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ORIGINAL ARTICLE

Influence of growing technology on Moreland F1 sweetcorn grain hybrid quality

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The article presents the results of research concerning the study of influence of cultivation technology elements on the formation of grain quality indices of sweetcorn hybrid Moreland F1 on sod-podzolic soils under conditions of Precarpathians of Ukraine. The studies have shown that sweetcorn quality indices for hybrid Moreland F1varied unequally with different agronomic complex of crop growing. Thus, pericarp thickness of the grain did not depend on the studied elements of agricultural technology and ranged from 0.174 to 0.206 mm. The weight of 1000 grains of the crop significantly depended on all elements of cultivation technology, and was the highest on the background of nutrition $N_{135}P_{90}K_{125}$ + N_{60} + N_{30} and plant density 60 thousand/ha - 181.51 g. The maximum content of sugar and dry matter was also for above mentioned agronomic complex, and composed 4.25 and 33.52%, respectively. Thus, it was found that the highest dry matter content provides a variant with application of mineral fertilizers at a dose of $N_{135}P_{90}K_{125}$ + N_{60} + N_{30}, which forms from 31.25 to 33.52% depending on thickening of plants.

Keywords: sweetcorn, mineral fertilizers, weight of 1000 grains, sugar content, dry matter.

Introduction

Corn is one of the most highly productive cereals for universal purposes, which is grown for food, feed and technical use. In the world countries, about 20% of corn grain is used for food needs, and for technical - 15%, the rest goes for fodder (Vihrachov, 2010; Hryhoriv, 2020).

The quality of sweetcorn depends on many factors. The basis for improvement of organoleptic properties of crop production is selection aimed at increasing sugar content in grain, improving its physical and chemical properties, increasing the size of cobs, etc. (Klimova, 2012; Cherchel, 2007; Scherner et al., 2016). However, numerous studies of domestic and foreign authors have shown that agrotechnical factors have a significant impact on the quality of sweetcorn, in particular: precursors, primary soil tillage, terms of sowing and harvesting, fertilization system, application of bacterial biological preparations and micro-fertilizers, method of growing (seedling or sowing), densification of crops, irrigation regime (Danylova, 2013; Kazakova, 2015; Sokolovska, 2011). The action and interaction of agricultural technology elements has its own distinctive features depending on genotypic characteristics of cultivated varieties and hybrids of crop, soil and climatic conditions of cultivation, and so on.

Fertilization - is one of the main factors of crop production intensification as it has high impact on crop productivity as well as on quality indices of the products. Development and implementation of a sound fertilization system for any crop taking into account natural fertility, meliorative state of soils, climatic and productive conditions, is an essential stage in the formation of the whole technology of its growing (Horodnii, 2008; Shiferaw et al., 2011; Kharchenko et al., 2019). Fertilizers play a leading role in yield increasing of food subspecies of corn comparing with other agrotechnical measures (Tsykov, 2013; Karpenko et al., 2019).

Both foreign and domestic researchers have carefully studied the issue of sweetcorn fertilization. It has been established that the increase of plant immunity to fungal diseases occurs with application of phosphorus-potassium fertilizers (Kyryk, 2011; Markov, 2011). Rational, balanced application of mineral macro- and micro-fertilizers can significantly increase plant resistance to diseases and pests, strengthen regenerative capacity of plants and reduce crop losses from existing damage (Slovtsov, 2008; Kolisnyk et al., 2020). Studies concerning establishment of optimal nitrogen fertilizer dose conducted in Shanliurfi (Turkey) found that application of N320 under sweetcorn gives 59.3% of cob yield increase compared to the control (N120). The further increase of nitrogen dose to 360 kg/ha of active substance led to decrease in plant productivity (Oktem, 2010). We should keep in mind that sweet pop is a vegetable crop, mostly eaten fresh and dietary and medicinal food. Therefore, excessive use of nitrogen fertilizers especially their nitrate forms should be avoided as it has negative impact on product quality and can be harmful to human health. The maximum nitrogen application doze for corn is 150 kg/ha of active substance (Horodnii, 2008).

The purpose of the research is to define optimal parameters of pre-harvest plant density and establish peculiarities of sweet-grain quality formation depending on nitrogen nutrition under conditions of Precarpathians of Ukraine.

