The effect of peptides on the sowing qualities of wheat seeds

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Abstract. The research was conducted in 2024 in a laboratory experiment at the Russian State Agrarian University - Moscow Timiryazev Agricultural Academy (Moscow). The use of a complex of short peptides made it possible to influence the intensity of seed germination, having a positive effect on the morphometric parameters of spring wheat seedlings: the weight of 100 pieces of roots increased when treated with KE dipeptide by 48...245% (by 1.7...4.9 g) compared with the control; when treated with AEDG tetrapeptide by 6...47% (by 3.6..7.3 g). At the same time, a significant increase in root length was noted by 17% (by 1.3 cm) when treated with KE dipeptide at a concentration of 1*10-9 g/l; by 16% (by 1.2 cm) when treated with AEDG tetrapeptide at a concentration of 1*10-12 g/l. The height of the sprout increased with a decrease in the concentration of dipeptide KE by 16..26% (by 1.5..2.4 cm); with the use of tetrapeptide AEDG by 33...35% (by 3.3..2.4 cm). The weight of the sprouts (100 pieces) of the grain increased by 27% (by 1.4..1.6 g) compared with the control (dipeptide KE).

1 Introduction

Short peptides contain fundamental molecular information, due to this, scientists around the world are currently using their unique properties in scientific research, defining great prospects for them in the innovative industry. Recently, short peptides have attracted increasing attention from scientists in the fields of biology, chemistry and medicine due to their properties. They are appreciated as new and effective therapeutic agents with reduced side effects. Their structural diversity, combined with the flexibility of their conformation, is used to control interactions with specific sites of target molecules. Peptides exhibit high selectivity due to specific interactions with their targets. Moreover, the number of studies on the effects of short peptides involved in important biological processes is steadily increasing [1, 2] . Plants face a number of serious abiotic stresses, including temperature fluctuations, excessive salinization, drought, floods, presence of toxic heavy metals in the soil and a shortage of essential nutrients vital to maintaining plant life. These factors can have an adverse effect on the physiological functions of plants, reducing the ability of the plant to cause immune or stress reactions, thereby leading to a significant decrease in both total yield and plant quality [3]. Numerous small peptides have been identified as regulators of tolerance mechanisms that help plants adapt to a variety of abiotic stresses [3,4]. The purpose of the

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study was to establish the effect of short peptides KE and AEDG on seed sowing qualities and growth rates at the initial stages of ontogenesis on soft wheat grains (Triticum aestivum L.), of the Svecha variety.

2 Materials and Methods

Studies on the effect of the use of short peptides on the sowing qualities of wheat seeds were carried out in 2024, using plant material of soft spring wheat grains (*Triticum aestivum* L.) of the Svecha variety, medium-sized, early-ripening variety, grain size 770 g/l, vitreous 55-57%, crude gluten content of the first quality group 30%, weight of 1000 grains 34.0 g.

Objects of research:

Dipeptide KE in concentrations: 10^{-6}; 10^{-9}; 10^{-12};10^{-15} g/l.

Tetrapeptide AEDG in concentrations: 10^{-6}; 10^{-9}; 10^{-12};10^{-15} g/l.

The form of peptides is lyophilizate (powder). The control is distilled water. Pre-sowing treatment of seeds with short peptides was carried out using the technology of "treatment with wetting" [5]. The tests were carried out on a natural infectious background. Seeds brought to sowing conditions were used for testing. Seeds are considered conditioned, according to their characteristics they meet the currently valid GOST. Seed sowing qualities were determined by placing 100 pieces of seeds in four repetitions in Petri dishes with a wet filter. The studied preparations were used in concentrations of 10-6; 10-9; 10-12; 10-15 g/l, simultaneously at the beginning of the experiment. The sowing qualities of seeds (germination energy, sprouting) were determined in accordance with GOST 12038-84. Germination energy was recorded in wheat seeds on day 3. Sprouting was recorded in wheat seeds on day 7. The mass of the sprouts and roots, the height of the sprouts, the number and length of the roots were determined. The sprouting and germination energy of the seeds were calculated as a percentage. The arithmetic mean of the results of determining the sprouting of all analyzed samples was taken as the result of the analysis, considering deviations in accordance with GOST using Straz software [6].

