PhD DISERTATION ABSTRACT

Key words: wheat, nutrients, growth stimulators, biomass, quality.

Grains including wheat produce, besides caryopses (seeds), straw, leaves, husks - useful goods, and an amount of biomass that remains in stubble and roots.

Global agricultural product is subdivided into main product - caryopses and secondary economic value products (straw, chaff, leaves).

From the biological potential-capacity plant to produce a certain amount of biomass emerges production potential or potential productivity, which includes only agricultural product with intrinsic economic value, a variable rate of biomass.

The PhD thesis entitled "**Biomass accumulation and structure at wheat crop under the influence of cultivar, nutrients and environmental conditions in the Moldavian Plain**" includes seven chapters, with 268 pages, 142 tables and 50 figures. The thesis has two parts: the first part is an overview of the importance and spread of wheat in the context of using the bibliographical data on the PhD thesis theme. This part contains 51 pages, 4 figures, 9 tables.

In the second part of the thesis are presented the material and method of research and own results on the subject of the thesis. This part contains 155 pages, 133 tables and 46 figures.

The location of the experiences was the didactic farm in Iasi, Ezăreni farm, during three agricultural years (2010-2011, 2011-2012 and 2012-2013), different in terms of climate. Climatic conditions were favorable in the agricultural year 2010-2011 for the winter wheat and yields were relatively high. Annual average temperatures were higher than the annual average by 1.2 ° C and relative humidity by 6.91%. The recorded rainfalls were more than 57.8 mm lower than the annual average, but appropriately spread to wheat, the agricultural year being considered slightly dry.

Temperatures recorded in the agricultural year 2011-2012 exceeded the annual average by 0.8 ° C and relative humidity was equal to the annual average, the recorded rainfalls were lower than the annual average, by 162.4 mm, the year being considered dry.

The agricultural year 2012-2013 is considered excessively rainy (ERY) as from October 2012 - July 2013 were recorded 710.6 mm rainfall, with 291.2 mm more than the annual average, the overcome being greater than 50%.

The experiments were located on a cambic chernozem with medium texture, glomerular structure with medium humus content (2.79%) a neutral reaction slightly alkaline (pH 7.2 to 8.4), an average content of nitrogen (0.198 g/100 g soil), very low supplied in mobile phosphorus (1.2 g per 100 g soil) and medium supplied with potassium (11.7 g per 100 g soil).

Our researches have proposed to determine how to increase wheat production and the quality of caryopses under the influence of mineral fertilizers, especially nitrogen based and capitalization of organic fertilizers remanence in three different years in terms of climate and a three-year rotation, in accordance with the primary and secondary biomass accumulation.

Also to increase the production and quality of caryopses in two years of research (2010-2012), three cultivars (Boema, Crina and Ariesan) have been treated with different concentrations (50 ppm, 25 ppm, 12.5 ppm) of three stimulators (BCO4 DMA, BCO4 K, BCO4 K + zinc acetate).

In both experiments were pursued the biomass accumulation and structure in the form of fresh and dry matter in the main development bio phases of wheat (stem elongation, bellows, flowering, maturity) in order to find the optimal moments allocation of production factors in the appropriate bio phases for the new wheat cultivars.

Two experiences were placed to achieve the objectives. The first experience was stationary, in triennial rotation: sugar beet - winter wheat - corn and was placed in plots with three repetitions and harvested area of 35 m^2. Experimental factors were: Factor A - a_1 - organic fertilizer and chemical fertilizers with phosphorus and potassium with three graduations: manure 30 t/ha applied to prior plant (sugar beet) + $P_{64}K_{64}$ each year to wheat a_2 - straw chaff 5 t/ha + 50 kg/ha N applied to sugar beet + beet leaves and stems + $P_{64}K_{64}$ each year to wheat; a_3 - $P_{64}K_{64}$ fertilizers every year to wheat. Factor B - nitrogen fertilization had five graduations: b_1 - N_0, b_2 - N_{40}, b_3 - N_{80}, b_4 - N_{120}, b_5 - N_{160}.

The second experience was trifactorial, of subdivided parcels ordered by method in three repetitions. Experimental factors were: Factor A - stimulators with three graduations: a_1 - BCO – 4 DMA; a_2 - BCO – 4 K; a_3 - BCO – 4 K + Zn acetate, factor B - concentration of growth regulators with graduations: b_1 - 50 ppm; b_2 - 25 ppm; b_3 - 12.5 ppm; factor C - wheat varieties with graduations: c_1 - variety Boema, c_2 - variety Crina c_3 - variety Ariesan.