Materials and methods

Field research was conducted at the dendrological park "Druzhba named after Zinovii Pavlyk" of Vasyl Stefanyk Precarpathian National University (Ivano-Frankivsk region, Ukraine), on sod-podzolic surface-gleyed soil during 2018-2020.
According to soil survey results, the soils of experimental area are of average humus - 2.63%. The sum of the absorbed bases ranges within 11-12 mg-eq. per 100 g of soil, degree of saturation of the bases - 85%, reaction of soil solution - acidic (pH of salt solution 4.1-4.4, hydrolytic acidity is negligible). Field and laboratory studies were conducted in accordance with generally accepted methods of research in agronomy (Lytvynov, 2011; Bondarenko, 2001; Radchenko et al., 2018).
Sowing was performed according to the scheme of experiment. Hybrid Moreland F1 was used for sowing.
Research topics involved studying such factors as Factor A - nutrition background: without fertilizers; $N_{90}P_{90}K_{90}$; $N_{135}P_{90}K_{125}$ + N_{60} + N_{30}. Factor B - plant densification, thousand/ha: 60, 70, and 80. The experiment was repeated four times. The total research area is 50 m^2, accounting area - 10 m^2. Placement of repetitions was carried out by a continuous method, arrangement of variants, using randomized split blocks. The variant without fertilizers served as a control. The following mineral fertilizers were used for research: complex - in the form of ammonium nitrate phosphate fertilizer (16% a.s.); ammoniac nitre (34.4% a.s.). Fertilizers were brought to the plots in spring for cultivation. Additional fertilization of sweetcorn crops was carried out with nitrogen fertilizers according to corresponding variants of the experiment scheme in the phase of 3-4 and 6-7 leaves.
During the experiments, meteorological observations were made on the following indicators: average air temperature, amount of precipitation (Lytvynov, 2011). During the study of meteorological indices were used data from Ivano-Frankivsk meteorological station. Weather conditions of vegetation period during the time of sweet pop growth were characterized by considerable diversity during the research and marked by significant deviations of leading meteorological indices from the average long-term data

Results and discussion

The results of our laboratory analyzes and measurements showed that the studied agrotechnical factors have significant impact not on all quality indices of sweetcorn. One of the critical indices of sweetcorn quality is the thickness of fruit cover - pericarp. Its measurement is possible in absolute value (mm, or μm) and percent to the whole grains' weight. Pericarp thickness is a vital varietal and selective trait as it affects the tenderness of sweet pop grain, its resistance to injury, crop suitability for combine harvesting, and the transportation of harvested crops for long distances.
Laboratory studies of sweet pop grain conducted by us during 2018-2020 did not reveal significant pericarp thickness on fertilization background. Measurements of pericarp thickness were performed on grains taken from commercial cobs collected from areas with plant standing density of the crop 60 thousand/ha. Fluctuations of the index by the studied variants were within the least significant difference limits, which indicates their insignificance. However, we noticed a tendency to a specific thickening of pericarp due to mineral fertilizers' application (Fig. 1).

