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# EFFICIENCY OF FERTILIZER APPLICATION UNDER SPRING BARLEY GROWING IN AGROCENOSES OF NORTHERN STEPPE

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*The efficiency of preplant use of complex mineral fertilizers separately and in combination with spray dressing of spring barley plants by nitrogen when grown after predecessors: soya, sunflower and winter wheat, is determined. The highest level of crop yield hulled and naked barley provided at growing after predecessor soya. It is established that local fertilizing by nitrogen of spring barley plants in the phase of tillering and its combination with the introduction of the complex fertilizer was less efficient than their separate application.*

***Keywords:*** *barley, mineral fertilizer, predecessor, crop yield, grain.*

In today's world the Ukraine's grain market has all chances to take the leading position. However, the increase in gross grain harvest hampers insufficient and unstable for years crop yields level of spring grain crops, due to the complex meteorological, agro-technological and agrobiological factors [1, 2]. Productivity of spring barley is largely determined by its biological characteristics. Among other spring cereals it is the most quickly growing crop, has higher drought tolerance and can more productively spend moisture to create a unit of organic matter. Conditions that spring barley requires during the growing season and provide the high yields are extremely rare, especially in the unstable moisture, and therefore yield potential of varieties used by an average for 30–50 %, and in some years, reduced to 20–25 % [3].

Spring barley due to poor root development, short growing season, high requirements for soil structure is among the most demanding crops to the predecessor [4]. Years of research in various soil and climatic conditions of Ukraine found that crop yields at replanting and especially in monoculture compared to their productivity in crop rotation are drops rate. Placing the same crops according to their biological requirements increases productivity per hectare of arable land by 20–25 % [5]. When implementing scientifically based crop rotation works the rotation factor as element of agriculture biologizing. It stabilizes crop rotation productivity levels even without fertilization [6].

Crop rotation has a positive effect on water and nutrient regimes, microbiological processes, phytosanitary condition of the soil, and in combination with fertilizers and other means of growing technology crop yields increased by 35–50 % at stable indicators of soil fertility [7].

Despite the high adaptability of spring barley to growing conditions, it is heavy feeder. To get high yields due to natural soil fertility is almost impossible, and crop rotation productivity increases only a certain level of fertilizer saturation [8]. But, as M. M. Opara notes [9] the fertilizer should be used under cultures that has most crop response, and their application must be local.

Exactingness of spring barley to soil fertility compared to other crops this is due to short period of consumption of primary plant food compounds, and an underdeveloped root system with low absorption inaccessible forms of nutrients [10]. With the harvest of 1 ton of grain, crop removal: nitrogen – 25 kg, phosphorus – 11, potassium – 18 kg. Barley starts to consume nutrients immediately after emergence. More intensively in the early growing season used nitrogen and potassium, whereas phosphorus – slowly. Till the stem elongation phase used the bulk of potassium (87 %) and nitrogen (74 %) of the total crop removal, and till the earing phase – all nitrogen and potassium. Good phosphorus mode is required by the end of the growing season [11]. Plant nutrition is one of the operating factors that affects the physiological processes and contributes to reach the full biological potential of culture [12].

Effect of fertilizers depends on the conditions of their use, which shaped in different ways for each year and the particular field [13]. Sometimes, due to lack of moisture in the later period, fertilizer may negatively affect the yield because of more developed plants on fertilized bac-

kgrounds are more suffers from its lack. Effect of fertilizers is also associated with the number of water during maximum demand for nutrients. If during this period the soil moisture is not enough, fertilizers, due to the low intensity of their income in plants and weakening due to lack of moisture all physiological processes, reduce their effectiveness [14]. In general, the increase in yield from fertilizer application in drought reduced by 25–30 % compared with the addition yield in years with favourable weather conditions. Unstable weather conditions, the cause fluctuations in crop yields in the range of 40–50 % [15].

Thus, the development of technology elements for naked and hulled spring barley growing will enable greater use of this crop potential in the Northern Steppe of Ukraine, which in its turn will increase the yield and economic efficiency of growing crops.

The aim of investigation was to determine the influence of mineral fertilizers on productivity of naked and hulled spring barley when grown after predecessors: soya, winter wheat and sunflower. Field research conducted in Kirovograd State Agricultural Experimental Station of Institute of Agriculture of Steppe zone (IASZ) of NAAS. Soil of experimental field – ordinary chernozem, deep medium humic, heavy loamy. Used varieties of hulled spring barley Statok and naked – Gatunok. Trial established by laying blocks at systematic variant placement, with four replications. Elementary plot area – 32 $m^2$, accounting – 25 $m^2$, plot drill – CH-16. Growing technology is generally accepted, except in the cases envisaged by experimental design.