Biostimulators were applied in the bellows bio phase according to the protocol in an amount of 625 l/ha, with sprayer in tranquil atmosphere conditions.

During the vegetation period, phenological observations and biometric measurements were made, and at harvest was determined the number of ears per m^2, stem height, length of ears, number

spikes/ear, number and weight of caryopses/ear, and interpretation of data was done by analysis of variance.

In laboratory conditions there was determined the mass of a thousand grains, hectolitre mass and protein and wet gluten content of the caryopses. The results were presented in tables and graphs that help in understanding better the obtained results.

In the **2010-2011** winter wheat fertilization with phosphorus and potassium fertilizers increased the values of the investigated biometric indicators: plant height, ears length ear number/m^2, number of spikes/ear.

Increasing doses of nitrogen have successively increased the height of the stems (from 60.1 cm to 63.3 cm), length of the ears (from 6.7 cm to 7.6 cm), the number of ears/m^2 (from 436.2 to 499.4 ears/m^2 ears/m^2) and the number of spikes/ear (from 12.3 to 14.9).

In each of the main bio phases of autumn wheat (straw elongation, bellows, flowering and maturity in wax) were taken 20 plants, used to determine biomass accumulation and main structure and organs.

Biomass accumulation in autumn wheat was influenced by fertilizers. Thus, for the straw elongation bio phase, $P_{64}K_{64}$ fertilizers influenced greater the accumulation of total biomass (5,142 kg/ha) compared to the organic fertilizers remanence and of the doses of nitrogen used was noted the one with 80 kg / ha, which has led to a total biomass of 4,262.26 kg/ha.

Of the total biomass, in straw elongation bio phase, the leaves were 21.83 to 32.52% and stems from 67.48 to 78.17%.

In the bellows bio phase, wheat fertilization, especially the chemical one, favoured the accumulation of biomass and the increasing dose of nitrogen led to its increase from 2,894.34 kg/ha (N_0) to 5,065.13 kg/ha (N_{160}), the increase being 75.00%.

With the age of the plant, from the total biomass, the stem mass and the one of leaves began to decrease at the expense of inflorescences, the last ones reaching to represent 23.20 to 27.20% in the blooming bio phase.

At maturity, wheat plants accumulated a total biomass of 12,713.02 kg/ha for the variant with manure 30 t/ha, 13,125.7 kg/ha for chopped straws 5 t/ha and 15,006.44 kg/ha for $P_{64}K_{64}$ chemical fertilizers. In the variant with chemical fertilizers ($P_{64}K_{64}$) there was obtained an increase of 18.03% compared to manure and of 14.32% compared to chopped straws variant.

Increasing the dose of nitrogen led to the increase of biomass of leaves, stems, rachis + husks, of the caryopses and hence the total biomass, reaching that at the N_{160} variant, the total biomass to be 15,009.5 kg/ha, of which 5.29% is leaf biomass, 30.45% the one of the stems, rachis and husks - 13.57% and 50.69% the caryopses biomass, harvest index being 1.03.

Phosphorus and potassium fertilizers ($P_{64}K_{64}$) positively influenced, besides the accumulation of biomass both caryopses production and caryopses' physical indicators (MMB and MH). The $P_{64}K_{64}$ chemical fertilizers led to the highest production of caryopses of 7,939 kg/ha, and to the highest values of the MMB (43.1 g) and MH (87.3 kg/hl).

Manure remanence for the 30 t/ha variant determined a production of the caryopses of 7055 kg/ha, with 884 kg/ha lower compared to that of fertilizers $P_{64}K_{64}$, but with a higher protein and wet gluten content, of 13.52% and 23.42%.

In the second year of research (**2011 - 2012**), the number of ears/m^2 and the number of spikes/ear were higher, of 556.3 ears/m^2 and 12.32 spikes/ear for the chemical phosphorus and potassium fertilization ($P_{64}K_{64}$) although the year was less favourable.