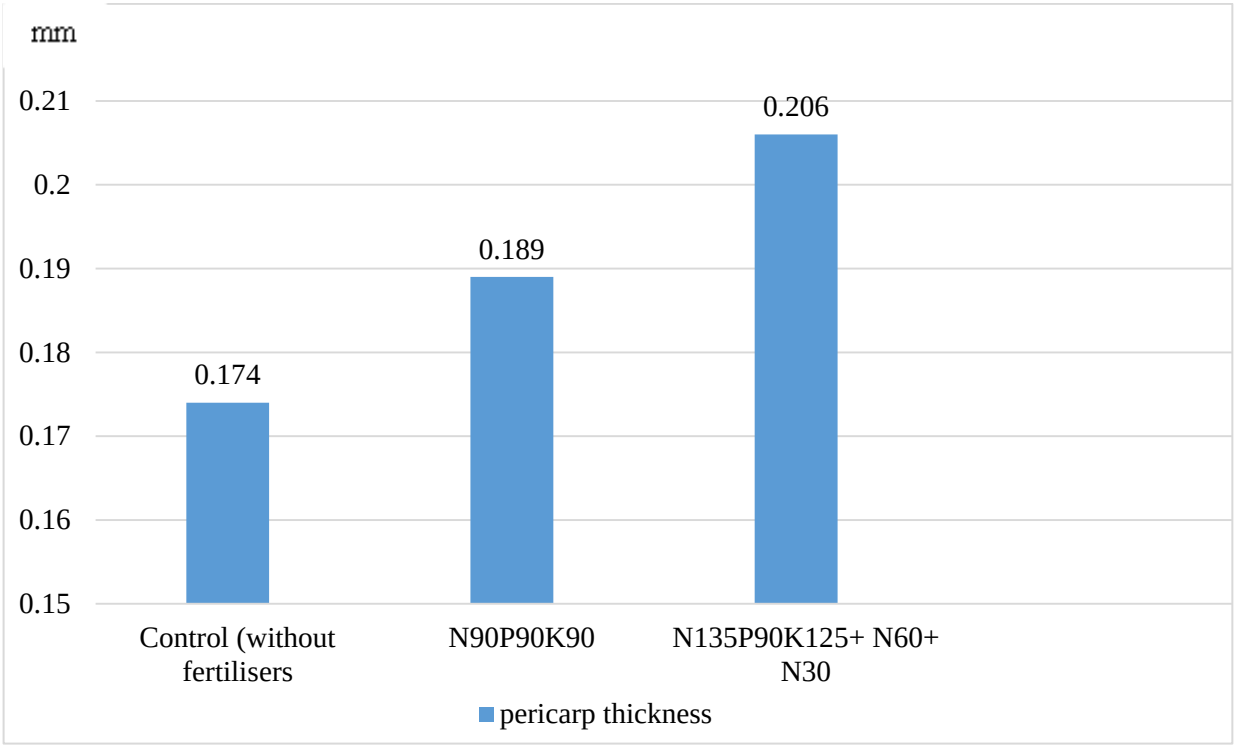

Fig 1. Sweetcorn pericarp thickness depending on the doses of mineral fertilizers, the average for 2018-2020.
Note. LSD_{05}: factor A - 0.035 mm.

An important index of sweetcorn quality is the weight of 1000 grains. Our research results revealed a significant dependence of its value on the elements of sweet pop agrotechnology (Fig. 2).

