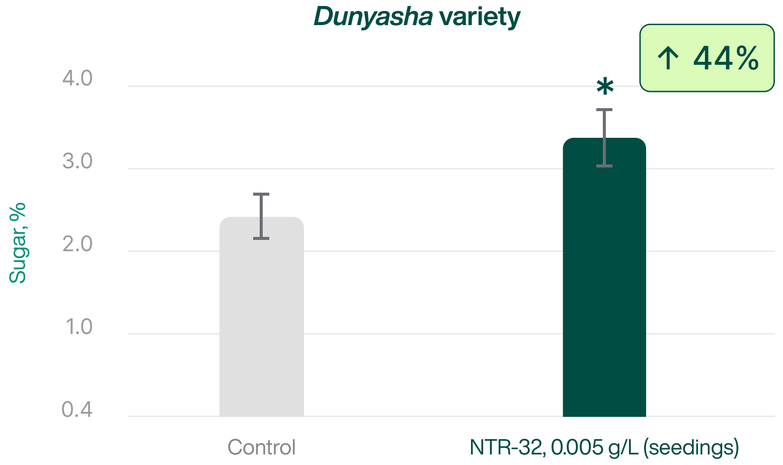
* - p < 0.05 compared to control

The molecules increase sugar and vitamin C content in tomatoes of the *Dunyasha* variety

The NTR-33 molecule at all concentrations and in all treatment options resulted in an average increase of 33% in vitamin C content in *Dunyasha* tomatoes compared to the control. The most significant increase was observed in the treatment option "seedlings + budding" with NTR-33 molecule at a concentration of 0.005 g/L. The NTR-33 molecule had no effect on the sugar content.



The NTR-32 molecule resulted in an average increase of 39% in content of sugar in *Dunyasha* tomatoes compared to the control. The most significant increase was observed in the treatment option "seedlings " with NTR-32 molecule at a concentration of 0.005 g/L.
The NTR-32 molecule had ambiguous effect on the vitamin C content - depending on the treatment, the sugar content was either higher or lower than in the control.



* - p < 0.05 compared to control

The effect of molecules on the sugar and vitamin C content of *Zarya Vostoka* tomatoes was also ambiguous. Additionaly, NTR-33 molecule at all concentrations and in all treatment options reduced the vitamin C content in the *Zarya Vostoka* tomatoes.

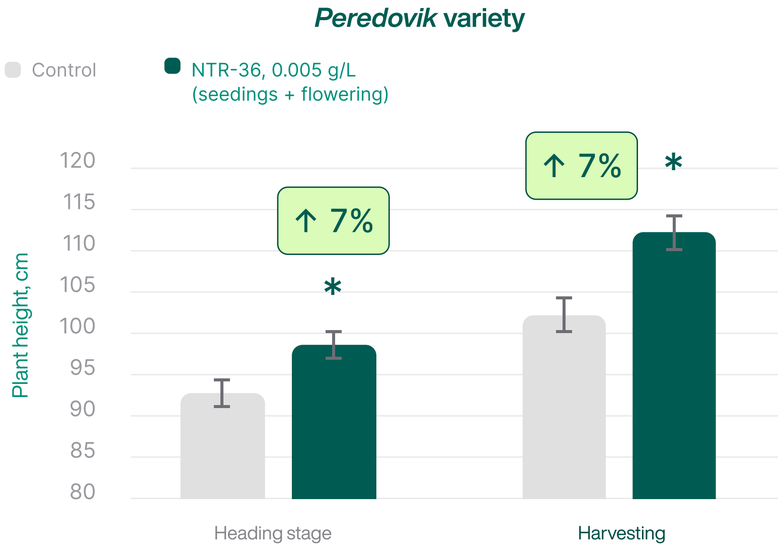
NTR-33 and NTR-36 molecules stimulate the growth of oats

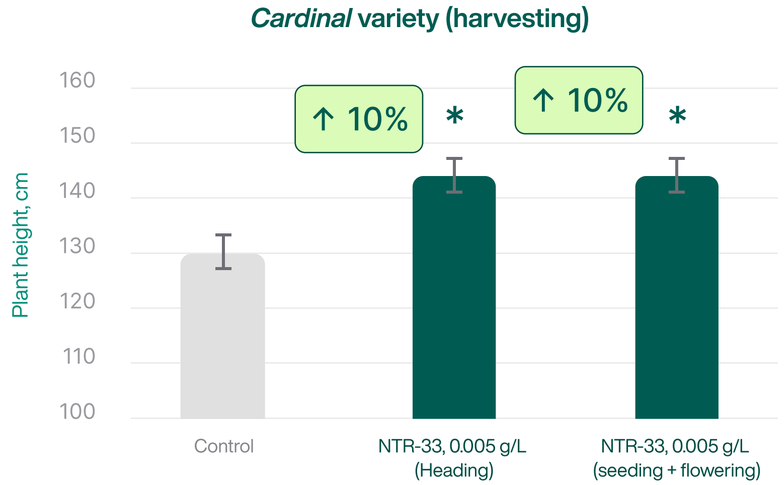
The experimental design involved treating plants at various stages of their development. All seeds were treated prior to planting. Subsequently, some plants were treated at emergence (seedlings), some at the flowering phase, and others at both emergence and flowering.

Height measurements were taken during the heading phase and the harvesting phase.

The NTR-36 molecule (0.005 g/L) significantly increased the height of Peredovik oat plants during the heading and harvesting phases when applied at the maximum treatment frequency (both at the seedling and flowering stages).

The NTR-33 molecule (0.005 g/L) significantly increased the height of Cardinal oat plants during the harvesting phases when applied at the maximum treatment frequency (both at the seedling and flowering stages), as well as during the flowering stage only.

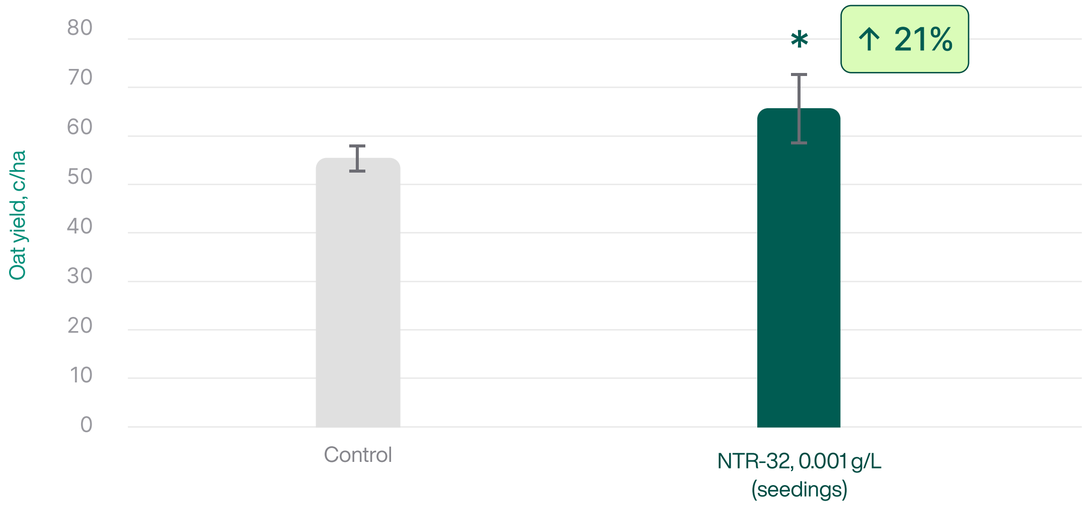




* - $p < 0.05$ compared to control, respectively

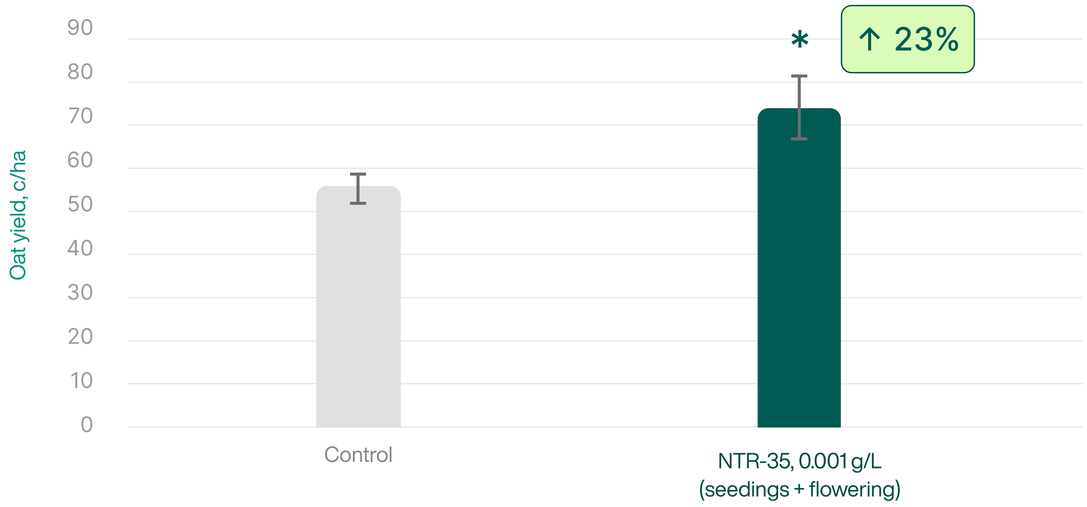
NTR-32 and NTR-35 molecules increase the yield of oat (*Cardinal* variety)

Oat yield under the treatment by NTR-32 molecule



* - p < 0.05 compared to control

Oat yield under the treatment by NTR-35 molecule



* - p < 0.05 compared to control

The use of NTR-32 and NTR-35 molecules at a concentration of 0.001 g/L stimulated the yield of oat (*Cardinal* variety).
The treatment with the NTR-32 molecule during the seedling phase increased the yield **by 21%**.
Applying the maximum number of treatments with the NTR-35 molecule (at both the seedling and flowering stages) increased the yield **by 23%.**

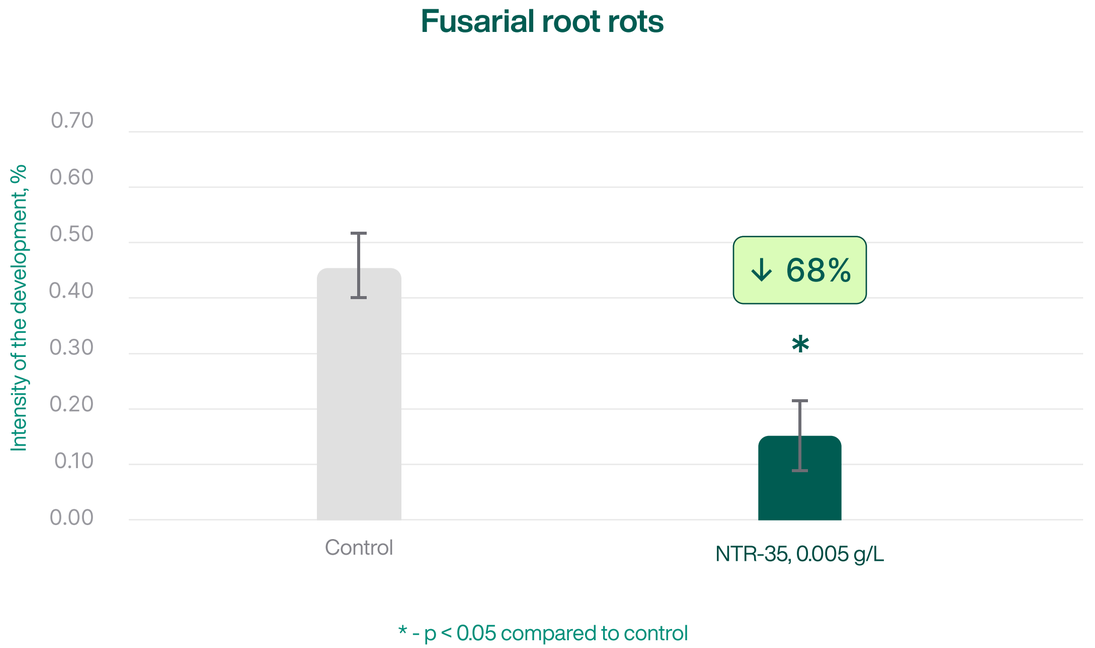
NTR-35 molecule reduces the incidence of oats (*Cardinal* variety) diseases: root rot and red-brown spot

Fusarial root rots are referred to as the "disease of modern farming systems." They can cause yield reductions of up to 30%.

Affected plants show a decline in all structural elements of yield: the number of productive shoots, the number of grains per ear, and the 1000-seed weight.

The NTR-35 molecule reduces the intensity of this disease in *Cardinal* oats.

