

ANNOTATION

**dissertation work of Sembayeva Aizada Sansyzbayevna on the topic:
«Optimization of irrigation regimes and mineral nutrition in the cultivation of
intensive corn hybrids for grain using drip irrigation» submitted for the
degree of Doctor of Philosophy (Ph.D) in the specialty
6D080100 – «Agronomy»**

1. Relevance of the research topic. Currently, corn is cultivated in at least 164 countries and produces more than 35 percent of the world's food and covers an area of about 200 million hectares worldwide. About 380 million tons of corn are harvested annually in the world. It has become one of the economically important agricultural crops in the world. Therefore, high and stable productivity of this crop is equally important for both industrialized and developing countries.

Water scarcity in Kazakhstan already exceeds 20%, and in the future, as consumption increases and water resources decrease, the deficit will only increase. In this regard, the prospects for water supply in the southern and southeastern regions of Kazakhstan, which are highly dependent on transboundary waters, as well as the degradation of hydro-reclamation systems and the unstable structure of agricultural production, as well as global climate change, have a more negative impact on the territory of Kazakhstan compared to the global average trend.

Most importantly, an increase in corn grain production will improve the food security of Kazakhstan, stimulate agriculture in the southern and southeastern regions to grow corn, and increase the production of valuable protein products and feed products produced as a by-product of grain processing. In order to increase the yield of corn, it is necessary to conduct intensive tests of global climate change and adapt foreign corn hybrids with high yield and quality. The research work carried out to solve these problems is relevant.

The thesis is aimed at achieving the potential yield of corn per grain, reducing the herbicidal load per unit area, and rational use of fertilizers and irrigation water. A fundamentally new technology of drip irrigation cultivation using modern agricultural techniques with minimal pesticide load per unit of irrigated area has been investigated. The main elements of agricultural technology of corn cultivation for grain have been studied by setting up and conducting multifactorial field experiments – basic tillage and methods of managing the phytosanitary condition of crops in various drip irrigation regimes using No-Till technology and the use of various fertilizers. The proposed results are important for the development of agriculture.

In the conditions of the south-eastern region of Kazakhstan, research is relevant in order to improve the optimization of irrigation and mineral nutrition using drip irrigation using water-saving technologies, increase corn yields by 1.5-2 times, and reduce yields by 1.5-2 times.

2. The purpose of the dissertation research. In the south-east of Kazakhstan, increase corn yield by 1.5-2 times through the use of water-saving drip irrigation technology, reduce labor costs by 1.5-2 times and optimize irrigation

and mineral nutrition.

3. The main objectives of the study:

- To study different ways of sowing corn with drip irrigation (plowing and No-Till technology);
- To determine the effect of soil treatment methods and mineral fertilizers (Novalon, CAS-32 and ammonium nitrate) on the agrochemical and agrophysical composition of the soil;
- To establish the dependence of yield and quality indicators of intensive corn hybrids for grain on the use of mineral fertilizers, irrigation standards and methods of tillage;
- To determine the contamination of corn crops for grain, depending on the methods of tillage and application of mineral fertilizers;
- To develop an irrigation regime for intensive corn hybrids grown in various ways with drip irrigation;
- To give an economic assessment of irrigation and mineral nutrition regimes in the cultivation of corn for grain under drip irrigation conditions.

4. Research methods:

- The dynamics of soil moisture reserves was studied during seed sowing and during the phases of plant vegetation. Soil moisture was determined by the thermostatic-weighing method by constantly drying soil samples to an air-dry mass (Vadyunina A.F. et al., 1986). The soil samples were taken in layers every 10 cm to a depth of 1 meter;
- The density of the soil layer was determined by the method of a cutting ring along the horizons every 10 cm to a depth of 30 cm (Sokolov A.V., 1968);
- The volume mass of the soil was determined by the method of A.S. Kaczynski (A.S. Kaczynski, 2001);
- Field germination of the sown seeds was recorded in all variants on four fixed sites of 0.25 m² each (Balashev L.L., 1968);
- Grain germination was taken into account at the beginning and at the end of the growing season by counting the number of plants per 1 m² with a triple repetition;
- Phenological observations of grain corn during the growing season were carried out according to the «Methodology of the state variety testing of agricultural crops»;
- The dynamics of maize biomass accumulation was determined by the phases of grain crop development by selecting 20 plants from each experimental variant, measuring their height and then drying them to a constant weight;
- The structural elements forming the yield were determined by the method of triple repetition. The following indicators were taken into account in the structural analysis of corn: plant height, the height of attachment of the main cob, the mass of the whole plant (leaves, stem, rod, wrappers, grain), humidity in organs. The structural analysis of the cob was carried out on a sample (25 pieces) according to the following indicators: total weight of the cob (rod, grain), number of rows, grain yield (%), number of grains per cob, weight of grains per cob, weight of 1000 grains. The structural analysis was determined according to the

methodology of the state variety testing;

