UDC 633«321»:631.84

THE EFFICIENCY OF FERTILIZER APPLICATION IN GROWING TECHNOLOGY OF SPRING SMALL GRAINS

A. D. Gyrka, *candidate of agricultural sciences*
Institute of Agriculture of Steppe zone of NAAS Ukraine

Наведено результати аналізу впливу добрив на особливості росту, розвитку рослин та фор-мування продуктивності ячменю і пшениці ярих та наявність хвороб, шкідників і бур'янів у їхніх посівах. Відмічені види добрив, які забезпечують ефективне споживання води посівами та стабільну реалізацію генетичного потенціалу врожайності зерна в широкому діапазоні зміни середніх тем-ператур повітря і умов водоспоживання північного Степу України.

Ключові слова: *ячмінь і пшениця ярі, ріст і розвиток рослин, водоспоживання, добрива, якість зерна, врожайність.*

The steady trend to a significant increasing in production and application the nitrogen fertilizers, especially liquid is traced worldwide. The main advantages of liquid nitrogen fertilizers, particularly ammonia, is a facilitation the production process, ease of mechanization, transportation and application of fertilizers in the soil, a more uniform distribution of nitrogen in the root layer. All this contributes to a significant decrease in the unit cost of nutrients in liquid fertilizers [1, 2].

Therefore, the main task of our research was to find out what form of nitrogen fertilizer is the most convenient and economically viable for growing spring wheat and barley. In conditions of the Eastern part of Northern Steppe the main limiting factor that affects the growth and develop-ment of each and every crop, and especially, spring small cereals, is a reserves of productive mois-ture in soil [3–5].

The study was conducted at the Donets'k State Agricultural Experimental Station of NAAS during 2012–2014, according to generally known methods [6, 7]. Soil of experimental field – ordinary chernozem, low-humic, loamy. The humus content in arable soil layer – 4,5 %, N – 0,28–0,31 %, P_2O_5 – 0,16–0,18 %, K_2O – 1,8–2,0 %, pH of water extract – 6,9.

Field experiments were laid in six-field crop rotation after predecessor peas on a background of application the different rates of nitrogen: without fertilizers (control), N_{30} ammonium nitrate, N_{30} anhydrous ammonia and biohumus (250 kg/ha). Seeding rate of spring barley (Donets'kyi 14) and wheat (Kharkivs'ka 23) – 4,5 million of seeds/ha. Soil preparation, sowing, care of crops and harvesting were carried out according to the zonal recommendations. Variants in a field experiment designed systematically, with three replications. Accounting plots area – 50 m^2.

Weather conditions during the investigation (2012–2014) were different, which made it possible to fully assess its impact on grain productivity potential of spring small cereals.

The aim of investigation was to identify the effective agro technological measures of increasing the grain productivity of spring barley and wheat in Northern Steppe of Ukraine by choosing the best forms of mineral nutrition.

Moisture reserves in the soil before sowing on all variants were identical, and their level was a baseline to determine the fluctuations of this factor during the phases of plants development. By the investigations were founded a tendency for strengthening water consumption under fertilizer application. Thus, at tillering phase of spring barley in areas where fertilizers were used, the amount of productive moisture was lower than the control at 0,9–1,3 mm in 0–20 cm soil layer and 6,1–7,9 mm – in 0–100 cm soil layer. Adding biohumus helped more economical water consumption by plants. In the 0–20 cm soil layer amount of productive moisture was higher compared with control for 2,4 mm (19%) and exceeded its contents on a background of mineral nutrition for 3,3–3,7 mm, and 0–100 cm soil layer – 1,8 mm (2 %), under mineral nutrition – for 7,9–9,7 mm respectively. At full ripeness of spring cereals in fertilized plots the soil moisture exceeded in 0–20 cm soil layer for 2,1–2,4 mm (mineral fertilizers) and 4,5 mm (organic fertilizer), and in 0–100 mm soil layer for 9,2–10,9 (mineral fertilizers) and