3 Discussion

Studies on the effect of the use of short peptides on the sowing qualities of wheat seeds allowed to establish the following pattern: the use of a complex of short peptides allowed to influence the intensity of seed germination, having a positive effect on the morphometric parameters of seedlings. There was a significant increase in the germination energy of spring soft wheat seeds by 12-40% compared with the control variant. The highest values in terms of germination energy were noted when using KE at concentrations of $1*10^{-9}$ g/l, $1*10^{-12}$ g/l, germination energy indicators in this variant were 87% and 83%, respectively (Figure 1-3). Thus, peptide KE at concentrations of 10^{-9}, 10^{-12}, 10^{-15} g/l stimulated the germination energy of wheat and did not affect sprouting, and at the highest concentration (10^{-6} g/l) did not affect the germination energy of wheat and reduced its sprouting.

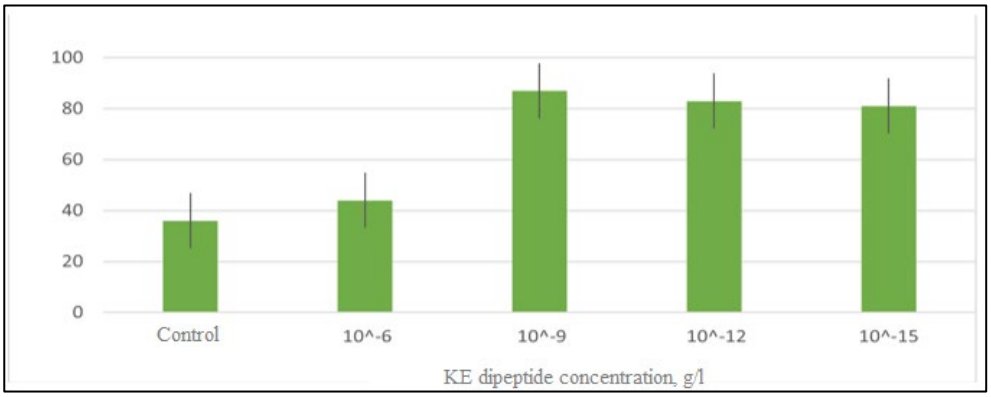

Fig. 1. The effect of the KE dipeptide on the germination energy of spring soft wheat grains of the Svecha variety, %.
Note: The data in the graphs are presented as the arithmetic mean and standard deviation. * - $p < 0.05$ compared to the control.

Peptide KE in all studied concentrations, except 10-6 g/l, stimulated germination energy by an average of 2 times compared with the control (Figure 1). The use of the KE peptide had no effect on sprouting, except for the variant with a concentration of 10-6 g/l, where germination was significantly reduced by 8.5% compared with the control.

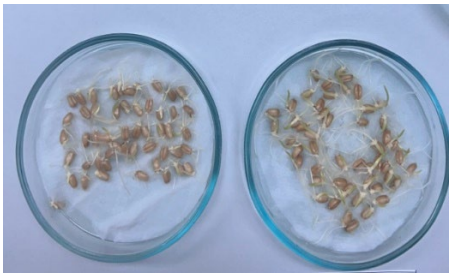

Fig. 2. Wheat germination energy when using KE peptide $1*10^{-9}$.

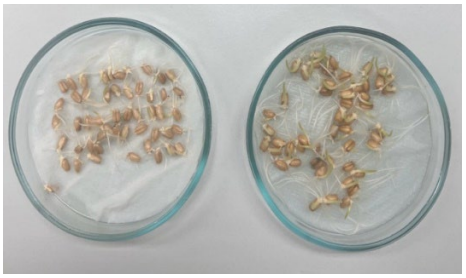

Fig. 3. Wheat germination energy when using KE peptide $1*10^{-12}$.

When treated with tetrapeptide AEDG in all studied concentrations, an increase in wheat germination energy was observed by 2-2.3 times compared with the control (Figure 4). The AEDG peptide had no significant effect on sprouting (Figure 5).