Weather conditions during the research were quite contrasting, thus allows comprehensively evaluate the impact of farming on the elements of growth, development and productivity of spring barley. Thus, the daily average temperature during the growing season of spring barley in 2011 was higher compared to the rate at yearly average 2,8 ºC (18,5 ºC), and rainfall was 235,7 mm. But at critical periods of growth and development of culture (in May), established shortage of rain 58 %. In 2012, during the growing season temperature was higher than long-time average annual rate at 5,9 ºC and was 21,6 ºC. During the growing season rainfall was 81,8 mm, which is 63 % lower than long-time average annual indicator. In the 2013 during the growing season fell 148,5 mm, which was 114 % of the yearly average rate. The peculiarity of the weather conditions, it was an intense accumulation of effective temperatures in April and May, which sped up the phases of tillering and elongation of plants. HTC during the growing season of spring barley in 2011 was 1,18, and in 2012 and 2013 – 0,42 and 0,75 respectively.

Plant nutrition is one of the operating factors that affect physiological processes and contributes to reach the full biological potential of culture. The analysis revealed that the predecessor and the use of fertilizers had a significant impact on the productivity of hulled and naked spring barley.

On the average for 2011–2013, crop yield on natural background fertility – no treatment (check or control) after predecessor soya was 3,64 t/ha, sunflower – 3,00 and after winter wheat – 3,43 t/ha. Shortage of crop yield at sowing barley after winter wheat, sunflower was 0,64 and 0,21 t/ha or 17,6 and 5,8 %, respectively compared with soya. Local fertilization $N_{10}P_{10}K_{10}$ – $N_{40}P_{40}K_{40}$ contributed to increasing productivity at 0,39–0,55; 0,33–0,71 and 0,25–0,64 t/ha. Application of $N_{30}$ on hulled spring barley plants in the phase of tillering after soya provided growth crop yield 0,21 t/ha or 5,8 %, after sunflower – 0,14 t/ha or 4,7 %. After winter wheat predecessor at applica-tion of nitrogen fertilizers it is observed downward trend culture's productivity. When combined with preplant complex fertilizer application with nitrogen fertilization in unstable moisture conditions of Northern Steppe after soya did not provide the expected increase in crop yield of spring barley compared to options where used only starting fertilization. After sunflower and winter wheat on the contrary it is established lower crop productivity. Higher yields of hulled spring barley (4,19 and 4,22 t/ha) were at sowing after soya at application $N_{40}P_{40}K_{40}$ and $N_{40}P_{40}K_{40}$ + $N_{30}$, additional crop yield was 0,55 and 0,58 t/ha or 15,1 and 15,9 % accordingly. After predecessor sunflower and winter wheat the maximal productivity of barley was achieved in the variant where applied $N_{30}P_{30}K_{30}$ and crop yield was 3,62 and 4,07 t/ha and additional yield to the control was 0,62 and 0,64 t/ha (20,7 and 18,6 %) respectively (table 1).

Results of analysis of variance showed that when grown hulled spring barley in unstable

moisture conditions crop yield depends: in 2011 for 46,7 % on predecessor and 36,8 % on chemical fertilizers, the interaction of investigation factors accounted for only 5,8 %; in 2012 the impact of predecessor – 61,4 %, fertilization – 21,6 %, the interaction of factors – 16,0 %; in 2013 from predecessor – 14,3 %, fertilizers – 50,5 %, and interaction of factors was 23,2 %. The influence of other factors that were not studied in the experiment varied from 1 to 12 %.

***1. Productivity of hulled spring barley depending on mineral fertilizer application (on the average for 2011–2013)***

| Application of mineral fertilizers (factor B) | | Predecessor (factor A) | | |
|---|---|---|---|---|
| | | soya | sunflower | winter wheat |
| No treatment (check) | | 3,64 | 3,00 | 3,43 |
| $N_{10}P_{10}K_{10}$ | | 4,03 | 3,33 | 3,68 |
| $N_{20}P_{20}K_{20}$ | | 4,07 | 3,51 | 3,80 |
| $N_{30}P_{30}K_{30}$ | | 4,14 | 3,62 | 4,07 |
| $N_{40}P_{40}K_{40}$ | | 4,19 | 3,71 | 3,95 |
| $N_{30}$ (spray dressing in tillering phase) | | 3,80 | 3,14 | 3,33 |
| $N_{10}P_{10}K_{10} + N_{30}$ | | 3,98 | 3,34 | 3,69 |
| $N_{20}P_{20}K_{20} + N_{30}$ | | 4,09 | 3,38 | 3,71 |
| $N_{30}P_{30}K_{30} + N_{30}$ | | 4,12 | 3,50 | 3,73 |
| $N_{40}P_{40}K_{40} + N_{30}$ | | 4,22 | 3,54 | 3,83 |
| $LSD_{05}$ | factor A | 0,02–0,09 | | |
| | factor B | 0,03–0,14 | | |
| | factor AB | 0,05–0,28 | | |