21,3 mm (biohumus).The dynamics of spring wheat productive moisture stocks observed similar to the barley pattern, but less clearly expressed. It is established that the use of various fertilizers significantly affected the rate of water consumption. Thus, the lowest water charges on the formation crop yield of spring barley (865,3 m^3/t) and wheat (1347,3 m^3/t) were marked on background of anhydrous ammonia. The use of ammonium nitrate resulted in the increase of water consumption to 882,0 and 1453,4 m^3/t according to cultures. Regarding to organic background, the plants in biohumus variant used 904,6 and 1485,9 m^3/t of water, while in the background a natural soil fertility coefficient of water consumption totaled 1101,1 and 1632,7 m^3/t respectively (Fig. 1).

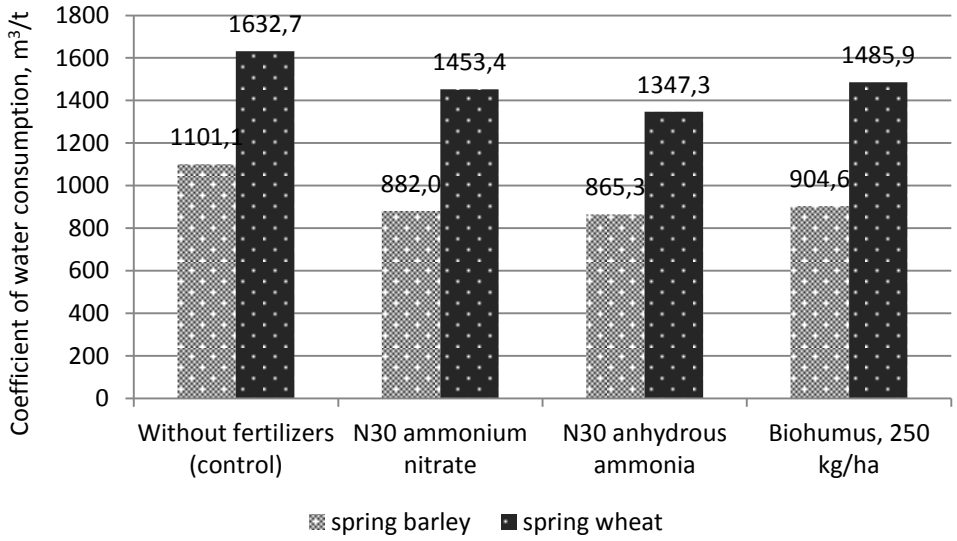

Fig. 1. Coefficient of water consumption under the influence of mineral and organic fertilizers, m^3/t (average for 2012–2014).

The coefficient of water consumption crops of spring barley in variant of anhydrous ammonia application was lower than the index in the variant of making ammonium nitrate by 1,9 %, biohumus – 4,5 and 27,2 % was lower than the control variant, and in the spring wheat crops – 7,9; 10,3 and 21,2 % respectively.

Creating the optimal nutrient status positively influenced on changing the biometric indicators of spring crops. Thus the plant height of spring barley on the background of mineral nut-rition exceeded the organic for 1,4–3,3 cm, and of spring wheat – 3,9–5,6 cm. The larger growth is observed in the variant with anhydrous ammonia.

The highest of tillering rate of spring barley (3,4) and spring wheat (2,8) obtained using anhydrous ammonia, somewhat lower – at making the ammonium nitrate. At biohumus application the tillering rate of spring barley and spring wheat plants were on a control level.

Increasing the number of plants tillering shoots provides forming the optimal density of stems in sowings of spring small cereals. The largest number of stems marked in crops of spring barley and wheat in variant of applying the anhydrous ammonia – 1512 and 1206 pcs./m^2. Use of ammonium nitrate as fertilizer and biohumus led to a reduction of barley stems for 5,0 and 6,1 %, and of wheat – for 7,3 and 18,0 %.