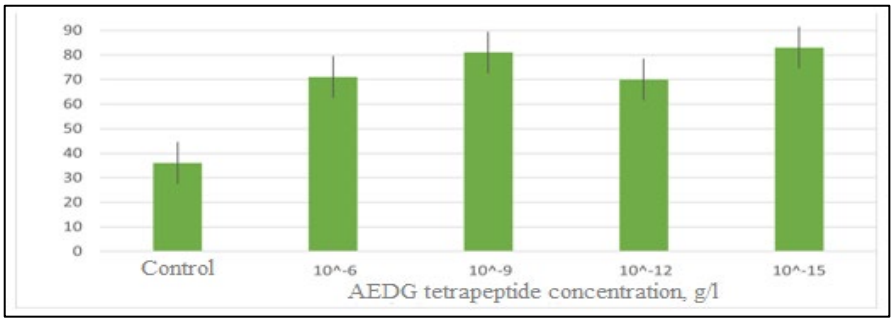

Fig. 4. The effect of AEDG peptide on the germination energy (%) of spring soft wheat of the Svecha variety.
Note: The data in the graphs are presented as the arithmetic mean and standard deviation. * - $p < 0.05$ compared to the control.

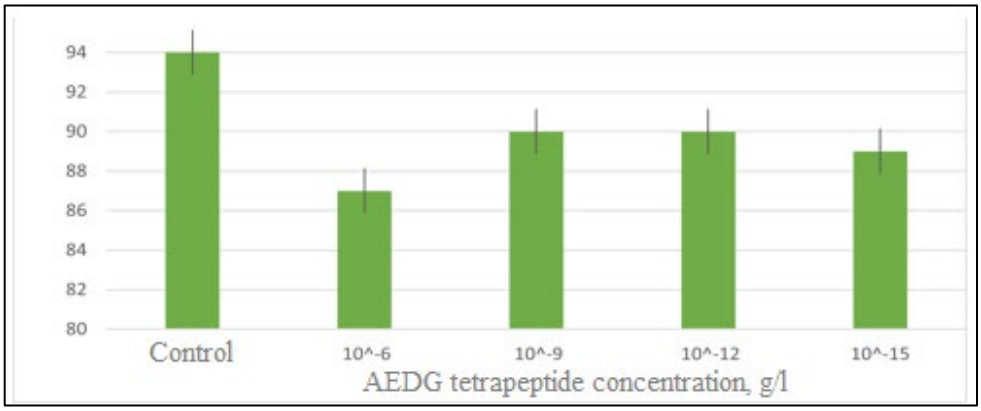

Fig. 5. Effect of AEDG peptide on sprouting (%) of spring soft wheat of Svecha variety.

Wheat grains were the most responsive to peptide treatments in the following variants: the mass of 100 pieces of roots increased by 48...245% (by 1.7...4.9 g) when treated with dipeptide KE compared with the control; when treated with tetrapeptide AEDG by 6...47% (by 3.6..7.3 g) (Table 1, 2). The most pronounced effect on the weight of 100 wheat roots was shown by concentrations of KE 10^{-9}, 10^{-12}, 10^{-15} g/l. The peptide had no significant effect on the length of the roots, except for the variant with the addition of a peptide at a concentration of 10^{-9} g/l.

Table 1. The effect of peptides on seed sowing qualities and growth indicators at the initial stages of wheat ontogenesis (average value by repetition).

option	germination energy %	sprouting, %	weight of 100 sprouts, g	weight of 100 roots, g	height of the sprout, cm	number of developed roots, pcs	length of the developed roots, cm
St wheat	36	94	6.30	3.36	9.21	5.10	7.13
AEDG 10^{-6}	71	87	6.79	8.95	8.74	5.05	6.69
AEDG 10^{-9}	81	90	9.27	10.75	12.47	4.95	7.81
AEDG 10^{-12}	70	90	8.21	6.97	11.60	5.05	8.29
AEDG 10^{-15}	83	89	8.04	9.32	11.56	4.95	7.36
KE 10^{-6}	44	86	8.00	5.13	10.72	5.20	7.17
KE 10^{-9}	87	93	6.62	8.34	11.34	5.00	8.39
KE 10^{-12}	83	88	7.66	7.07	11.01	5.05	7.15
KE 10^{-15}	81	90	7.94	6.79	11.65	5.00	8.14

At the same time, a significant increase in root length was noted by 17% (by 1.3 cm) when treated with KE dipeptide at a concentration of $1*10^{-9}$ g/l (Figure 6); by 16% (by 1.2 cm) when treated with AEDG tetrapeptide at a concentration of $1*10^{-12}$ g/l (Figure 7).