Biomass accumulation in the four bio phases of wheat was positively influenced, also in 2011-2012, by chemical fertilization with phosphorus and potassium. Thus, in straw elongation bio phase, $P_{64}K_{64}$ fertilizers determined a total biomass of 2,887.2 kg/ha, in bellows bio phase produced 6,313.9 kg/ha, in flowering – 8,970.9 kg/ha, and in the maturity in wax bio phase, 10,912.5 kg/ha total biomass.

Increasing the dose of nitrogen successively increased the total biomass of winter wheat in all four bio phases. Thus, in straw elongation bio phase, total biomass increased from 2,077.6 kg/ha (N_0) to 2,977.3 kg/ha (N_{160}), 43.3%, in bellows bio phase , from 3,355.9 kg/ha up to 6686.7 kg/ha, with 99.26%, in flowering bio phase from 5,366 kg/ha to 9,874.3 kg/ha, with 84,01% and for the maturity in wax this increased from 6,999.5 kg/ha up to 12,399.3 kg/ha, the increase thus being 77.14%.

In **2011-2012**, due to poor weather conditions, production and productivity elements of the caryopses were lower compared to the previous year, but still high.

Phosphorus and potassium fertilizers ($P_{64}K_{64}$) positively influenced the production of caryopses achieving its highest value of 5647 kg/ha, with 934 kg/ha more than control variant 1 (manure 30 t/ha).

Caryopses production increased with the nitrogen doses, from 3,506 kg/ha (N_0) to 6,398 kg/ha (N_{160}) the increase being of 84.48%.

The highest values for MMB, of 45.66 g and MH of 82.66 kg/hl were obtained for the $P_{64}K_{64}$ chemical fertilizer variant and for the fertilizer interaction $P_{64}K_{64}$ x N_{160} there were recorded values of the MMB of 44.2 g and also of 84.02 kg/hl for MH.

Caryopses' contents in protein and wet gluten were influenced to a greater extent by the remanence of organic fertilizers. The variant using manure 30 t/ha achieved their highest values of 15.47% and 27.24%.

The maximum dose of nitrogen recorded values of the protein content of 16.44% and 28.92% for wet gluten, very good values for the baking purpose.

In the agricultural year **2012-2013**, the investigated biometric indicators were differently influenced by fertilization. Thus, the number of ears/m^2 also the number of spikes/ear recorded high values of 485 ears/m^2 and 14.92 spikes/ear for the $P_{64}K_{64}$ chemical fertilization and the stem height and length of the ears have achieved high levels of 58.28 cm and 6.76 cm for the organic fertilizers remanence (chopped straw 5 t/ha respectively manure 30 t/ha).

The largest caryopses production of 5732 kg/ha was achieved for the variant using chemical fertilizers $P_{64}K_{64}$, followed by 30 t/ha manure, with 5,617 kg/ha and chopped straw 5 t/ha with 5,467 kg/ha. The increasing nitrogen doses caused an increased production of caryopses from 4,564 kg/ha for the N_0 to 6,839 kg/ha for the N_{160}, the increase being of 49.84%. Analysing the influence of the interaction between the two factors on the production of caryopses, we observe that the interaction for the $P_{64}K_{64}$ x N_{160} chemical fertilizer variant produced the highest yield of 7,195 kg/ha and the lowest for the $P_{64}K_{64}$ x N_0 of 4,433 kg/ha, the difference between them being 62.30%.

Phosphorus and potassium fertilizers positively influenced MMB of and MH values (49.19 g and 83.87 kg/hl), while organic fertilizers remanence influenced in a greater extent the caryopses' protein and wet gluten content.

As average for the three agricultural years (**2010-2013**) the production of caryopses was 5796 kg/ha for the variant using manure 30 t/ha, 5899 kg/ha for chopped straws variant 5 t/ha and 6440 kg/ha for $P_{64}K_{64}$ chemical fertilizer.

Analysing the influence of nitrogen dose on average production we note that the highest production of 7226 kg/ha was achieved in the variant with the highest dose of nitrogen (160 kg N/ha) with 51.74% higher than the production of the N_0 variant (4762 kg/ha).

MMB values were close on average per the three agricultural years on the three agro funds, of 45.06 g on manure 30 t/ha, 45.37 g for chopped straws variant 5 t/ha and 45.99 g for $P_{64}K_{64}$ chemical fertilizer variant. The application of 120 kg N/ha increased the MMB at 46.48 g.

For the interaction between chemical fertilizers and the organic ones remanence on the protein content was obtained in most variants protein levels values exceeding 13%, framing wheat in very good quality class.