Concerning the nodal roots of spring barley, their biggest number observed in the variant with organic fertilizer – biohumus (357 pcs./m^2), and of spring wheat – at the use of anhydrous ammonia (338 pcs./m^2).

Laboratory analysis of sheaf samples in spring small cereals shows that the identified patterns in the growth and development of plants preserved to the phase of full ripeness (Table 1).

The maximum ear length and amount of grains in it of spring barley (variety Donets'kyi 14) marked at using the anhydrous ammonia (7,3 cm and 16,3 pcs.), of spring wheat – at ammonium nitrate (6,4 cm and 30,8 pcs.) and exceeded the control variant for these indicators

respectively for 0,5 cm and 0,9–1,9 pieces.

The smallest weight of 1000 kernels of spring barley (40,8 g) and wheat (36,4 g) formed in variants without fertilizers. In average for years of research the use of ammonium nitrate and anhydrous ammonia provided increasing the weight of 1000 grains of spring barley for 3,4 and 2,7 %, while the spring wheat – for 1,9 and 2,7 % compared with a control variant. On the background of biohumus the weight of 1000 kernels of spring small cereals grew the least – only for 1,7–0,8 %.

1. Crop yield structure of spring small cereals under the influence of mineral and organic fertilizers (average for 2012–2014)

Fertilization variant	Plant height, cm	Ear length, cm	Amount of grains per ear, pcs.	1000 kernel weight, g	Grain unit, g/l
Spring barley (Donets'kyi 14)					
Without fertilizers (control)	57,9	6,8	14,4	40,8	624,5
N_{30} ammonium nitrate	60,1	7,1	15,5	42,2	620,7
N_{30} anhydrous ammonia	59,0	7,3	16,3	41,9	621,2
Biohumus, 250 kg/ha	59,9	7,2	16,1	41,5	622,4
Spring wheat (Kharkivs'ka 23)					
Without fertilizers (control)	74,7	5,9	29,9	36,4	727,1
N_{30} ammonium nitrate	77,0	6,4	30,8	37,1	726,8
N_{30} anhydrous ammonia	77,3	6,3	30,1	37,4	724,9
Biohumus, 250 kg/ha	76,6	6,3	30,1	36,7	728,8

On average for the years of research the grain unit of spring barley varied slightly within 620,7–624,5 g/l, and spring wheat – 724,9–727,8 g/l. Significant increase in grain unit under the influence of nutrition backgrounds compared with a control variant were not found.

Studies indicate a significant positive effect of organic and mineral nutrition on crop yield structure indicators of spring small cereals, which subsequently led to the formation an appropria-te level of plants productivity. The highest grain yield of spring barley (3,57 t/ha) and wheat (2,41 t/ha) was at making anhydrous ammonia (Fig. 2).

When using the ammonium nitrate and biohumus in spring barley crops received an increase the additional crop yield – 0,59 and 0,41 t/ha over the control, while in spring wheat – 0,29 and 0,23 t/ha, respectively.

Thus, the use of mineral fertilizers at spring crops growing, contributes to a significant increase in crop yield from 20,4 to 23,5 % (spring barley) and from 15,0 to 24,1 % (spring wheat), and on a background of biohumus – for 14,1 and 11,9 % respectively, listed above cultures.

Also important is the problem of influence the nutrient background on the indicators of grain quality of spring cereals that is not adequately studied and therefore has considerable scientific and practical interest.