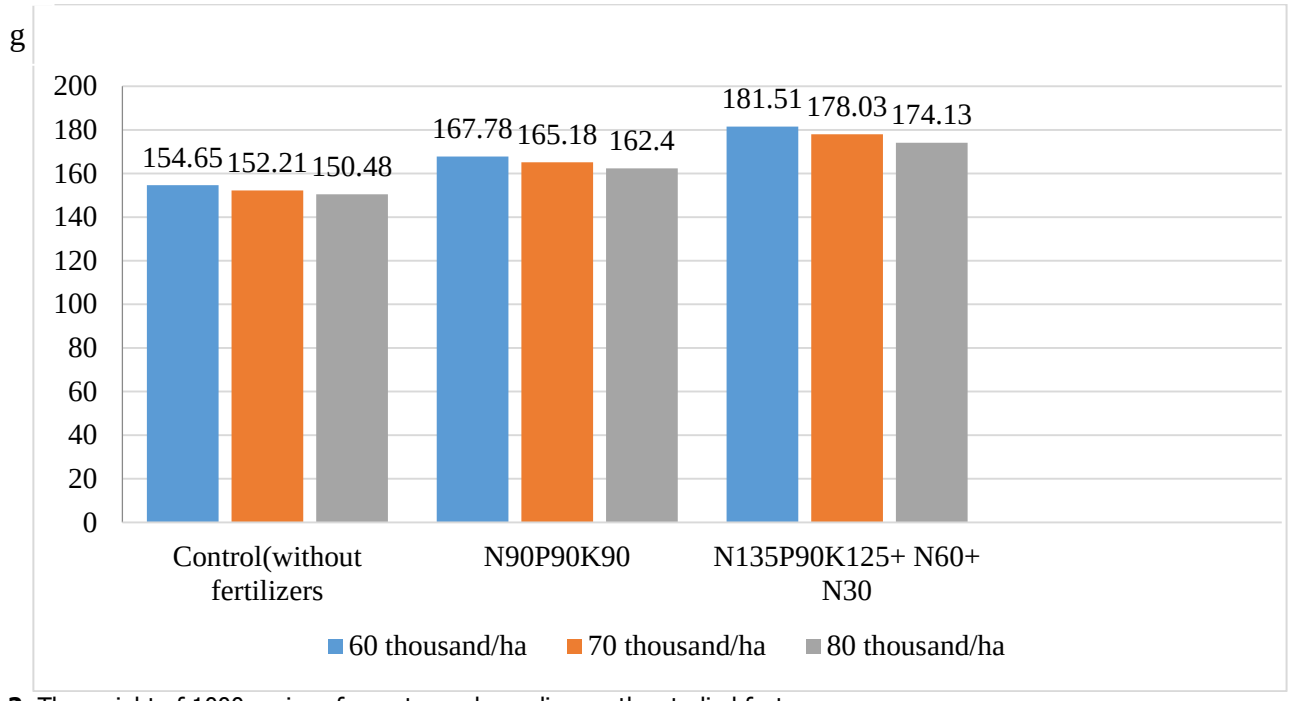

Fig. 2. The weight of 1000 grains of sweetcorn depending on the studied factors.
Note. LSD_{05}: factor A - 0.61 g; factor B - 1.55 g; for complex action of AB factors - 3.52 g.

Thus, the maximum mass of 1000 grains in raw weight is provided by agrotechnical complex with fertilizer background $N_{135}P_{90}K_{125}$+ N_{60}+ N_{30} and plant densification 60 thousand/ha - 181.51 g. It is established that fertilizer background has the most significant influence on the weight of 1000 grains: the share of the factor influence was 83.5%. It was determined that sweetcorn crop densification significantly reduced the value of the index, on average by 3.2%, while the share of the factor was minimal - only 2.2%.
The most important index of sweetcorn crop quality is the content of sugars in the grain, as the taste and aroma depend on their quantity (Fig. 3).

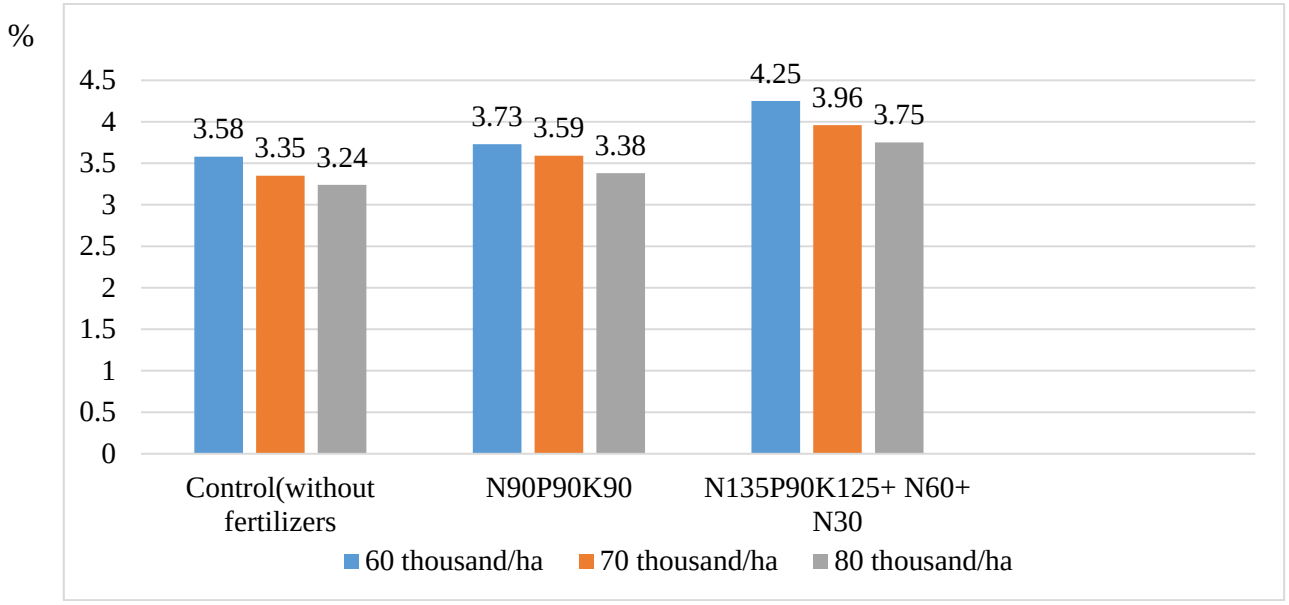

Fig. 3. Total sugar content in the grain of sweetcorn at the beginning of milk-wax ripeness, the average for 2018-2020.
Note. LSD_{05}: factor A - 0.021%; factor B - 0.033; for complex action of AB factors - 0.083%.