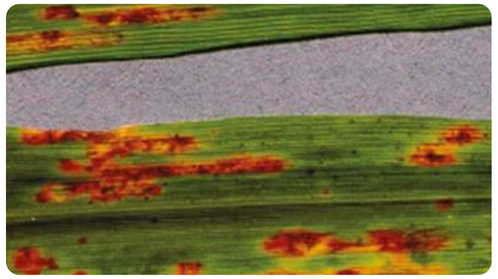
Fusarial root rots



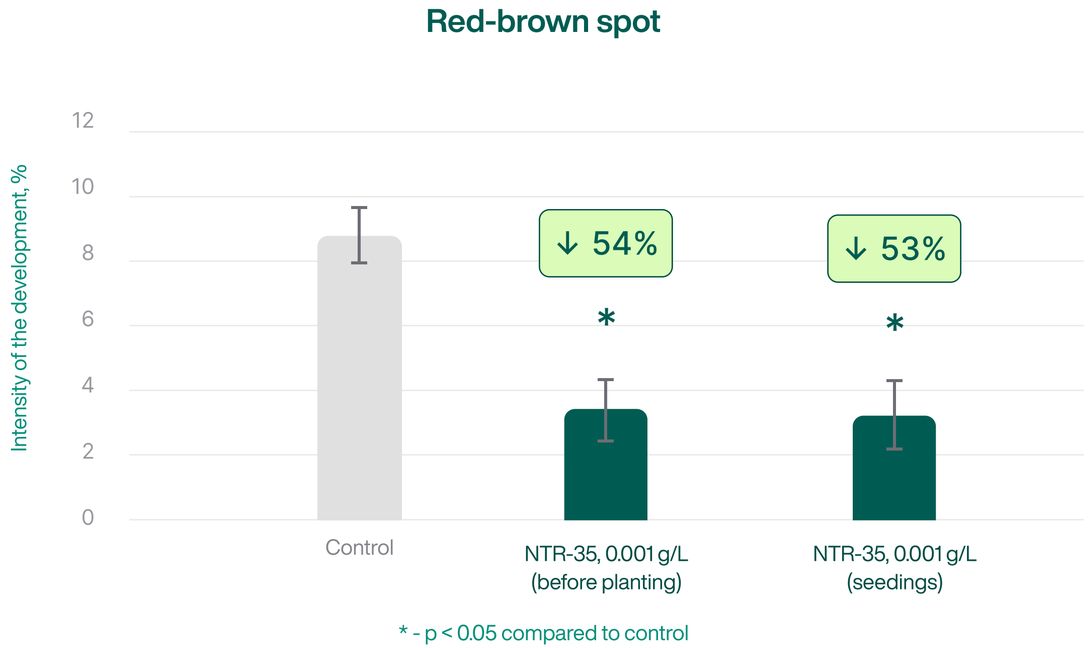
* - p < 0.05 compared to control

NTR-35 molecule reduces the incidence of oats (*Cardinal* variety) diseases: root rot and red-brown spot

Red-brown spot is a fungal disease caused by the phytopathogenic fungus *Drechslera avenae*.
It affects cereal crops, particularly oats and barley. The pathogen causes thinning of crops, the formation of shriveled grains, and sterility of the ear. In cases of disease development, the yield loss can exceed 10%.
The NTR-35 molecule reduces the intensity of this disease in *Cardinal* oats **by 53-54%** compared to control.



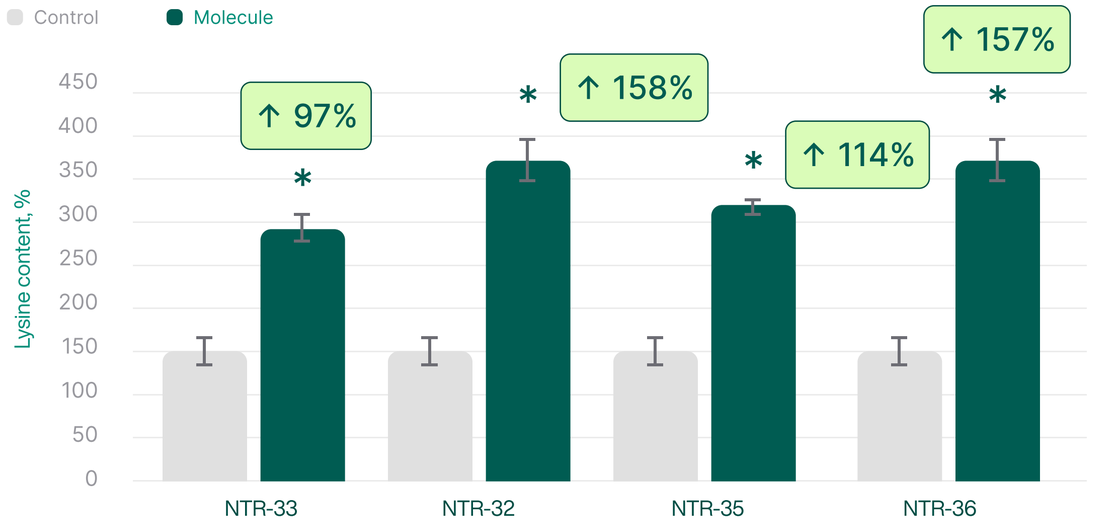
Leaf red-brown spot in oats



The effect of molecules was variable — depending on the treatment, the intensity of diseases development was either higher or lower than in the control. NTR-32 molecule increased the red-brown spot in Cardinal oats in average by 57% compared to control.

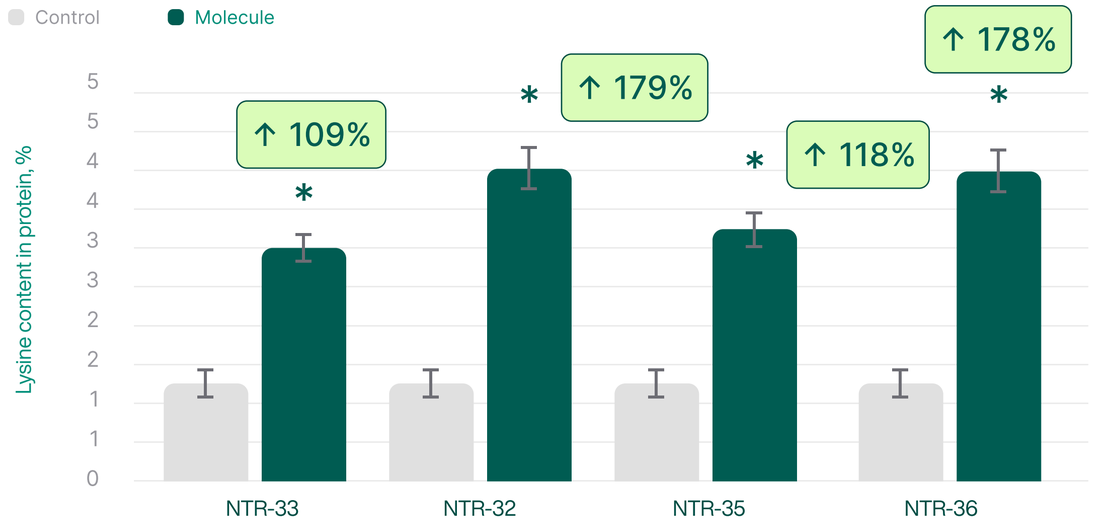
NTR-32, NTR-33, NTR-35 and NTR-36 molecules increase the lysine content in *Peredovik* oat yield

Lysine content in oat under treatment by molecules



* - p < 0.05 compared to control

Lysine content in protein under treatment by molecules



* - p < 0.05 compared to control

All tested concentrations and treatment variants with NTR-32, NTR-35, and NTR-36 molecules increase lysine in oat and lysine in protein content of the *Peredovik* variety. A similar increase was also observed with the NTR-33 molecule, although it was not seen in all treatment variants. The diagrams illustrate the maximum increase in lysine content and lysine concentration in oat protein for each of the molecules studied.

Investigation of the effect of different concentrations of the molecules on plant growth and development

Effect of NTE-41, NTE-46, NTE-47 molecules and combination of these molecules on yield indicators of wheat variety Lada (field research)

Study design

Study molecules:
NTE-41, NTE-46, NTE-47 molecules and its combination (NTE-41+NTE-46+NTE-47) in 3 different concentrations.

Study design:
Plants were treated with molecule solutions in different concentrations using the spray method.
The control field was sprayed by water without molecules.

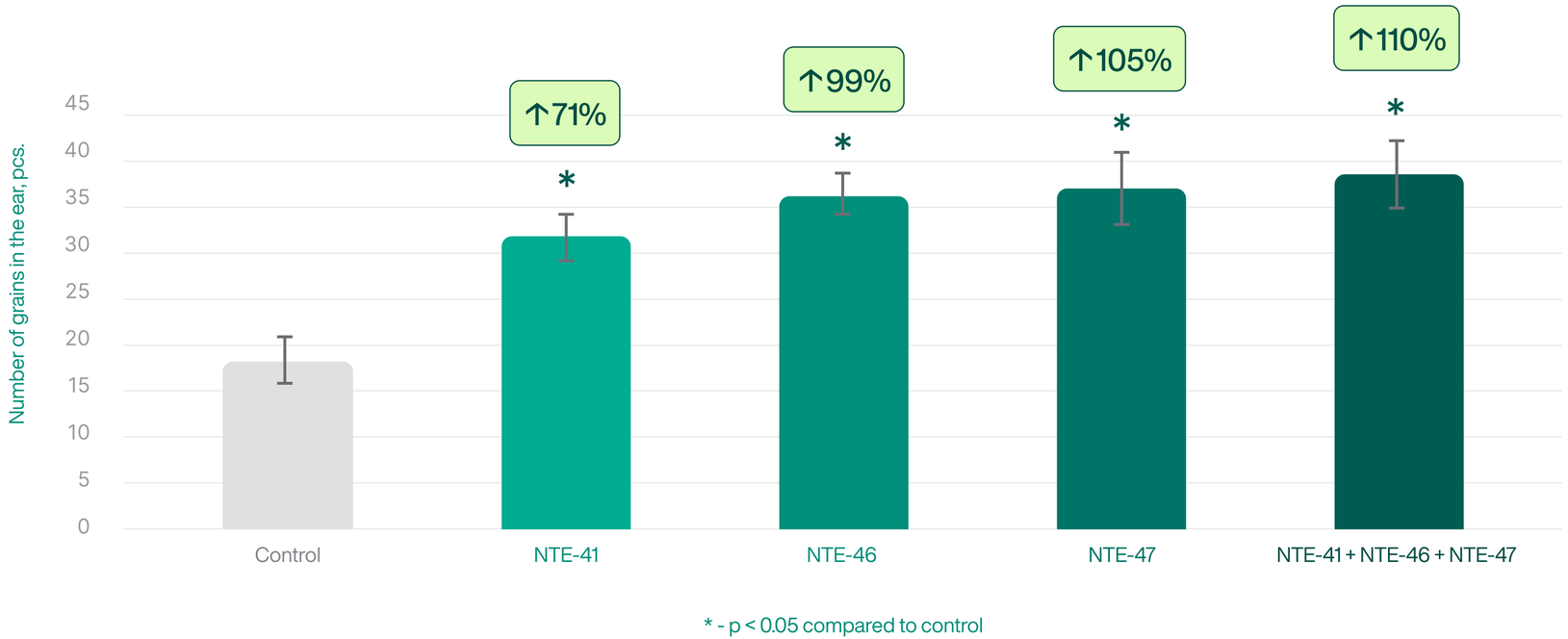
Timeline:
Sowing: May 27, 2024
Spraying by molecule solutions: July 1, 2024
Harvesting: September 7, 2024

Determined parameters:
- weight of 1000 seeds,
- number of grains in an ear,
- protein content in wheat

Common wheat (*Triticum aestivum L.*) variety Lada:
the field (in the photo above)
the seeds (in the photo below)

Study of molecules effect on wheat variety *Lada* (preliminary results)

Molecules and their combination at a maximal concentration were the most effective and increased number of grains in the ear of wheat variety Lada by **71-110%** compared to the control.



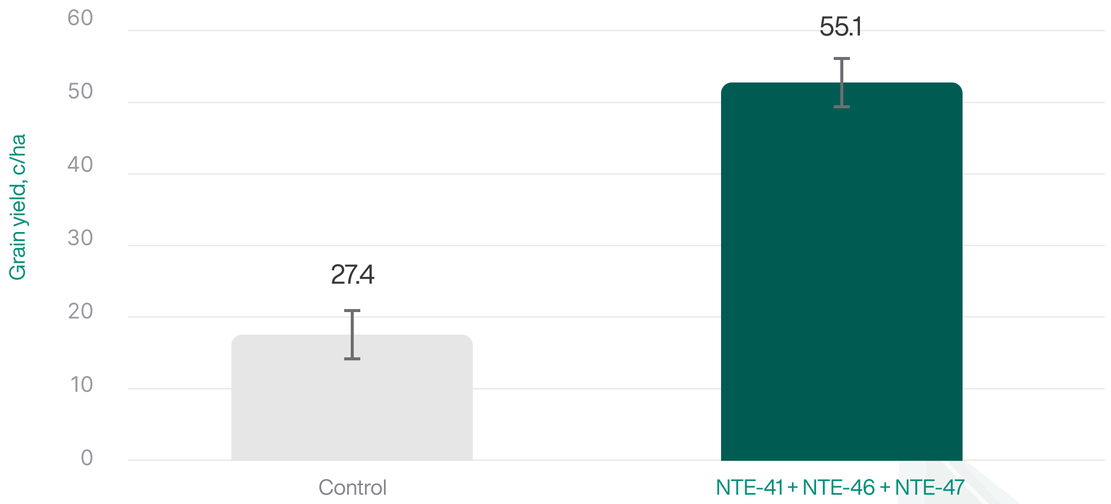
* - p < 0.05 compared to control

Molecules and their combination at lower concentrations were less effective, but statistically significant increased the number of grains in the ear of wheat variety Lada **by 24-96%** compared to the control.

The NTE-47 molecule had the most pronounced effect on this parameter.
The effect of molecule combinations is comparable to the effect of NTE-47 molecule.

Studied molecules had no effect on weight of 1000 seeds and protein content of wheat (data are not presented).

Study of molecules effect on wheat variety *Lada* (preliminary results)



Taking into account the grain harvest from 1 m2 and recalculation per 1 ha,
it can be stated that in the control the grain yield was 27.4 c/ha.
Molecules combination (NTE-41, NTE-46 and NTE-47) increased this parameter in 2 times till 55.1 c/ha.

Thus, the maximum increase in yield under molecules applying was 27.7 c/ha.

Effect of NTE-41, NTE-46 and NTE-47 molecules on growth and yield indicators of wheat of 3 varieties (field research)

Study design

Study molecules:
NTE-41, NTE-46, NTE-47, in 3 different concentrations.