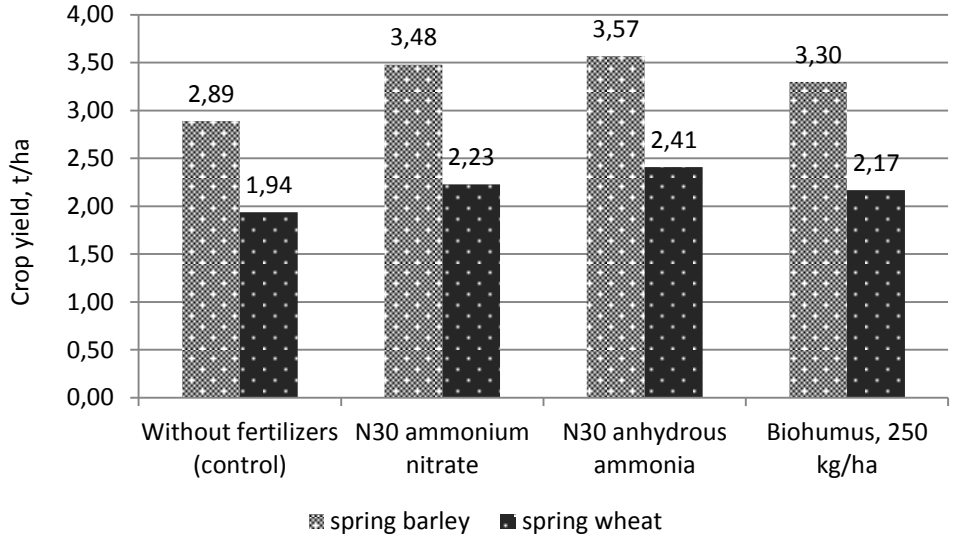

Fig. 2. Crop yield of spring small cereals under the influence of mineral and organic fertilizers, t/ha (average for 2012–2014).

On average over three years of research the highest protein content in grain of spring barley has noted at using biohumus (10,71 %), which is 0,75 % higher than in the control variant and 0,40–0,46 % more than at the use of fertilizers (Table 2).

2. Grain quality of spring small cereals under the influence of mineral and organic fertilizers, (average for 2012–2014)

Fertilization variant	Protein content in barley grain, %	Content in wheat, %	
		protein	gluten
Without fertilizers (control)	9,96	13,58	21,61
N_{30} ammonium nitrate	10,42	14,28	23,89
N_{30} anhydrous ammonia	10,36	14,15	24,30
Biohumus, 250 kg/ha	10,71	14,28	24,85
LSD_{05}, %	0,25	0,11	2,20

As for the quality of spring wheat, the highest protein content in grain was noted at application the mineral fertilizers and biohumus (14,28 %) and at the use of anhydrous ammonia (14,15 %). The highest gluten content in wheat grain received at the use of biohumus (24,85 %), which is 0,55–0,96 % more than in variants with mineral fertilizers and 3,2 % above control variant.

It should be noted, that the use of mineral and organic fertilizers contributed to the rational use of plant nutrients during the growing season, which is allowed to obtain not only increase the crop yield of spring cereals, but also influenced the increase in protein content in grain of spring barley and protein and gluten content – in grain of spring wheat.

The results showed that plants of spring barley and wheat, depending on the use of fertilizers had different degree of diseases damage. Thus, during the years of researches it is founded a greater degree of progress and spread of brown rust and yellow leaf blotch in spring barley crops and Sep-
toria disease and root rot – in spring wheat crops. The use of ammonium nitrate led to an increase progress of disease (from 0,3 to 4,3 % compared to control variant) of both crops, and spread of root rot in spring wheat crops reached 42,3 % (7,3 % over the control).

Describing the phytosanitary conditions of spring small cereals depending on the application of biohumus is worth be noted, that the indicators of accounting the progress and spread of stem-leaf diseases and root rot in options remained on the control level. In the use of anhydrous ammonia
were founded certain characteristics. Thus, if the progress of brown rust, Septoria disease and

yellow leaf blotch in spring small cereals were at the level of the above stated variants, the progress of root rot was significantly lower not only at use the ammonium nitrate and biohumus, and then control variant. The explanation of this phenomenon, obviously, is properties, method and period of application the anhydrous ammonia, as far as autumn applying it accelerates the decomposition of plant residues in the soil. Part of the nitrogen fixed by bacteria, fungi and other organisms involved in the process of decomposition. Ammonia also has a toxic effect on other soil microorganisms, including reducing the number of fungi, bacteria and actinomycetes, causing soil decontamination, which was manifested in the reduction of spread and harmfulness of diseases such as root rot and promotes partial recovery plants in crops. Usually toxicity of anhydrous ammonia initially restricted by zone with a radius of 7,5 cm from the place of application, but over a long period (from the autumn application to early spring sowing campaign of spring small cereals, often accompanied with thaws) observed an increase of its activity area.