The interaction $P_{64}K_{64}$ x N_{160} led to the biggest of the gluten content of 28.49%, wheat quality being very good.

In the second experiment set in field we aimed, in the first agricultural year, the biomass accumulation and structure of winter wheat in maturity in wax bio phase and the quantity and quality of wheat caryopses, and in the second agricultural year, biomass accumulation and structure

of wheat in the four bio phases (straw elongation, bellows, flowering, maturity in wax), the quantity and quality of caryopses.

In the **2010-2011** agricultural year, winter wheat biometric indicators were influenced both by the biostimulators, their concentrations as well as by the biological material used. Thus, the biostimulator BCO 4 DMA obtained 437.4 ears/m^2 and the height of the stem of 62.73 cm, while the ears length of 8.12 cm was registered by BCO 4 K + zinc acetate variant, and the most spikes/ear of 14.19 were obtained using BCO 4 K biostimulator.

Concentration of 50 ppm registered 436 ears/m^2, with a stem height of 64.48 cm and a length of the ears of 8.16 cm.

Wheat variety Ariesan obtained 441.0 ears/m^2 with stems height of 67.69 cm and length of ears of 8.39 cm.

In the 2010-2011 agricultural year, applying plant growth regulator BCO 4K to wheat conducted to a total biomass of 14,738.29 kg/ha, of which 5.99% are leaves, stems are 31.37%, 16.11% rachis + husks and 46,46% are caryopses.

With increasing concentration of the biostimulators, the total biomass of wheat also increased from 13,966.01 kg/ha (12.5 ppm) to 15,480.76 kg/ha (50 ppm), the increase being of 10.84%. Of the total biomass, the stems were 30.87% - 32.37% the leaves 5.40% - 5.63%, rachis + husks 16.83% - 17,22% and caryopses 45,02% - 46 90%.

The biological material used positively influenced the biomass accumulation. The wheat variety Boema realized 14,317.97 kg biomass/ha, variety Crina obtained 14,308.59 kg/ha, and the variety Ariesan 15,065.17 kg/ha. Of the total biomass, the stems were 31.0% - 31.88% the leaves 5.42% - 5.72%, rachis + husks 15.61% - 18.74% and caryopses 42.32% - 46.33%.

The interaction of BCO 4DMA x 25 ppm x Crina variety obtain a percentage of caryopses of 51.55%, where the total biomass was 13,809.74 kg/ha, harvest index being 1.064.

BCO 4 K biostimulator influenced, in addition to the accumulation of biomass , the caryopses production, achieving 7,862 kg/ha, followed by BCO 4 DMA with 7,626 kg/ha and BCO 4 K + zinc acetate with 7,600 kg/ha, while the variant treated with water realized a production of 6,479 kg/ha. Compared to the variant treated with water was obtained an increase of 17.7% with the biostimulator BCO 4 DMA, of 21.30% with BCO 4 K and of 17.3% with BCO 4 K + zinc acetate biostimulator.

With increasing concentration of the biostimulators also increased the production of caryopses reaching for the 50 ppm variant to achieve 7,837 kg caryopses/ha, the same production also being achieved for Crina wheat variety.

In the agricultural year **2011-2012**, the number of ears/m^2 realized the highest density, of 562.8 spice/m^2 by the application of growth regulator BCO 4K + Zn acetate, the largest height of 45.62 cm for BCO 4K, and the highest length of ears of 5.53 cm for BCO 4K + Zn acetate.

Increasing the concentration of the biostimulators determined the decrease of the biometrical studied indicators, yielding 45.72 cm in height at 50 ppm variant compared to 46.46 cm at 12.5 ppm variant, 5.29 cm ears length compared to 5.62 cm to 12.5 ppm variant, more spikes/ear for the 50 ppm variant (10.92 spikes/ear) to 10.37 spikes/ear at 12.5 ppm variant.

Wheat variety Ariesan realized also in the second year of research most ears/m^2 (558.3), exceeding the control variety (Boema) with 7.4 ears/m^2.

Because biostimulators were applied in bellows bio phase, biomass accumulation and structure were influenced in first bio phases by the biological material used. Thus, of the three cultivars used in the experiments, Crina variety was noted which has achieved in the straw elongation bio phase a total biomass of 2,793.1 kg/ha and in the bellows bio phase 4,845.3 kg/ha.