Study design:
Plants were treated with molecule solutions in different concentrations using the spray method.
The control field was sprayed by water without molecules.

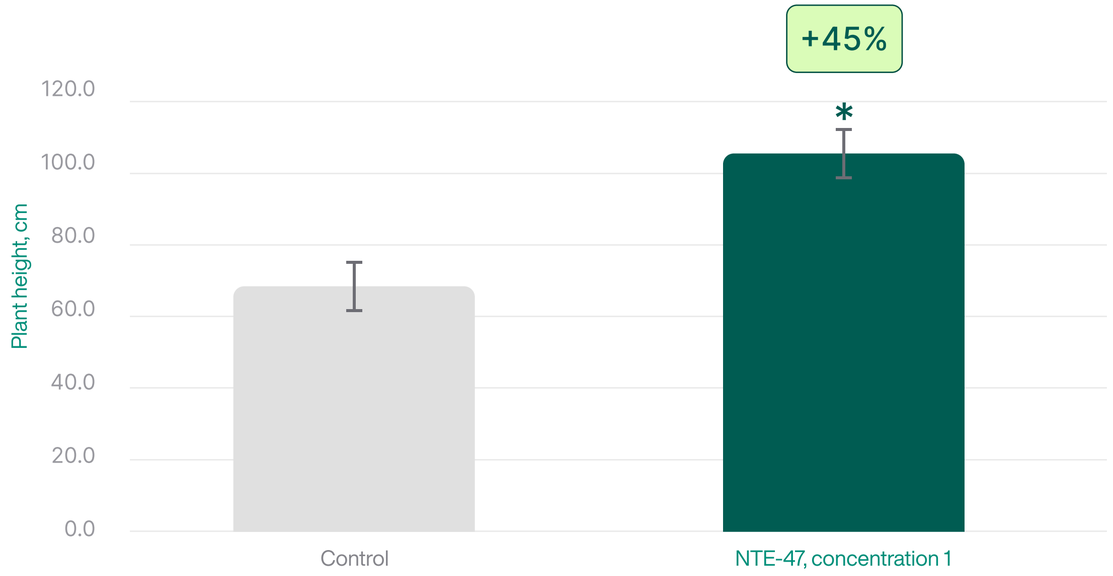
Timeline:
Sowing: May 16, 2024
Spraying by molecules solutions: July 10, 2024
Harvesting: August 4, 2024

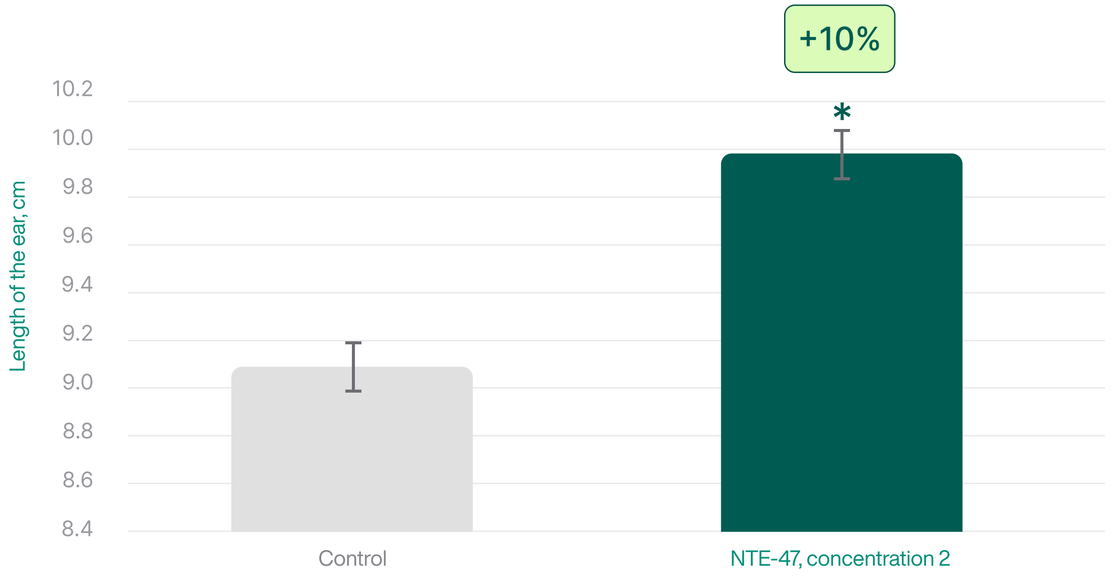
Studied varieties of wheat:
Zlata, Ester, Radmira

Determined parameters:
- Morphometric and yield indicators
- Technological qualities of grain
- Macronutrients in grain and straw

Effect of NTE-47 molecule on common wheat variety *Zlata*: morphometric indicators

NTE-47 molecule in different concentrations stimulated the growth of the wheat, by increase the plant height and the length of the ear by **45%** and **10%** compared to control, respectively.



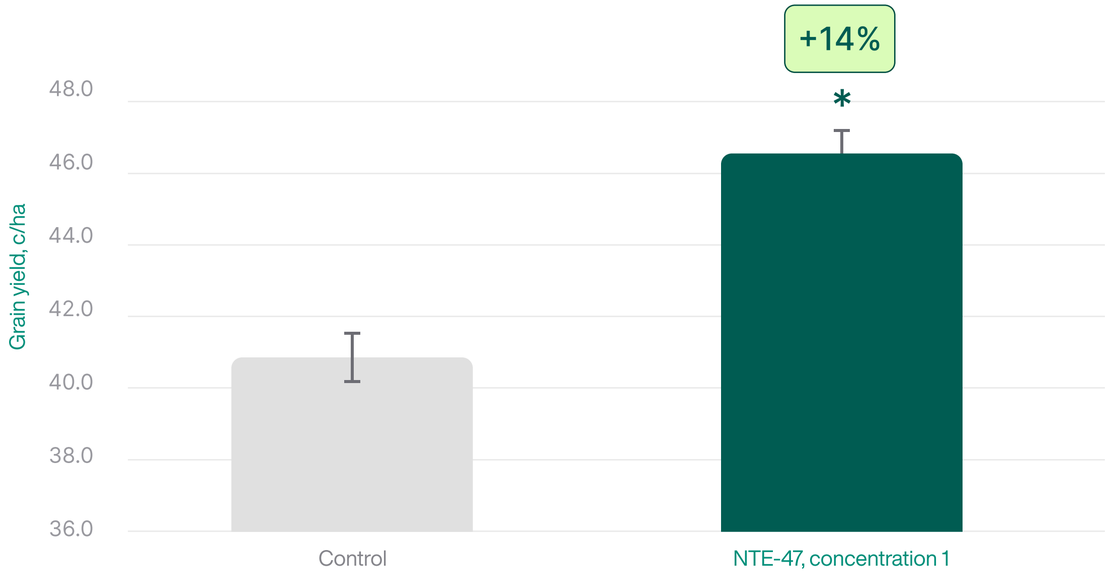


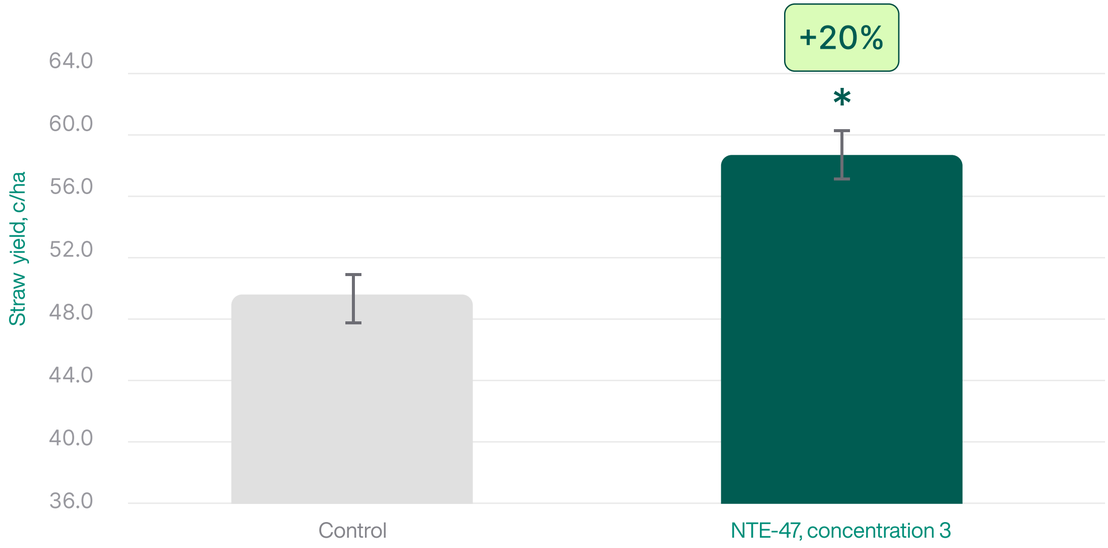
* - p < 0.05 compared to control, respectively

NTE-47 molecule in different concentrations also increased the number of spikelet's in wheat by **18-45%** compared to the control (data are not presented)

Effect of NTE-47 molecule on common wheat variety *Zlata*: yield indicators

NTE-47 molecule in different concentrations increased wheat yields, by increase the grain and straw yield by **14%** and **20%** compared to control, respectively.





* - $p < 0.05$ compared to control, respectively

NTE-47 molecule in different concentrations also increased the number of grains per ear by **14-59%**, but decreased the mass of 1000 grains by **23-27%** compared to the control (data are not presented)

Effect of NTE-47 molecule on common wheat variety *Zlata*: technological qualities of grain

* - p < 0.05 compared to control

NTE-47 molecule in different concentrations increased gluten content in grain, by **12-50%** compared to control.

NTE-47 molecule also increased grain transparency by **4%** (equal for all concentration).

NTE-47 molecule in different concentrations decreased the gluten deformation index and falling number by **4%** and **6%** compared to control, respectively.

Effect of NTE-47 molecule on common wheat variety *Zlata*: macronutrients in grain and straw: preliminary results

Grain, % in relation to control

	Calcium	Phosphorus	Fat	Ash	Fiber	Protein	
Concentration 1	1225%	45%	41%	-6%	-59%	14%	
Concentration 2	825%	47%	34%	-9%	-56%	11%	-
Concentration 3	522%	7%	9%	-15%	-39%	5%	

Treatment of *Zlata* wheat with the NTE-47 molecule increases the content of protein, lipids, calcium, and other macrocomponents in the grain, which indicates an increase in grain quality.

Effect of NTE-47 molecule on common wheat variety *Zlata*: macronutrients in grain and straw: preliminary results

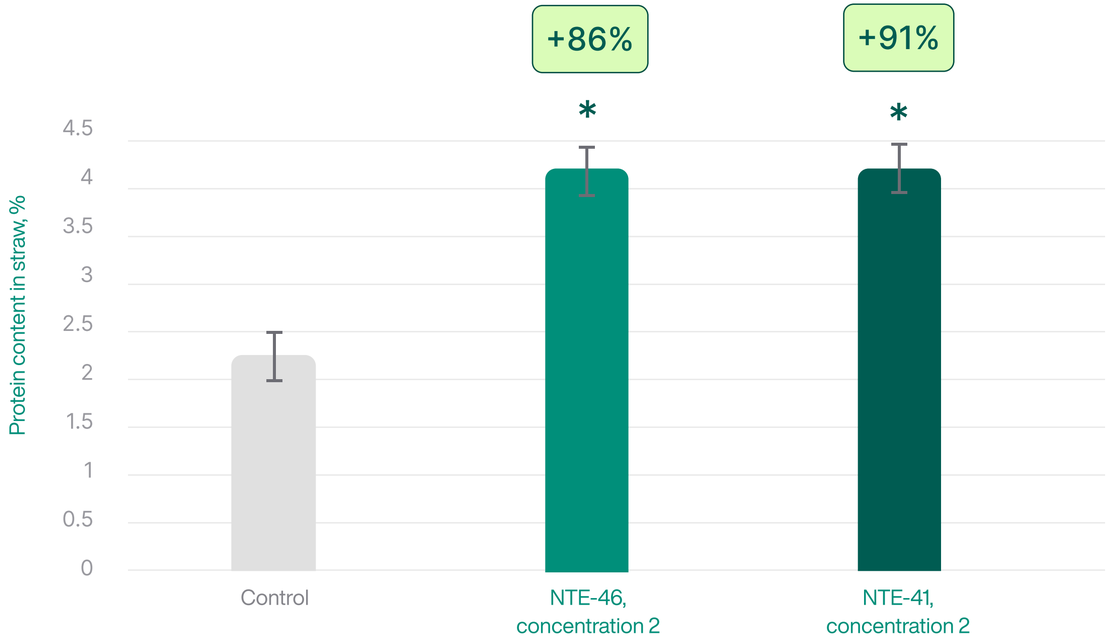
Straw, % in relation to control

	Calcium	Phosphorus	Fat	Ash	Fiber	Protein	
Concentration 1	1281%	-2%	24%	-14%	-1%	88%	
Concentration 2	1346%	8%	13%	1%	-5%	90%	-
Concentration 3	45%	4%	24%	-15%	-5%	86%	

Treatment of *Zlata* wheat with the NTE-47 molecule increases the content of protein, lipids, calcium and other macrocomponents in the straw, which indicates an increase in its quality.