The research results testifies that naked spring barley in Northern Steppe formed slightly lower crop yield compared to hulled, but differs in other economically useful indicators that enhances value to varieties that belong to this type. The average crop yield of naked barley for three years in the control variant was 2,59 t/ha after predecessor soya, after sunflower – 2,04 t/ha, and after winter wheat – 2,16 t/ha. Application the complex mineral fertilizers provides increasing the crop yield to 0,49–0,65 t/ha (after soya), 0,50–0,67 (after sunflower) and 0,56–0,68 t/ha (after winter wheat). Spray dressing of plants in tillering phase by $N_{30}$ on a background of preplant fertili-

***2. Productivity of naked spring barley depending on mineral fertilizer application (on the average for 2011–2013)***

| Application of mineral fertilizers (factor B) | | Predecessor (factor A) | | |
|---|---|---|---|---|
| | | soya | sunflower | winter wheat |
| No treatment (check) | | 2,59 | 2,04 | 2,16 |
| $N_{10}P_{10}K_{10}$ | | 3,24 | 2,54 | 2,72 |
| $N_{20}P_{20}K_{20}$ | | 3,17 | 2,71 | 2,79 |
| $N_{30}P_{30}K_{30}$ | | 3,18 | 2,67 | 2,75 |
| $N_{40}P_{40}K_{40}$ | | 3,08 | 2,67 | 2,84 |
| $N_{30}$ (spray dressing in tillering phase) | | 2,79 | 2,13 | 2,15 |
| $N_{10}P_{10}K_{10} + N_{30}$ | | 3,13 | 2,56 | 2,72 |
| $N_{20}P_{20}K_{20} + N_{30}$ | | 3,20 | 2,73 | 2,87 |
| $N_{30}P_{30}K_{30} + N_{30}$ | | 3,13 | 2,70 | 2,78 |
| $N_{40}P_{40}K_{40} + N_{30}$ | | 3,02 | 2,57 | 2,82 |
| $LSD_{05}$ | factor A | 0,02–0,07 | | |
| | factor B | 0,03–0,11 | | |
| | factor AB | 0,06–0,21 | | |

zing an additional crop yield was 0,43–0,61; 0,52–0,69 and 0,56–0,71 t/ha respectively to predecessors. Feeding of naked barley just with $N_{30}$ had no significant effect on crop yield. Higher productivity (3,24 t/ha) naked spring barley formed after soya in variant with $N_{10}P_{10}K_{10}$ – additional

crop yield was 0,65 t/ha or 25,1 % comparatively to control. At further gradual increasing in dose of fertilizers to $N_{40}P_{40}K_{40}$ observed the decreasing of fertilizer efficiency. After sunflower the higher crop yield (2,71 t/ha), naked barley provided at application of $N_{20}P_{20}K_{20}$ – an additional crop yield was 0,67 t/ha or 32,8 %, and after winter wheat (2,87 t/ha) – an increase of crop yield was 0,71 t/ha or 32,9 % in the variant of $N_{20}P_{20}K_{20}$ + $N_{30}$ (table 2).

When growing naked spring barley in 2011, a piece of predecessor action was 30,4 %, fertilizing – 36,7; an interaction of factors – 14,0 %. In 2012 a piece of predecessor action was 85,1 %; 10,2 – fertilizers, an interacting factors – 4,1 %. In 2013 the crop yield depends on predecessor for 20,4 %, fertilizing – 64,8%, an interaction – 12,7 %.

**Conclusions.** Higher level of crop yield the hulled and naked spring barley provided when grown after predecessor soya. Seeding after sunflower resulted the shortfall in grain production an average for 0,62 and 0,52 t/ha or 15,4 and 17,0 %, after winter wheat – 0,31 and 0,39 t/ha or 7,7 and 12,8 % for hulled and naked barley respectively. Spray dressing of spring barley plants in tillering phase by nitrogen and its combination with the application of complex fertilizers was less effective compared to their separate application. Higher crop yield of hulled spring barley after predecessor soya provided fertilizing with $N_{40}P_{40}K_{40}$ and $N_{40}P_{40}K_{40}$ + $N_{30}$, but after the sunflower and winter wheat – $N_{30}P_{30}K_{30}$. When growing naked barley the higher crop yield formed after soya at application of $N_{10}P_{10}K_{10}$, after sunflower – $N_{20}P_{20}K_{20}$, after winter wheat – $N_{20}P_{20}K_{20}$ + $N_{30}$.

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***Анотація***

***Гирка А. Д., Іщенко В. А., Гирка Т. В., Андрейченко О. Г. Ефективність мінеральних добрив при вирощуванні ячменю ярого в агроценозах північного Степу.*** *Визначено ефективність передпосівного використання комплексних мінеральних добрив окремо і при поєднанні з підживленням рослин ячменю ярого прикоренево азотом за вирощування після попередників: соя, соняшник та пшениця озима. Вищий рівень врожаю ячмінь ярий плівчастий та голозерний формував при вирощуванні після передника соя. Встановлено, що локальне підживлення рослин ячменю ярого у фазі кущення азотом та його поєднання з внесенням комплексних добрив було менш ефективним порівняно з окремим застосуванням цих заходів.*

***Ключові слова****: ячмінь ярий, мінеральне добриво, попередник, урожайність, зерно.*