In the flowering bio phase the biomass accumulation and structure were influenced by the biostimulators, their concentrations but also by the cultivar.

Considered separately, the biostimulators positively influenced the accumulation of biomass, which increased from 6805.5 kg/ha (for BCO 4 DMA) to 8,134.5 kg/ha (for BCO 4K + Zn acetate), with a difference of 19.52%.

Of the total biomass of 7,790.6 kg / ha achieved by the bio stimulators concentration of 50 ppm, 17.34% was the leaves mass, 57.33% the mass of stems and 25.33% the mass of the inflorescences.

Wheat varieties Crina and Ariesan have exceeded with 690.7 kg/ha, respectively 686.3 kg/ha the control variety (Boema), which conducted to a total biomass of 6,888.5 kg/ha.

For the interaction between the three factors, of the total biomass, the stems represented 44.07% at BCO 4 K + acetate ppm Zn x 12.5 ppm x Boema and 62.09% at 25 ppm x BCO 4 K x Ariesan, the leaves were 13.56% to BCO 4 K x 25 ppm x Boema and 24.36% at the BCO 4 DMA x 25 ppm x Boema; inflorescences from 17.34% at BCO 4 DMA x 25 ppm x Boema and 34.32% at interaction BCO 4 K + acetate Zn x 25 ppm x Boema.

At maturity in wax, in 2011-2012, the biomass of winter wheat was lower than in 2010-2011 due to drought in some wheat growing stages.

The application of growth regulator BCO 4K + zinc acetate determined obtaining 402.3 kg leaves/ha, 2,729.8 kg stems/ha + 1,743.0 kg rachis + husks/ha and 4,150.7 kg caryopses/ha, resulting in a total biomass of 9,025.8 kg/ha, or 4.46% leaves, 30.24% stems, 19.31% rachis + husks and 45.99% caryopses.

Interaction BCO 4K x 25 ppm x Crina achieved, from the total biomass, 51.81% caryopses, 21.69% rachis + husks, 23.38% stems and 3.12% leaves at harvest, with a harvest index of 1.075.

In the **2011-2012** agricultural year, caryopses production ranged from 3,907 kg/ha (BCO 4 DMA x 12.5 ppm x Boema) as the control variant and 6,290 kg / ha (BCO 4K + Zn acetate x 25 ppm x Ariesan) with a difference of 60.99% compared to control.

On average these two agricultural years, the quantity and quality of wheat caryopses were influenced by biostimulators, their concentrations and the cultivars used in research.

BCO 4K + Zn acetate biostimulator, although it achieved the highest average production of caryopses, of 6,250 kg/ha, had small differences compared to BCO 4DMA and BCO 4K. The interaction BCO 4K x 12.5 ppm x Crina ranked first with an average production of 7,332 kg/ha, with 21.03% higher than the control variant (BCO 4DMA x 12.5 ppm x Boema).

Performing a calculation of economic efficiency of the research results it was found that economic efficiency is influenced by climatic conditions of the year, the yields obtained, the use of chemical fertilizers and biostimulators as the amont of the expenses per hectare wiche together influence market prices.

In 2010-2011 and 2012-2013 agricultural years, favourable to wheat crop, net profit rate was the highest for the $N_{80}P_{64}K_{64}$ variant, with 50.55% in 2011 and 56.21% in 2013 for the $N_{160}P_{64}K_{64}$ fertilization variant, and in 2011-2012, a dry year, net profit rate was 91.84% for the $N_{120}P_{64}K_{64}$ variant. In a dry year the rate of profit can be higher if high yields are also obtained, in addition to a much higher selling price than in normal years.

We conclude, from the results obtained, that on short term, chemical fertilizers and especially nitrogen based ones cause higher output than when using organic fertilizers remanence to a preceding culture as sugar beet, a plant considered predatory for nutrients.

Organic fertilizers remanence is beneficial for a sustainable agriculture, where they exist and applied, but only supplemented by chemical fertilizers.

Compared to the period 1960 - 1970 when the cultivated varieties were Bezostaia 1 Triumph, Odvos 241, Cenad 156, with a harvest index of on average 0.483, production of caryopses representing 32.50% of the total biomass, for the current Romanian cultivars experimented in three years, and the harvest index was 1.0312, with 113.49% higher than the one from about 50 years ago.