Effect of NTE-41 and NTE-46 molecules on common wheat variety *Zlata*: preliminary results

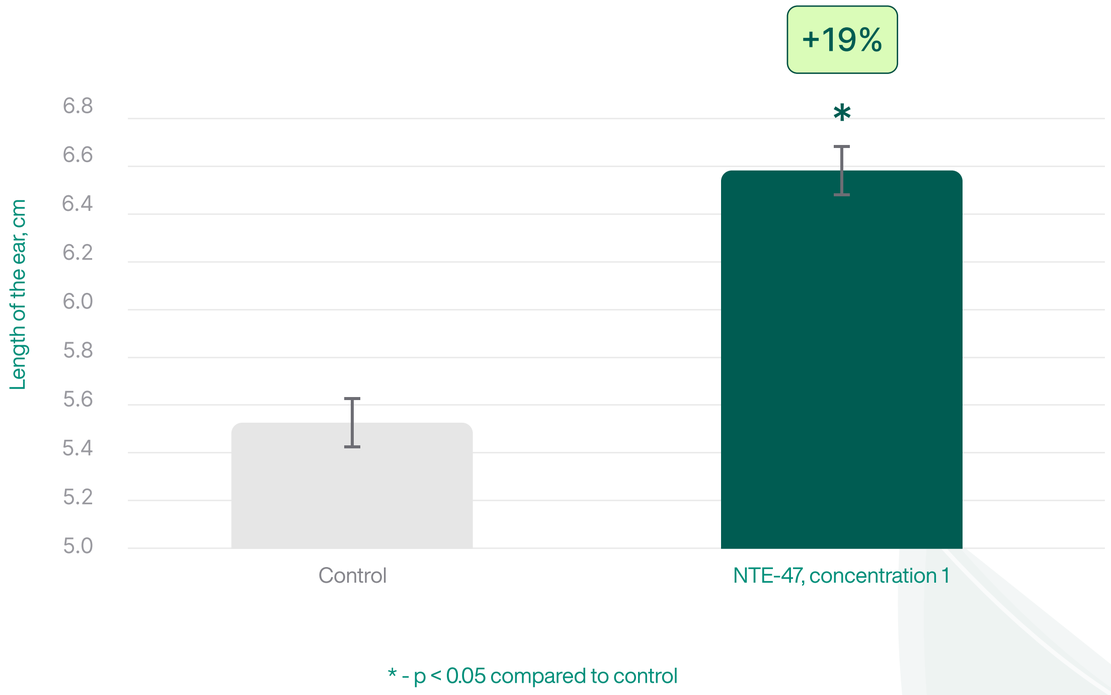
NTE-41 and NTE-46 molecules in different concentrations increased the grain yield and protein content in straw.



* - $p < 0.05$ compared to control, respectively

NTE-41 and NTE-46 molecules in different concentrations decreased the mass of 1000 grains in wheat by **14-22%** compared to the control. Molecules in different concentrations increased the straw yield by **1-6%** (data are not presented).

Effect of NTE-47 molecule on common wheat variety *Ester*: morphometric indicators



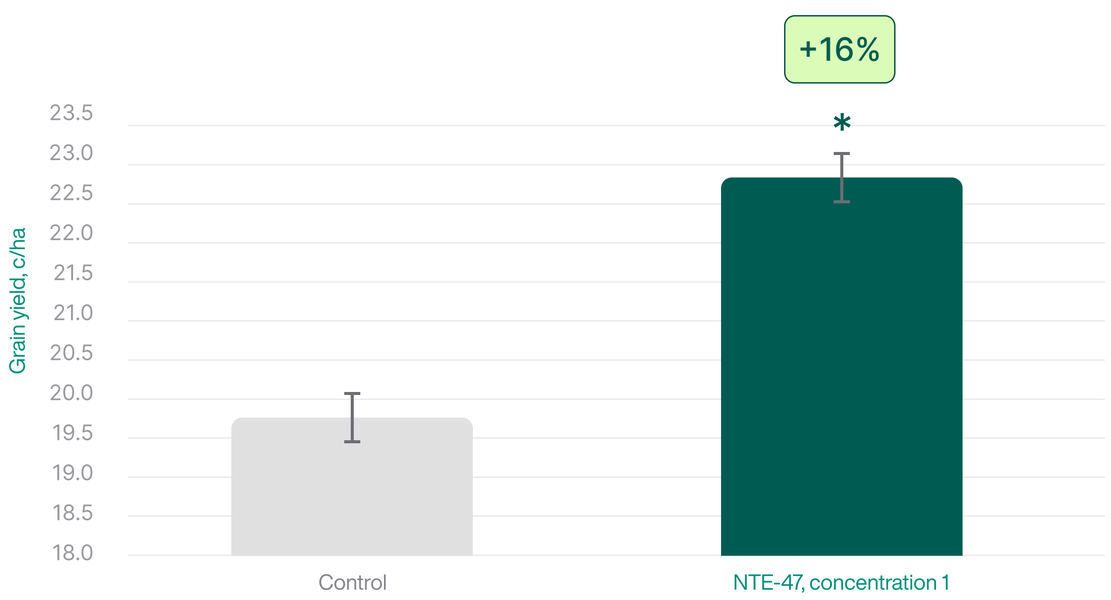
* - p < 0.05 compared to control

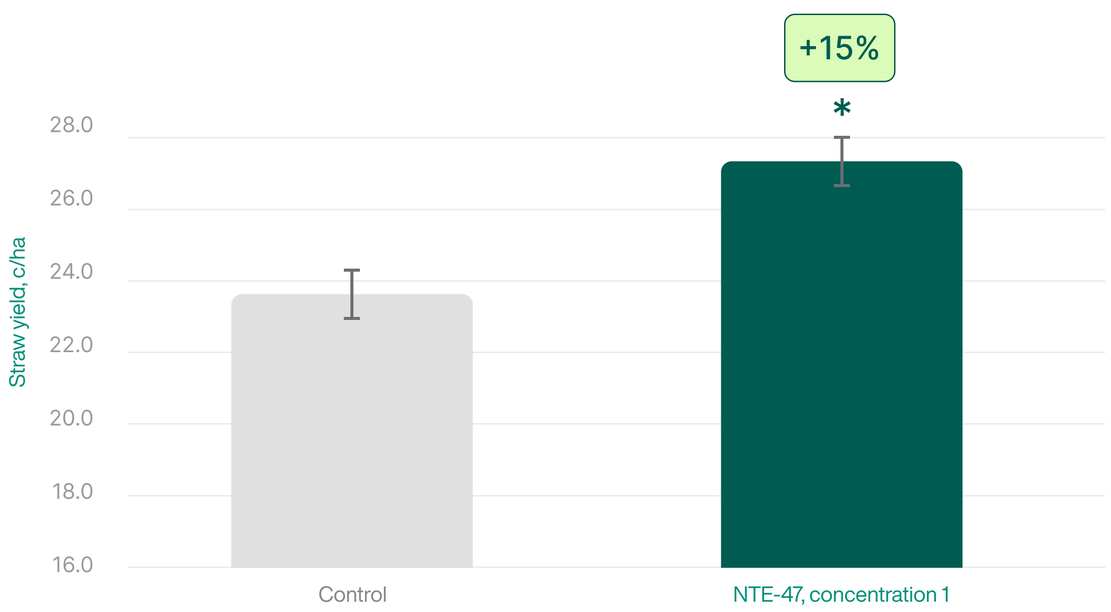
NTE-47 molecule stimulated the length of the ear by **19%** compared to control.

NTE-47 molecule in different concentrations decreased the number of spikelets in wheat by **5%** compared to the control (data are not presented). The molecule had no effect on the plant height.

Effect of NTE-47 molecule on common wheat variety *Ester*: yield indicators

NTE-47 molecule in minimal concentration increased the grain and straw yield by **16%** and **15%** compared to control, respectively.

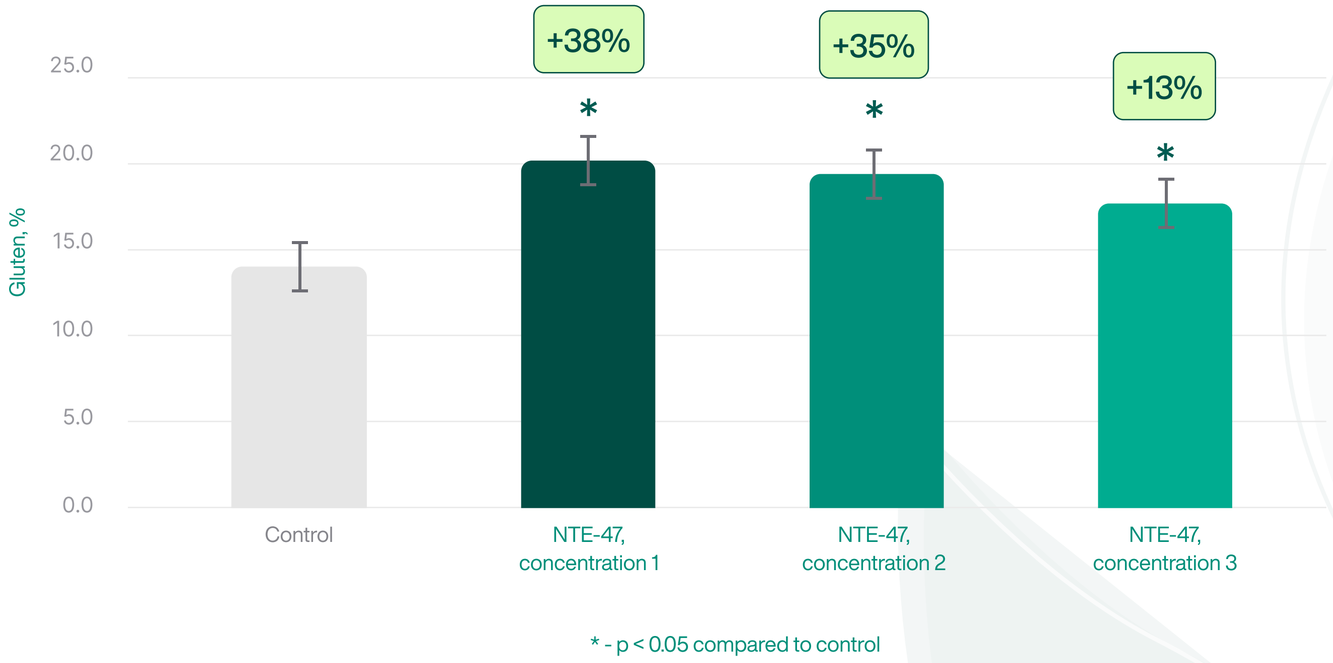




* - p < 0.05 compared to control, respectively

NTE-47 molecule in different concentrations also increased the number of grains per ear by **6-25%** compared to the control (data are not presented)

Effect of NTE-47 molecule on common wheat variety *Ester*: technological qualities of grain



* - p < 0.05 compared to control

NTE-47 molecule in different concentrations increased gluten content in grain, by **13-38%** compared to control.

NTE-47 molecule in different concentrations also increased grain transparency by **2-12%.**

NTE-47 molecule in different concentrations decreased the falling number by **3-5%** compared to control and had no effect on gluten deformation index.

Effect of NTE-47 molecule on common wheat variety *Ester*: macronutrients in grain and straw: preliminary results

Grain, % in relation to control

	Calcium	Phosphorus	Fat	Ash	Fiber	Protein	
Concentration 1	91%	111%	171%	17%	38%	13%	
Concentration 2	93%	91%	160%	17%	21%	13%	-
Concentration 3	63%	29%	53%	13%	11%	6%	

Treatment of Ester wheat with the NTE-47 molecule increases the content of protein, lipids, calcium, fiber and other macrocomponents in the grain, which indicates an increase in grain quality.

Effect of NTE-47 molecule on common wheat variety *Ester*: macronutrients in grain and straw: preliminary results