Results of studies indicates, that spring small cereal plants depending on organic and mineral fertilizers had different degrees of weed-infestation, affection by diseases and pest damage. Thus, the inspection conducted in late tillering phase of culture plants showed that the lowest weed-infestation level observed in spring barley crops in variant without fertilization (19,4 pcs./m^2), which varied depending on fertilization from 23,1 (at using ammonium nitrate) to 24,4 pcs./m^2 (when using biohumus). Weaker growth and development of spring wheat plants (compared with barley) provided less optically dense stem formation, which led to an increase in crops the number of weeds. Thus, if in the control the weed infestation level was 19,4 pcs./m^2, at application of ferti-
lizers it grew to 23,9–26,7 pcs./m^2.

Increase in the number of insects and their larvae at the application of organic and mineral fertilizers, is associated with improved nitrogen nutrition of plants. Under these conditions, along with activating the process of plants growth and development in their cell sap increases the concen-tration of nitrogen compounds, which are very attractive to pests, especially with sucking mouth-parts.

Conclusions. Thus, as a result of the three-year experimental studies on detection the effect-tiveness of organic and mineral fertilizers in spring small cereals growing technology was found that anhydrous ammonia is an important reserve to optimize the introduction of nitrogen fertilizers. Ammonia is fixed by the soil, and its transformation into a soluble form slows because of low temperatures and completely stops, when temperatures go below zero.

It is established, that ammonia nitrogen, applied in November, during the nongrowing sea-son of winter crops, almost not nitrified till March next year. Fast nitrification begins in mid-April, and its completion took about 8 weeks. This can reduce the number of process operations associated with the introduction of nitrogen during the intense spring sowing campaign. Test results confirmed the previously established position that, on efficiency, the anhydrous ammonia nearly equivalent to ammonium nitrate and in some cases (as observed during 2012–2014 in Donbas) at difficult spring-summer weather conditions of arid Steppe the advantage was anhydrous ammonia.

Bibliography

1. Агрохімія: [підручник] / [*М. М. Городній, С. І. Мельник, А. С. Малиновський* та ін.]. – К.: ТОВ Алефа, 2003. – 778 с.
2. *Борисоник З. Б.* Яровые колосовые культуры. – [2-е изд., перераб. и доп.] / *З. Б. Борисоник*. – К.: Урожай, 1975. – 176 с. – (на укр. языке).
3. *Опара М. М.* Шляхи застосування органічних і мінеральних добрив у сучасних умовах / *М. М. Опара* // Матеріали обл. наук.-практ. конф. з питань ефективного ведення землероб-ства, 16–17 січ. 2003 р. / Полтав. держ. аграр. акад. – Полтава, 2003. – С. 48–53.
4. *Артюшина Н. А.* Удобрения в интенсивных технологиях возделывания сельскохозяйст-венных культур / *Н. А. Артюшина*. – М.: ВО Агропромиздат, 1991. – 113 с.
5. *Детковская И. П.* Влияние удобрений на урожай и качество зерна / *И. П.*

Детковская, Е. М. Лишанова. – Мн.: Урожай, 1987. – 74 с.
6. *Циков В. С.* Методические рекомендации по проведению полевых опытов с зерновыми, зернобобовыми и кормовыми культурами / *В. С. Циков, Г. Р. Пикуш.* – Днепропетровск, 1983. – 46 с.
7. *Доспехов Б. А.* Методика полевого опыта / *Б. А. Доспехов.* – М.: Агропромиздат, 1985. – 351 с.