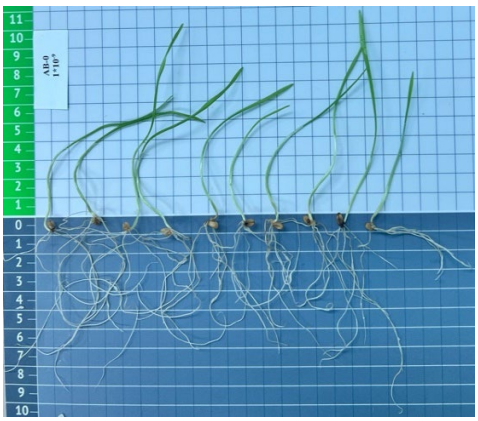

Fig. 6. The length of the roots when using the peptide KE $1*10^{-9}$.

Fig.7. Root length when using AEDG peptide $1*10^{-12}$.

The height of the sprout increased with a decrease in the concentration of dipeptide KE by 16..26% (by 1.5..2.4 cm) (Table 2); with the use of tetrapeptide AEDG by 33...35% (by 3.3..2.4 cm). The weight of the caryopsis sprouts (100 pieces) increased by 27% compared with the control (by 1.4...1.6 g) (dipeptide KE (Table 2).

Table 2. The effect of treatment with dipeptides on changes in dynamic growth indicators (average value for repetitions).

Option	Weight gain of 100 roots, g	Increase in length of the roots, cm	Increase in height of the sprout, cm	Weight gain of 100 sprouts, g
KE 10^{-6}	±1.7	-	±1.5	-
KE 10^{-9}	±4.9	±1.3	±2.1	±0.3
KE 10^{-12}	±3.7	-	±1.8	±1.4
KE 10^{-15}	±3.5	±1.0	±2.4	±1.6
AEDG 10^{-6}	±5.6	-	-	-
AEDG 10^{-9}	±7.3	±0.7	±3.3	±3.3
AEDG 10^{-12}	±3.6	±1.2	±2.4	±2.4
AEDG 10^{-15}	±5.9	±0.2	±2.4	±2.4

4 Conclusion

The conducted studies have shown that the use of a complex of short peptides made it possible to influence the intensity of seed germination, having a positive effect on the morphometric parameters of spring wheat seedlings. Dipeptide KE in all studied concentrations, except 10-6 g /l, significantly increased the germination energy of spring soft wheat by an average of 2 times compared with the control, but did not affect the germination of wheat, except for the variant with a concentration of 10-6 g/l, where wheat sprouting decreased by 8.5% compared with the control. Stimulation of the weight gain of the roots of seedlings was noted – 1.5-2.5 times compared with the control. The KE peptide had an effect on the root length only at a concentration of 10-9 g/l, increasing this indicator by 17% compared with the control. The KE dipeptide had no effect on the number of roots of seedlings, height and weight of seedlings. Wheat caryopsis were the most responsive to treatment with peptides: the mass of 100 pieces of roots increased by 48...245% (by 1.7...4.9 g) when treated with dipeptide KE compared with the control; when treated with tetrapeptide AEDG by 6...47% (by 3.6 ..7.3 g). At the same time, a significant increase in root length was

noted by 17% (by 1.3 cm) when treated with KE dipeptide at a concentration of $1*10^{-9}$ g/l; by 16% (by 1.2 cm) when treated with AEDG tetrapeptide at a concentration of $1*10^{-12}$ g/l. The height of the sprout increased with a decrease in the concentration of dipeptide KE by 16..26% (by 1.5..2.4 cm); with the use of tetrapeptide AEDG by 33...35% (by 3.3..2.4 cm). The weight of the sprouts (100 pieces) of the grain increased by 27% compared to the control (by 1.4..1.6 g).

Acknowledgments

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