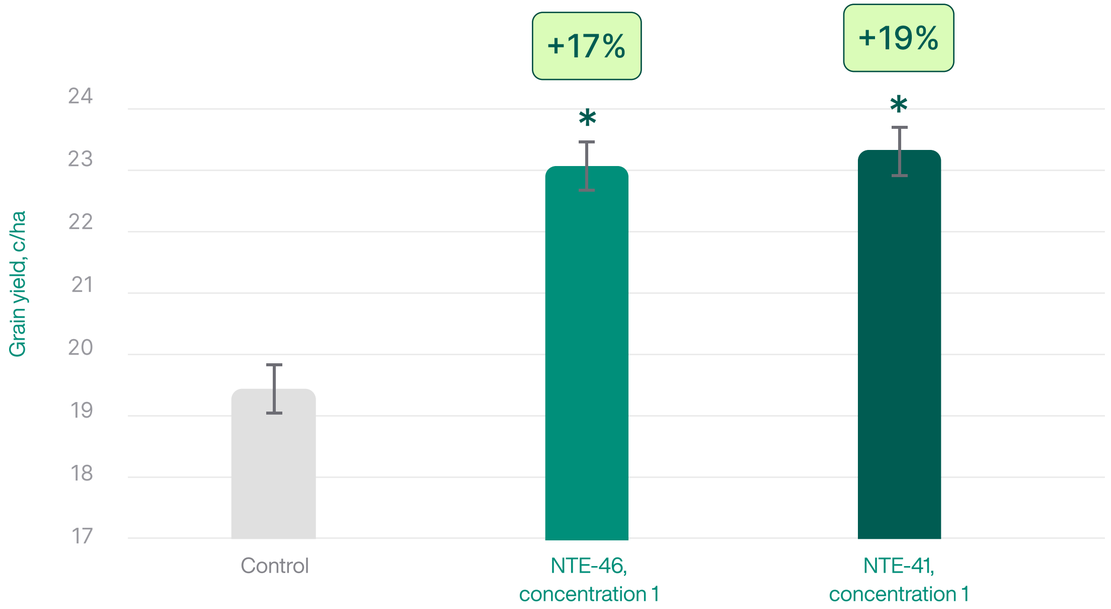
Straw, % in relation to control

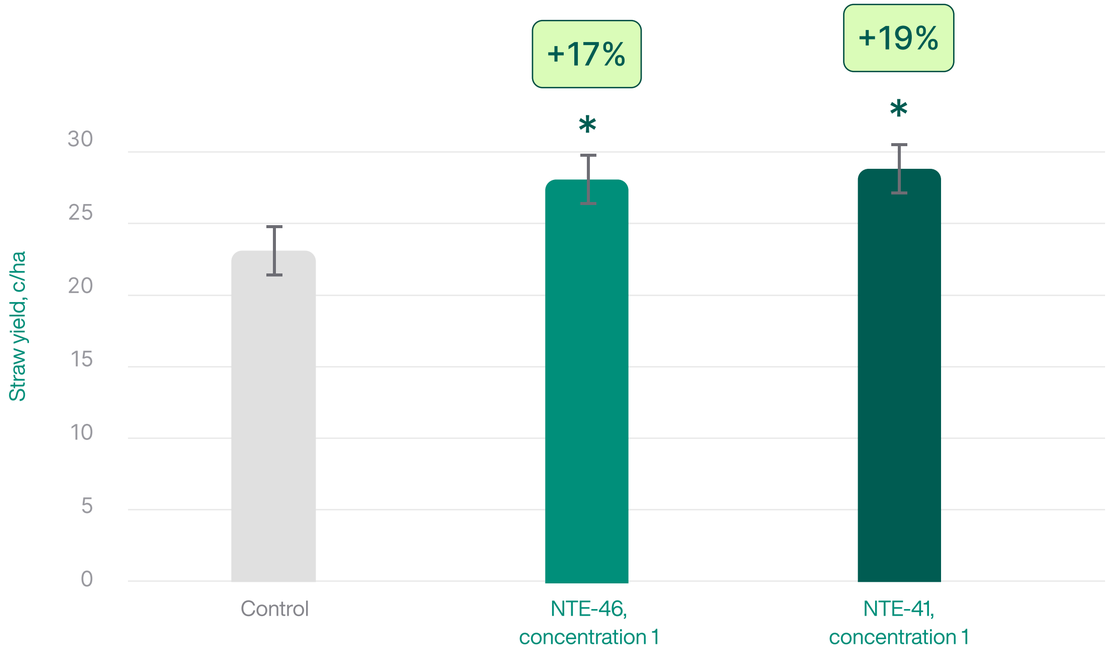
	Calcium	Phosphorus	Fat	Ash	Fiber	Protein	
Concentration 1	115%	29%	8%	20%	1%	75%	
Concentration 2	111%	27%	12%	12%	1%	43%	-
Concentration 3	135%	10%	8%	5%	-3%	8%	

Treatment of *Ester* wheat with the NTE-47 molecule increases the content of protein, lipids, calcium, and phosphorus in the straw, which indicates an increase in the quality of the straw.

Effect of NTE-41 and NTE-46 molecules on common wheat variety *Ester*: preliminary results

NTE-41 and NTE-46 molecules in different concentrations increased the grain and straw yield of wheat.

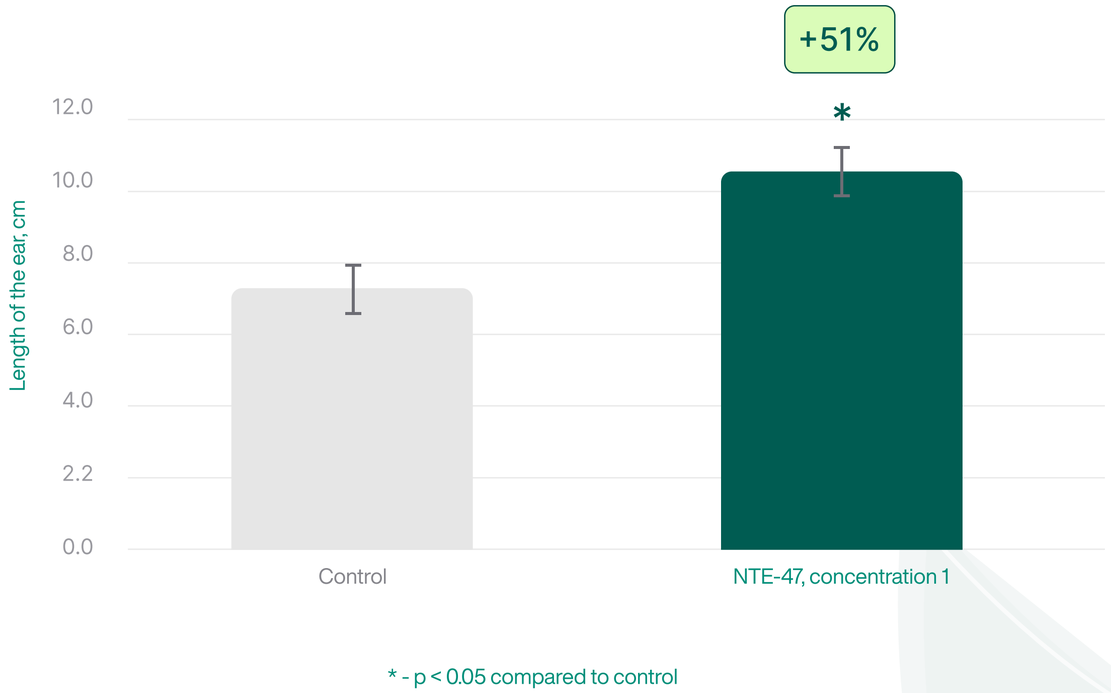




* - p < 0.05 compared to control, respectively

NTE-41 and NTE-46 molecules in different concentrations increased the mass of 1000 grains in wheat by **1-6%** compared to the control.
Molecules in different concentrations increased the protein content in straw by **8-16%** (data are not presented).

Effect of NTE-47 molecule on common wheat variety *Radmira*: morphometric indicators



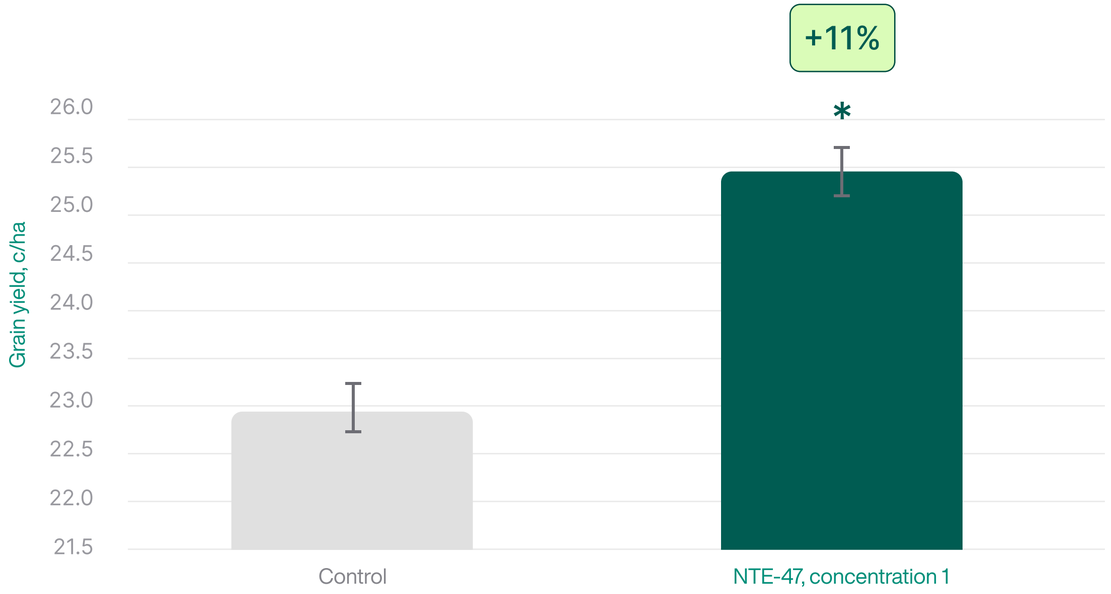
* - p < 0.05 compared to control

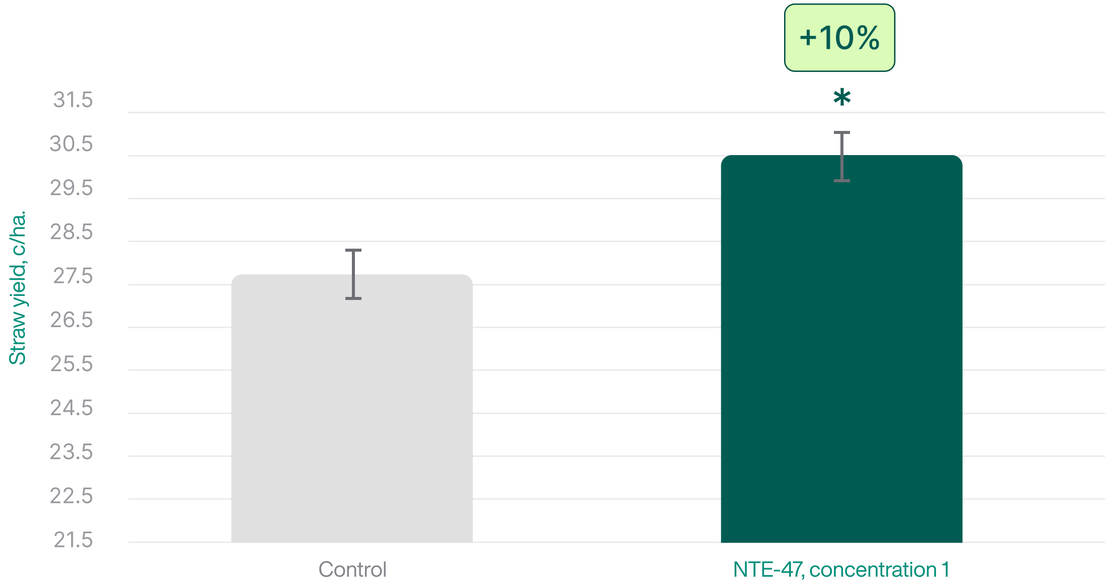
NTE-47 molecule stimulated the length of the ear by **51%** compared to control.

NTE-47 molecule in concentration 1 increased the number of spikelets in wheat by **6%** compared to the control (data are not presented).
The molecule had no effect on the plant height.

Effect of NTE-47 molecule on common wheat variety *Radmira*: yield indicators

NTE-47 molecule in minimal concentration increased the grain and straw yield by **11%** and **10%** compared to control, respectively.





* - p < 0.05 compared to control, respectively

NTE-47 molecule in different concentrations also increased the mass of 1000 grains by **10-42%** compared to the control, but decreased the number of grains per ear by **16-22%** (data are not presented)

Effect of NTE-47 molecule on common wheat variety *Radmira*: technological qualities of grain: preliminary results

* - p < 0.05 compared to control

NTE-47 molecule in different concentrations increased gluten content in grain, by **11-50%** compared to control.

NTE-47 molecule had no effect on the grain transparency, falling number and gluten deformation index.

Effect of NTE-47 molecule on common wheat variety *Radmira*: macronutrients in grain and straw: preliminary results

Grain, % in relation to control

	Calcium	Phosphorus	Fat	Ash	Fiber	Protein	
Concentration 1	967%	45%	41%	-5%	-58%	13%	
Concentration 2	733%	49%	35%	-10%	-56%	11%	-
Concentration 3	417%	8%	9%	-14%	-39%	4%	

Treatment of Radmira wheat with the NTE-47 molecule increases the content of protein, lipids, calcium, and other macrocomponents in the grain, which indicates an increase in grain quality.

Effect of NTE-47 molecule on common wheat variety *Radmira*: macronutrients in grain and straw: preliminary results