- To determine the timing of the next watering, the moisture content of the meter-high soil layer was systematically determined. The daily watering rate was calculated at the suggestion of N.N. Ivanov. This formula is used to calculate irrigation rates for corn and other crops.;

- The study of photosynthetic activity and productivity of corn plants was carried out according to the unified classical methodology of A.A. Nichiporovich et al.;

- The supply of photosynthetically active radiation (PAR) to corn plants was determined by the formula of H.G. Tooming and B.I. Gulyaev;

- The determination of root residues was carried out in layers of 0-10, 10-20 and 20-30 cm by selecting soil monoliths measuring $30 \times 20 \times 10$ cm, in two repetitions, followed by washing on a sieve with a diameter of 0.25 mm according to the Dospekhov method;

- The technological assessment of grain quality was carried out according to the methodology described in the «Handbook on Grain Quality Assessment», as well as in accordance with GOST 10846-91, GOST 10986-76 and GOST 13586.5-2015;

- Statistical data processing was performed in the R-Studio program. The obtained results were mathematically processed according to the method of B.A. Dospekhov (1985).

5. The main provisions submitted for defense:

- In the southeastern region of Kazakhstan, irrigation and mineral nutrition regimes for growing intensive hybrids of grain corn using drip irrigation technology have been substantiated for the first time in multifactorial field experience.;

- To study various ways of sowing corn with drip irrigation (plowing and No-Till technology);

- To determine the effect of soil treatment methods and mineral fertilizers (Novalon, KAS -32 and ammonium nitrate) on the agrochemical and agrophysical composition of the soil;

- Determination of yield and quality indicators of intensive grain corn hybrids, depending on the norms of mineral fertilizers and irrigation and methods of tillage;

- To develop an irrigation regime for intensive corn hybrids grown in various ways with drip irrigation.

6. Description of the main research results:

1. In the irrigated lands of southeastern Kazakhstan, it was found that lower soil density was observed during dump plowing, that is, during traditional cultivation, where, depending on the year of research, they amounted to 1.17-1.22 g/cm³, whereas with untreated No-Till technology - 1.20–1.23 g/cm³.

2. It was found that the application of Novalon water-soluble mineral fertilizer through fertigation contributes to a maximum increase in the content of easily hydrolyzable nitrogen (61-68 mg/kg), mobile phosphorus (47 mg/kg) and

exchangeable potassium (300-386 mg/kg) not only during dump plowing, but also when using No-Till technology.

3. Increased irrigation rates (4,500 m³/ha) in all cases contributed to higher yields. That is, the irrigation rate of 4,500 m³/ha compared to 3,000 m³/ha ensured a higher yield. In the Tauelsizdik hybrid, grain moisture ranged from 22.0–35.0%, in the LG 30500 hybrid – from 17.7–33.7%. The highest crude protein yield was obtained in variants using Novalon and KAS -32 fertilizers and amounted to 812 and 832 kg/ha with dump plowing, and 699 and 700 kg/ha with No-Till technology, respectively. The carbohydrate content in the corn grain in the control variant during dump plowing was 2.67%, with No-Till technology – 2.46%. In the variants with the addition of Novalon, KAS -32 and ammonium nitrate, the carbohydrate content in corn grain increased to 2.94% with dump plowing and up to 2.74% with No-Till technology.

4. It was found that the largest amount of root residues of grain corn is concentrated in the soil layer of 0-10 cm. This indicator was 71.2–76.0% for dump plowing, and 75.3–82.5% for No-Till technology. On average, over three years, the number of weeds during dump plowing was 33.8–39.0 pcs./m², with No-Till technology – 36.7–59.3 pcs./m². The number of annual and biennial weeds during sowing mainly depended on the methods of tillage. In crops of grain corn grown using No-Till technology, the use of mineral fertilizers contributed to an increase in the number of annual and biennial weeds.

5. Additional application of Novalon fertilizers, KAS-32 and ammonium nitrate contributed to an increase in the mass of grain on the cob, the mass of 1000 grains and the total yield. Under drip irrigation, the coefficient of water consumption of grain corn, depending on climatic conditions, cultivation technology and varietal characteristics, averaged 442–584 m³/t. Especially the use of Novalon and KAS-32 fertilizers ensured high yields and high-quality grain maturation. The highest yields in both hybrids were noted in variants with dump plowing + irrigation of 4,500 m³/ha + fertilization of KAS-32, which amounted to 160.2 kg/ha for the Tauelsizdik hybrid, and 159.8 kg/ha for the LG 30500 hybrid.