Research shows that the most critical factor influencing the content of sugars in corn grain is mineral fertilizers (share of influence - 67%). Due to the intensive fertilization system of sweetcorn, a significant (on average, 1.2 times) increase of sugar content in the grain is possible. The tendency to sugar content decrease with the densification of crops has been defined. It is explained by the increase of interspecific competition in an agrophytocenosis.
We have to note that when analyzing the quality of crop products it is necessary to take into account the dry matter content. This index is of particular importance for technologists involved in the processing, transportation, and storage of vegetable products, as just dry matter content determines the caloric value of products, i.e. amount of energy accumulated in the process of photosynthesis.
The results of the conducted analysis of products revealed the significance of the influence of studied agrotechnology elements on the dry matter content in the grain of sweet pop at the beginning of milk-wax ripeness (Fig. 4). It is established that the increase in density of corn plants leads to a decrease of dry matter content in the product, and application of mineral fertilizers, on the contrary, increases it.

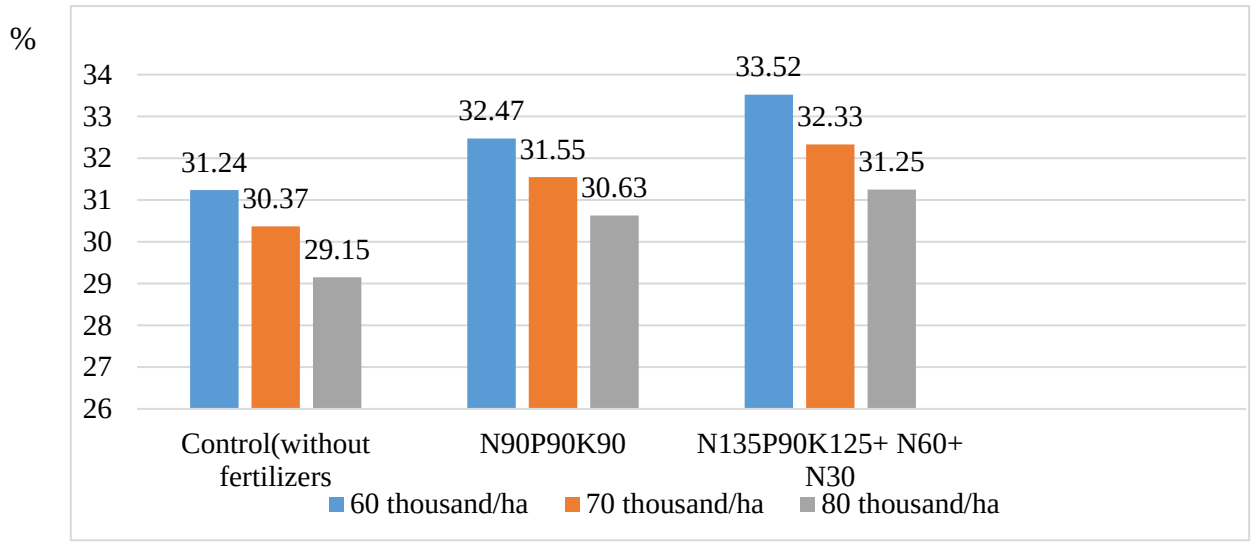

Fig. 4. Dry matter content in the grain of sweetcorn at the beginning of milk-wax ripeness, the average for 2018-2020.

Thus, it was found that the variant provides the highest dry matter content with application of mineral fertilizers at a dose of $N_{135}P_{90}K_{125}+ N_{60}+ N_{30}$, which is 31.25-33.52% depending on densification of plants. While in control (without fertilizers), this index ranged from 29.15 to 31.24%.

Conclusion

According to the results of the study of sweetcorn quality indices of hybrid Moreland F1, depending on the elements of agrotechnology, it has been established that the following agro-technological complex provides the best quality: application of mineral fertilizers at a dose of $N_{135}P_{90}K_{125}+ N_{60}+ N_{30}$ and plant densification of 60 thousand/ha.
The quality indices of sweetcorn for hybrid Moreland F1 varied unequally with different agro-technical complex of the crop cultivation. Thus, the grain's pericarp thickness did not depend on agrotechnology studied elements and ranged from 0.174 to 0.206 mm. The weight of 1000 grains of the crop significantly depended on all elements of cultivation technology, and was the largest with fertilizer background of $N_{135}P_{90}K_{125}+ N_{60}+ N_{30}$ and plant densification 60 thousand/ha - 181.51 g. The maximum sugar and dry matter content was also with the previously mentioned agrotechnology complex and were 4.25 and 33.52%, respectively.

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