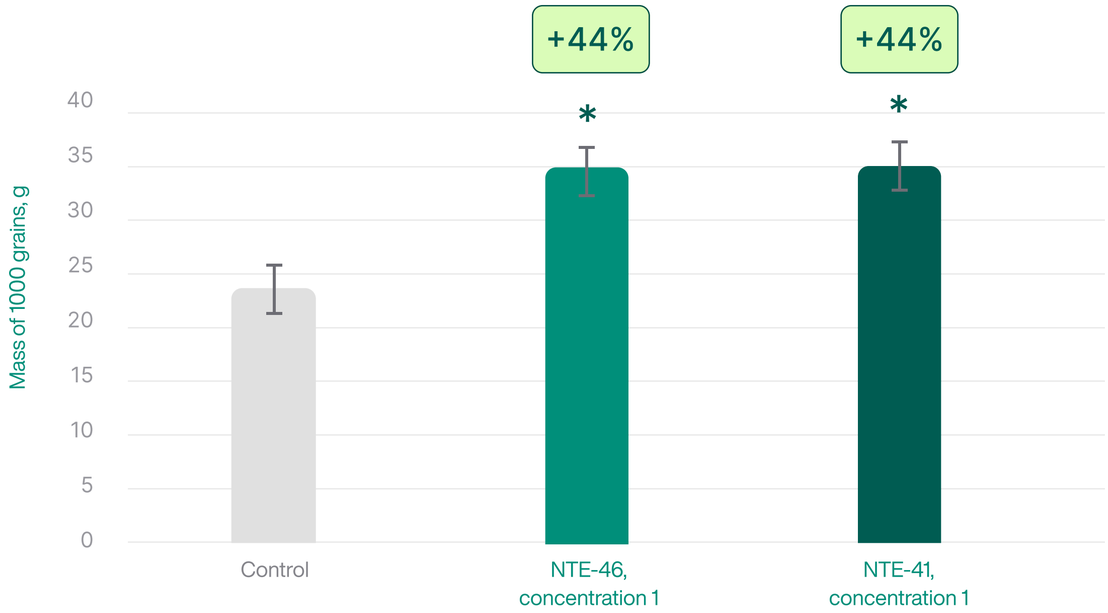
Straw, % in relation to control

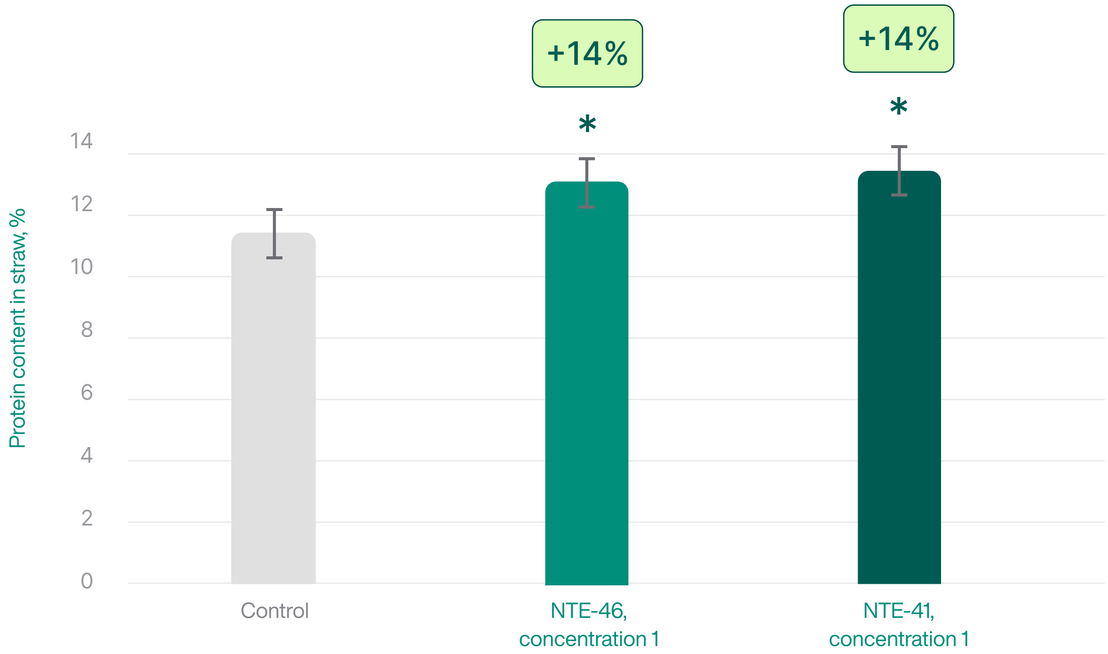
	Calcium	Phosphorus	Fat	Ash	Fiber	Protein	
Concentration 1	332%	9%	17%	42%	1%	40%	
Concentration 2	312%	9%	10%	10%	1%	23%	-
Concentration 3	232%	4%	6%	4%	0%	9%	

Treatment of *Radmira* wheat with the NTE-47 molecule increases the content of protein, lipids, calcium, phosphorus and other macrocomponents in the straw, which indicates an increase in its quality.

Effect of NTE-41 and NTE-46 molecules on common wheat variety *Radmira*: preliminary results

NTE-41 and NTE-46 molecules in different concentrations increased the mass of 1000 grains and protein content in straw.





* - $p < 0.05$ compared to control, respectively

NTE-41 and NTE-46 molecules in different concentrations increased the grain and straw yield of wheat by **4-12%** (data are not presented).

Conclusions

1. Wheat of various varieties (*Zlata, Ester, Radmira, Svecha*) reacts differently on short molecules with various structure (NTE-41, NTE-46, NTE-47).

2. The effect of molecules varies depending on the wheat variety. Molecules had pronounced effect on *Zlata* variety, increasing morphometrics indicators by **10-45%**, yield indicators by **14-20%**, technological qualities of grain by **4-50%** compared to control.

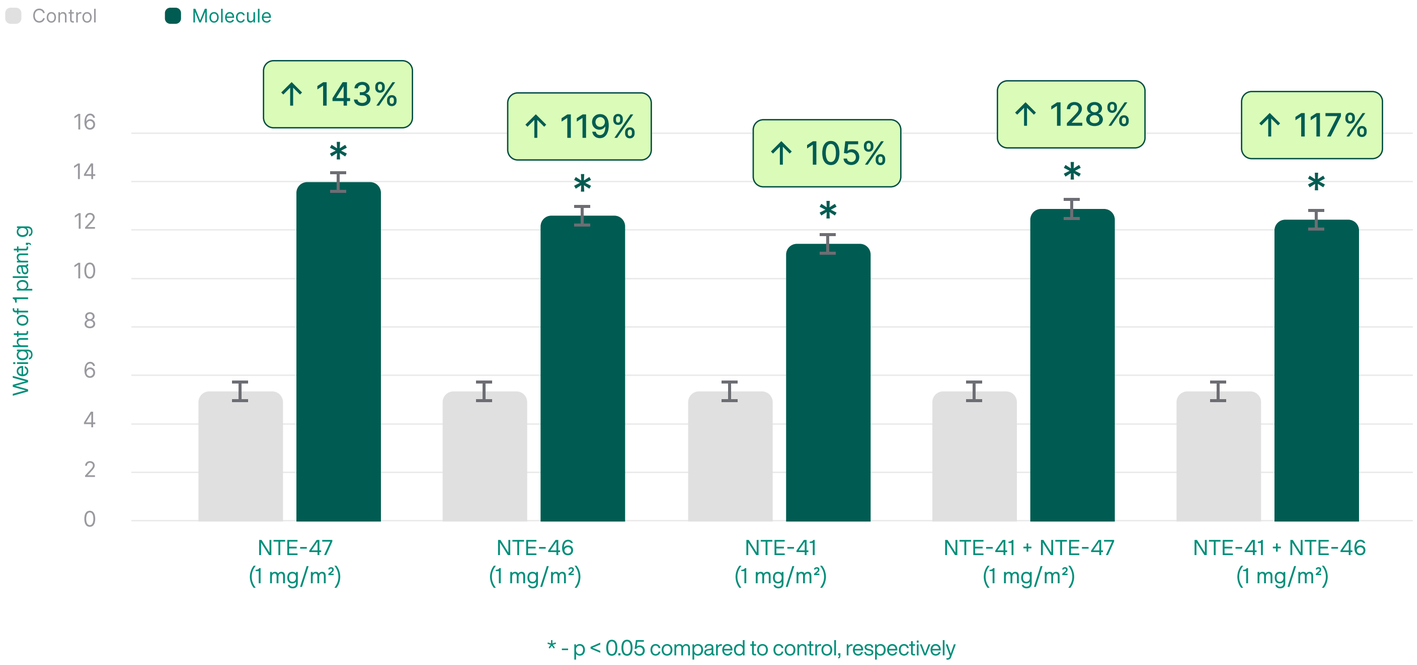
3. The use of molecules contributes to a change in the chemical composition of wheat. The most noticeable changes are observed for the calcium content in grain and straw of the *Zlata* variety - a **12-fold increase** after applying NTE-47 molecule. The *Ester* variety shows an increase in fiber content in grain by **11-38%**.

4. Combination of NTE-41, NTE-46, NTE-47 molecules has an effect comparable to that of individual molecules. NTE-47 molecule had the most pronounced effect on the number of grains in the ear of wheat variety *Lada*, increasing this indicator by **105%** compared to control. The combination of these molecules increased this indicator by **110%**.

Effect of NTE-41, NTE-46, NTE-47 molecules and combinations of these molecules on white mustard

Study of effects of short molecules on white mustard variety *Elena* (preliminary results)

Molecules and their combinations at a concentration of 1 mg/m^2 were the most effective and increased the weight of a single plant of white mustard variety Elena by **105-143%.**



* - p < 0.05 compared to control, respectively

- Molecules and their combinations at a lower concentration (0.1 mg/m²) were less effective, but statistically significant increased this parameter by 63-132%.
- The NTE-47 molecule had the most pronounced effect on this parameter.
- It appears that increasing the concentration enhances the stimulating effect of the NTE-41, NTE-46, and NTE-47 molecules by 15-36%. However, the effect of molecule combinations (NTE-41 and NTE-47, NTE-41 and NTE-46) did not exceed the effect of the individual molecules.

Study of the effect of NTE-47 molecule on white mustard of the *Elena* variety (preliminary results)

01.09.2024

NTE-47 molecule Control

08.09.2024

Control NTE-47 molecule

15.09.2024

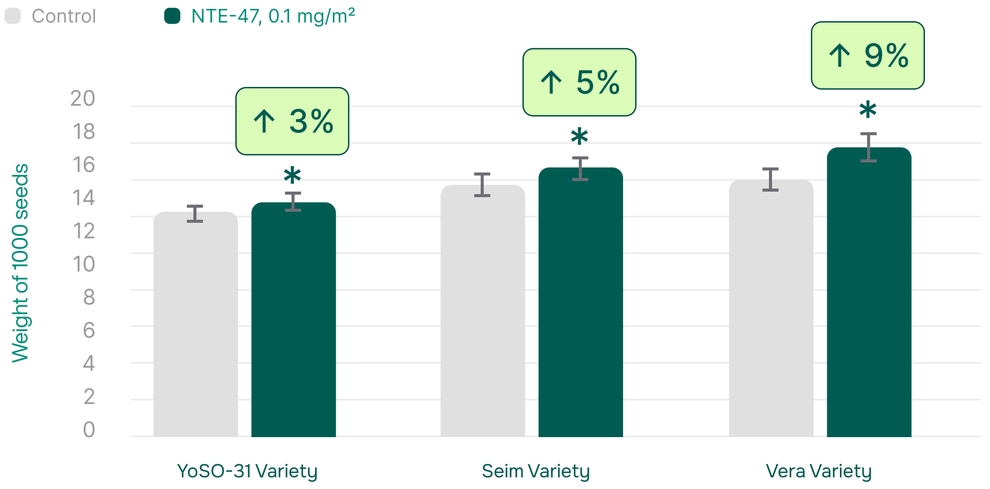
Control NTE-47 molecule

The NTE-47 molecule increased the air-dry mass of 1 plant dynamically compared to the control

Effect of NTE-41, NTE-46, NTE-47 molecules and combination of these molecules on industrial hemp (preliminary data, field research)

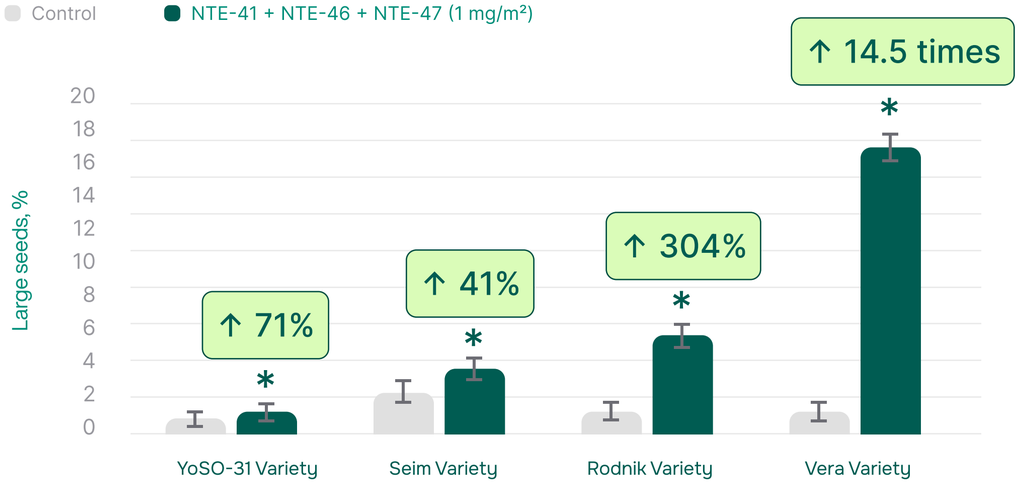
Study of molecules effect on industrial hemp (preliminary data)

Four varieties of industrial hemp were tested: YuSO-31, Seim, Rodnik, and Vera.
Each variety was treated with NTE-41, NTE-46, and NTE-47 molecules at concentrations of 0.1 and 1 mg/m^2, as well as with their combination (NTE-41 + NTE-46 + NTE-47).
The seed quality indicators were measured, including the weight of 1000 seeds and the percentage of large seeds.



The NTE-47 molecule increased the weight of 1000 seeds **by 3-9%** depending on the hemp variety, with the greatest effect observed on the Vera variety. The combination of molecules increased the weight of 1000 seeds **by 4-10%**, also having the greatest effect on the Vera variety.

Molecules and their combination effectively increased the percentage of large seeds depending on the variety.
In the case of the Vera variety, the percentage of large seeds increased **by 14.5 times** compared to the control when treated with the molecules combination.



* - p < 0.05 compared to control, respectively

Data received on August 19, 2023:

Control

NTE-41 molecule

In the control field (left photo), plants are low, with yellowish leaves.

In the field after treatment with NTE-41 molecule (right photo) plants are taller, leaves are bright green.

Left after winter: (data received on April 20, 2024)

Control

NTE-41 molecule

After wintering, industrial hemp plants are almost 2 times higher in the group with treatment by the NTE-41 molecule.

Study of the effect of the NTE-41 molecule on industrial hemp of different varieties (preliminary data, summer 2024)

Control

NTE-41 molecule

In the control field (left photo), plants are low, with yellowish leaves.