6. Due to increased irrigation standards and optimal selection of the fertilizer system during dump plowing, the profitability of products was 89–105%. In the variants with the addition of Novalon, KAS-32 and ammonium nitrate, profitability indicators reached 104.1–105.6%. Despite the fact that the No-Till technology provided a slightly lower yield level, it significantly reduced production costs and provided an acceptable level of profitability - in the range of 82–94%.

7. Justification of the novelty and importance of the obtained results.

In the southeastern region of Kazakhstan, irrigation and mineral nutrition regimes for intensive hybrids of grain corn using drip irrigation technology have been substantiated for the first time in multifactorial field experience.

A patent for a utility model «Method of cultivating corn» was obtained (No. 10999, date of adoption: 05.15.2025, date of issue: 15.08.2025). Patent holder: «Kazakh Research Institute of Agriculture and Plant Growing» LLP. Authors: Ospanbayev Zh., Zhapaev R.K., Kunypiyaeva G.T., Sembayeva A.S., Kydyrov

A.K.

8. Compliance with development directions or government programs

The dissertation work was carried out at the «Kazakh Research Institute of Agriculture and Plant Growing» LLP according to the following programs:

- under the scientific and technical program «Creation of an innovative agrotechnological park for precision farming» - «Introduction of high-tech technologies for cultivating leading field crops in the precision farming system. Transfer and adaptation of highly productive agricultural crops» for 2018-2020 (IRN BR06349590), state registration number No.0118RK01213, program code O.0869, as part of the financing of the Ministry of Agriculture of the Republic of Kazakhstan.

- under the scientific and technical program «Development of an agricultural system for the cultivation of crops (cereals, legumes, oilseeds and technical) using various elements of cultivation technologies, differentiated nutrition, plant protection products and equipment for profitable production based on comparative studies of various technologies for the regions of Kazakhstan» – «Development of scientific and methodological recommendations for the cultivation of crops on irrigated lands, taking into account the increase in the area of irrigated land to 3.0 million hectares in Kazakhstan» for 2021-2023 (IRN BR10764908), state registration number No. 0121RK00781, program code O.0990, as part of the financing of the Ministry of Agriculture of the Republic of Kazakhstan.

9. The contribution of the doctoral student to the preparation of each publication. The main results and conclusions of the dissertation work have been published in 10 articles in domestic and foreign publications. Among them: 3 articles – in scientific publications recommended by the Committee for Quality Assurance in the field of Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan; 4 articles – in the materials of international scientific conferences and scientific journals; 2 articles – in the SABRAO Journal of Breeding and Genetics (Scopus database, 59 percentile, Q3); 1 article – in the journal Food Science and Technology (Scopus database, 58 percentile, Q3). He is the co-author of 1 monograph and has received 1 utility model patent.

Articles have been published in publications recommended by the Committee for Quality Assurance in Science and Higher Education of the EOM of the Republic of Kazakhstan: in the scientific-expert Magazine «Search results» (2021, №4 (92), p. 78-86; 2021, №1 (89), p. 156-166); «Bulletin of the Kazakh agricultural research university named after S. Seifullina» (2023, №3 (118), p. 313-322); in the journal «Education and Science» (2022, №4-2 (69), p. 83-92).

Approbation of the work

The main results of the dissertation research were presented and discussed at international and national scientific conferences and round tables, including: The International Scientific and Theoretical Conference «Resource-saving technologies of crop cultivation – the future of agriculture», dedicated to the 70th anniversary of the Doctor of Agricultural Sciences, Professor, Academician of the Academy of

Agricultural Sciences of the Republic of Kazakhstan D.A. Sydyk (Shymkent, 2021); Round table «History and modernity: agricultural research in the field of agriculture and crop production», dedicated to the 90th anniversary of the Kazakh Research Institute of Agriculture and Plant Growing (Almalybak, 2024); International round table «Technologies of corn cultivation», organized by the University of Novi Sad (June 18-19, 2021).

10. Volume and structure of the dissertation

The dissertation is computer-typed on 143 pages and consists of an introduction, a definition of the research direction, independent research, research results, conclusions, recommendations for production and a list of references. The work is presented in 28 tables, 34 figures and 7 appendices. The list of references includes the works of 163 domestic and foreign scientists.