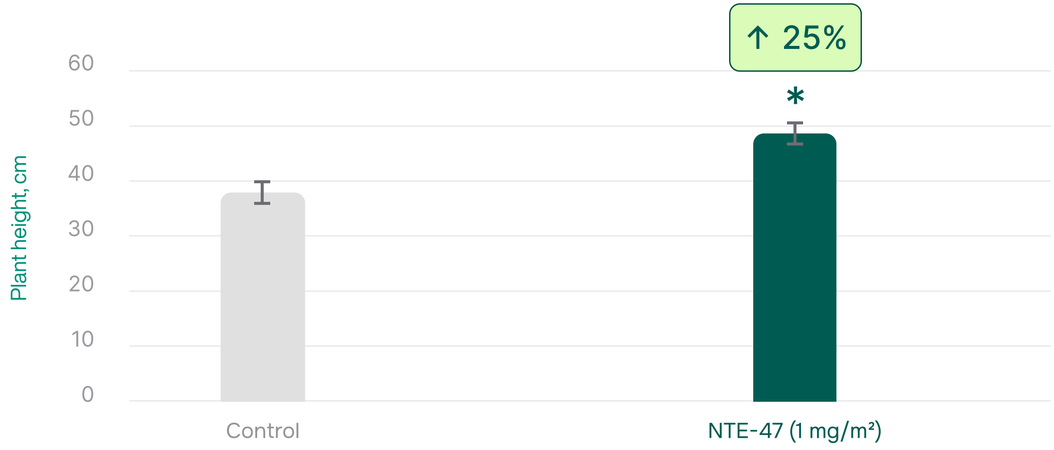
In the field after treatment with NTE-41 molecule (right photo) plants are taller, leaves are bright green.

Effect of NTE-47 molecule and on barley (preliminary data, field research)

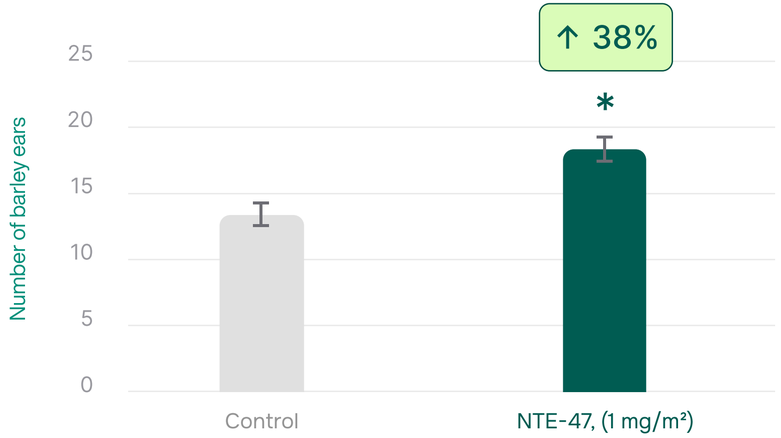
Study of the molecules effect on barley variety *Nur* (preliminary data)

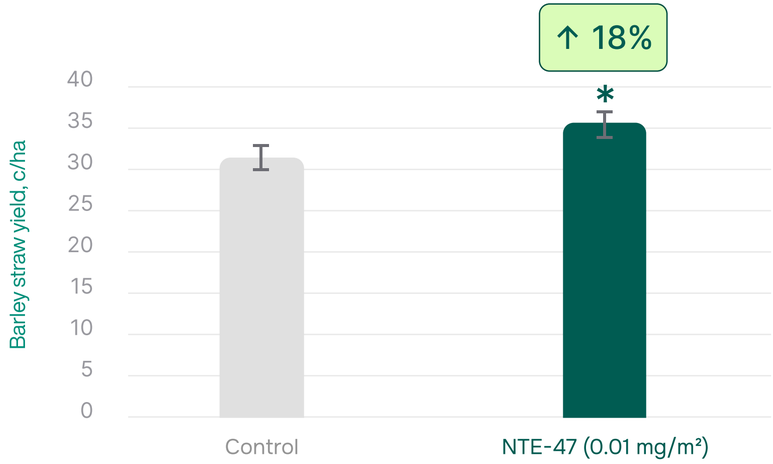
The NTE-47 molecule at various concentrations increases plant height, barley straw yield, and the number of barley ears **by 18-38%.**
The molecule was effective both at the highest concentration of 1 mg/m^2 and at the lowest concentration of 0.01 mg/m^2.

Seeds of barley variety *Nur*

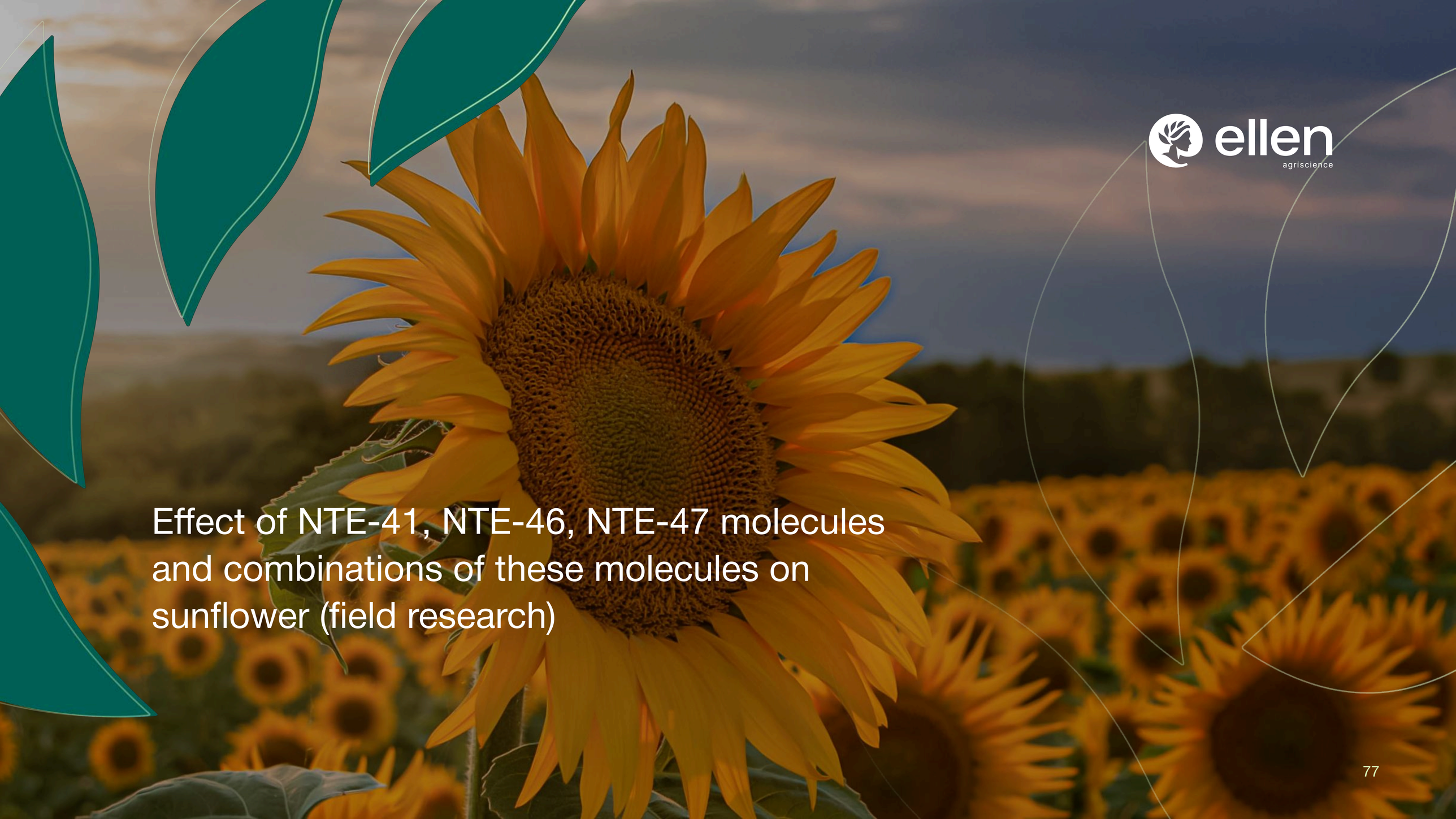


* - p < 0.05 compared to control





* - p < 0.05 compared to control



Effect of NTE-41, NTE-46, NTE-47 molecules and combinations of these molecules on sunflower (field research)

Study design

Study molecules:
NTE-41, NTE-46, NTE-47, and combinations of these molecules in 3 different concentrations.

Study design:
Plants were treated with molecule solutions in different concentrations using the spray method.
The control field was sprayed by water without molecules.

Timeline:
Sowing: May 16, 2024
Spraying by molecules solutions: June 27, 2024
Harvesting: August 10, 2024

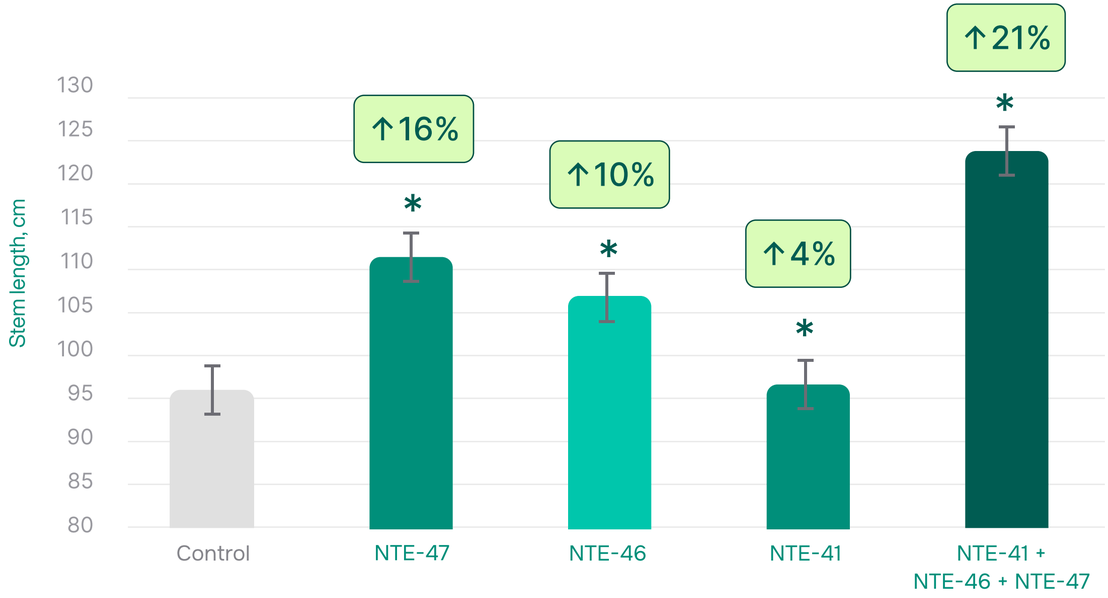
Studied variety of sunflower (*Helianthus annuus L.*):
Suri

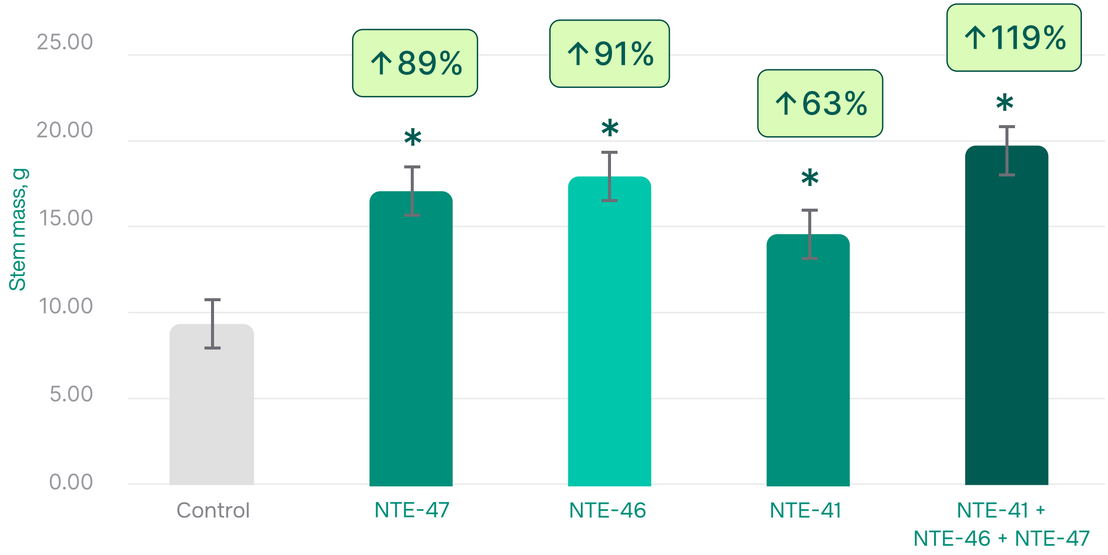
Determined parameters:

- Morphometric and yield indicators
- Technological qualities: Husk content (the mass fraction of fruit coats in the total mass of seeds. The husk content index affects the oil content of seeds, as well as the resistance of seeds to damage by pests and diseases)

Effect of NTE-41, NTE-46, NTE-47 molecules and their combinations on sunflower variety *Suri*:

NTE-41, NTE-46, NTE-47 molecules and their combinations at the maximal concentration increased the length and weight of sunflower stems by **4-21%** and **63-119%** compared to the control.

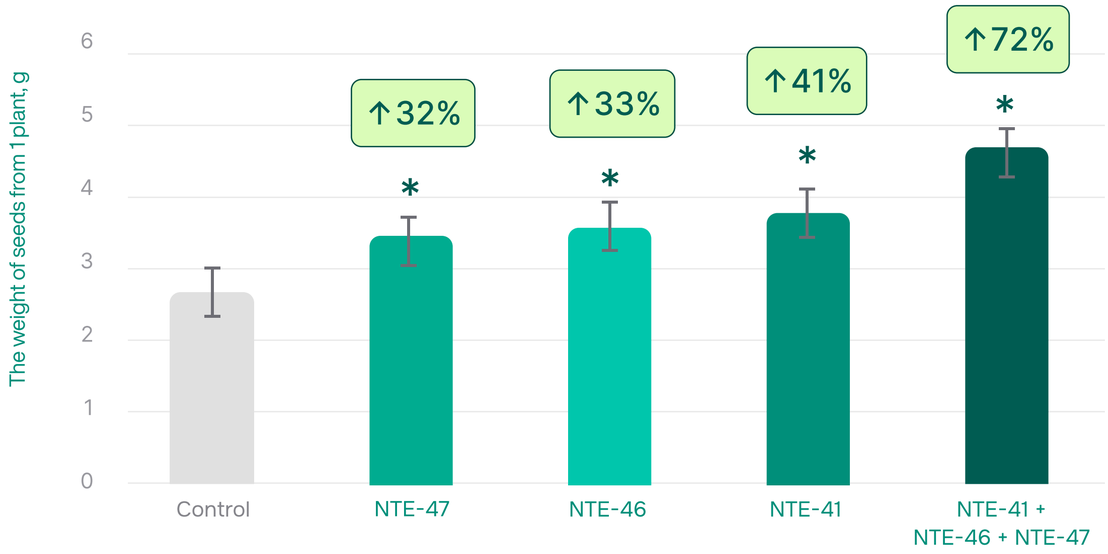




* - $p < 0.05$ compared to the control, respectively; diagrams represent the data which were obtained for the maximal concentration

NTE-47 molecule and combination of all three molecules were the most effective.

Effect of NTE-41, NTE-46, NTE-47 molecules and their combinations on sunflower variety *Suri*:

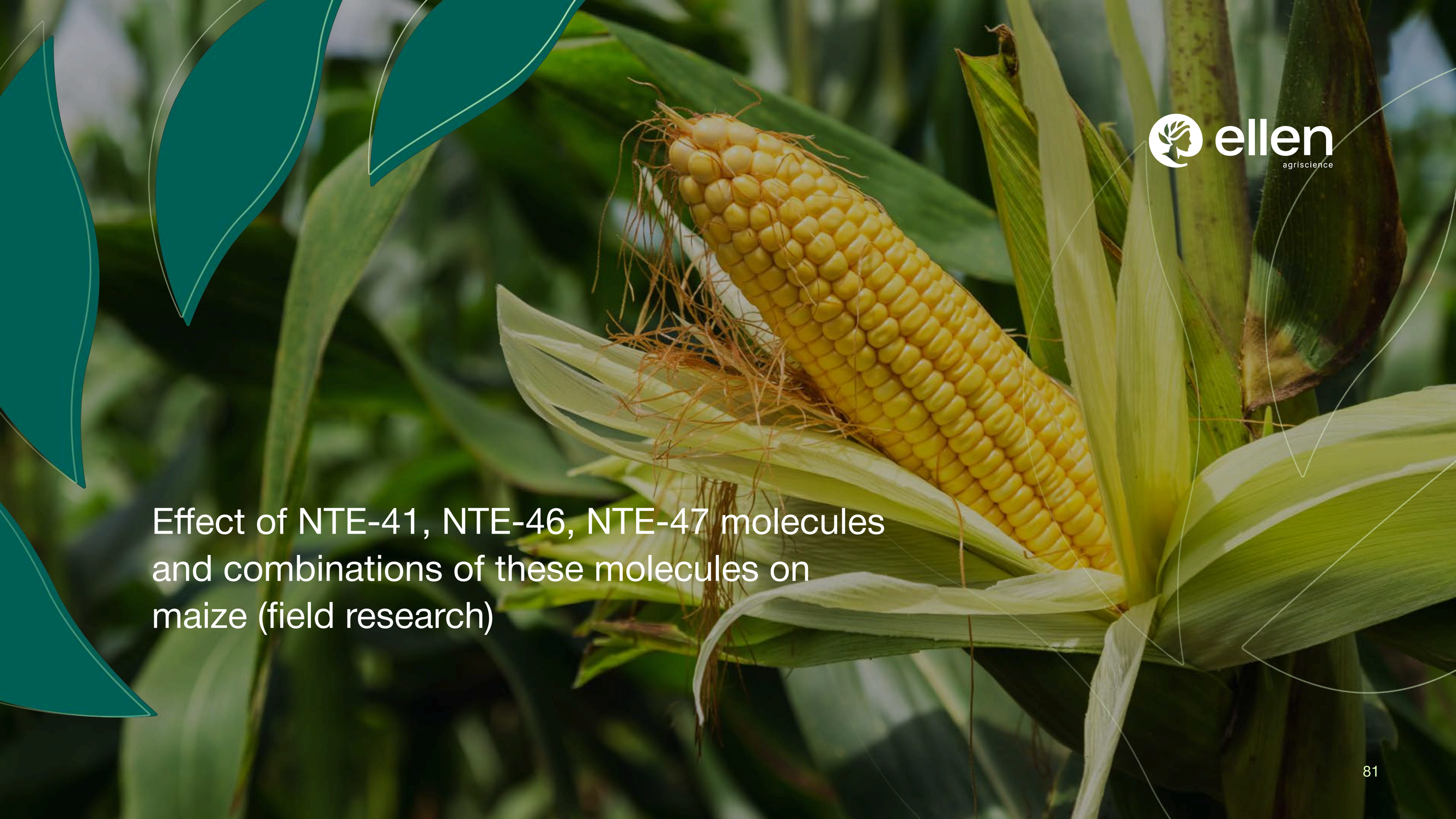


* - p < 0.05 compared to the control, respectively; diagrams represent the data which were obtained for the maximal concentration

NTE-41, NTE-46, NTE-47 molecules and their combinations at the maximal concentration increased the weight of seeds from 1 sunflower plant by **32-72%** compared to the control.

Separately used molecules increased the weight of 1000 seeds of sunflower by **32-41%** compared to control. NTE-41 molecule was the most effective among separately used molecules.

Effectivity of combinations of NTE-41, NTE-46 and NTE-47 molecules was greater than for separately used molecules. Combination of molecules increased the weight of 1000 seeds of sunflower by **72%** compared to control.



Effect of NTE-41, NTE-46, NTE-47 molecules and combinations of these molecules on maize (field research)

Study design

Study molecules:
NTE-41, NTE-46, NTE-47, and combinations of these molecules in 2 different concentrations.

Study design:
Plants were treated with molecule solutions in different concentrations using the spray method.
The control field was sprayed by water without molecules.

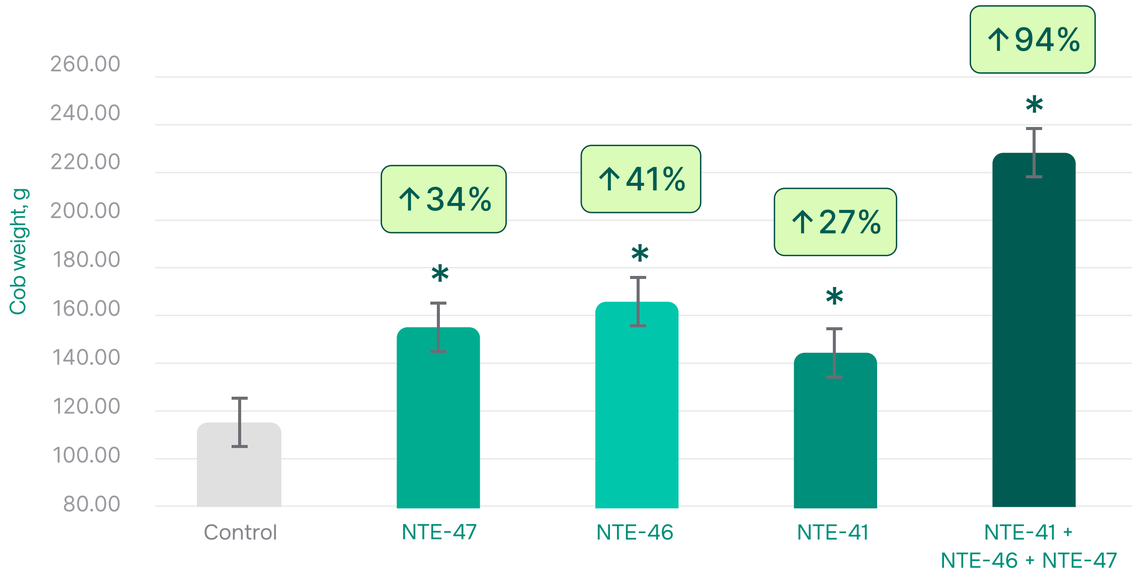
Timeline:
Sowing: May 16, 2024
Spraying by molecules solutions: June 28, 2024
Harvesting: August 17, 2024

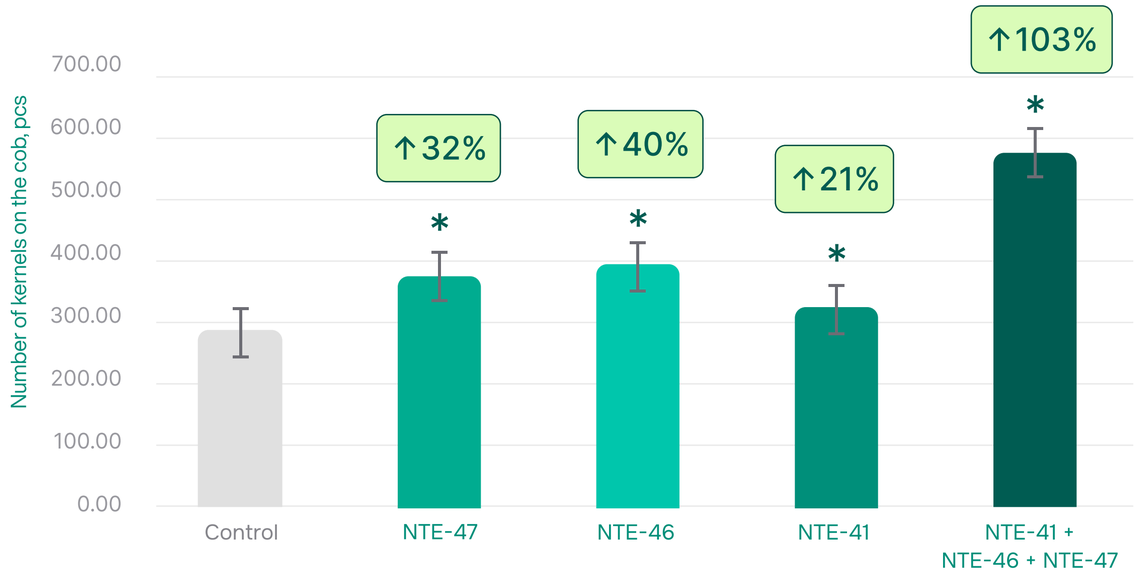
Studied variety of maize:
Early delicacy

Determined parameters:
- cob weight
- number of kernels per ear
- weight of 1000 seeds
- yield

Effect of NTE-41, NTE-46, NTE-47 molecules and their combinations on *maize*

NTE-41, NTE-46, NTE-47 molecules and their combination at the maximal concentration increased the weight of the cob and the number of kernels on the cob of corn by **27-94%** and **21-103%** compared to the control.

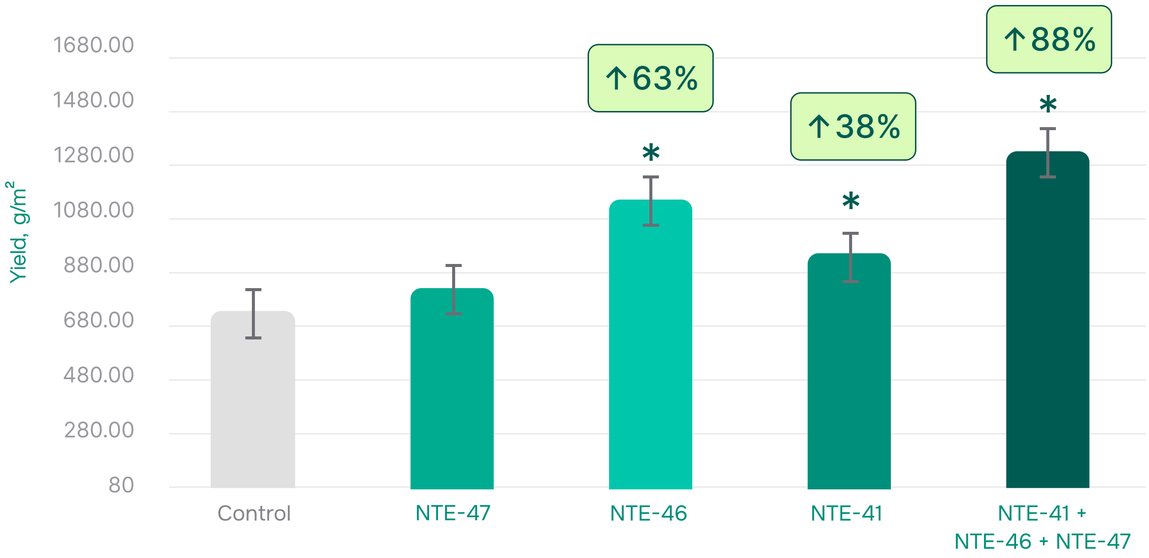




* - p < 0.05 compared to the control, respectively; diagrams represent the data which were obtained for the maximal concentration

NTE-46 molecule and combination of all three molecules were the most effective.

Effect of NTE-41, NTE-46, NTE-47 molecules and their combinations on *maize*



* - $p < 0.05$ compared to the control, respectively;
diagrams represent the data which were obtained for the maximal concentration

NTE-46 and NTE-41 molecules increased the yield of maize by **38-63%** compared to control. NTE-47 molecule did not have such effect on this parameter.

Combination of NTE-41, NTE-46 and NTE-47 molecules was the most effective and increased the yield of maize by **88%** compared to control.

Countries of Cooperation