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CROP CAPACITY AND QUALITY OF WINTER RYE DEPENDING ON THE NORMS AND TIME CONSTRAINTS OF APPLYING NITROGENOUS FERTILIZERS

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This article covers the question of forming winter rye crop capacity and the content of protein in it depending on the norms and time constraints of applying nitrogenous fertilizers. It is proved that the highest rates of crop capacity and the content of protein in it can be reached while applying nitrogenous fertilizers separately during the 2nd and 4th phases of organogenesis.

Under present-day conditions crop farming in Ukraine is characterized by slight growth of crop production, winter crops in particular [1].

The studies carried out by S.M. Kalenska on the basis of Institute of crop farming were dealt with great influence of technologies with different levels of anthropogenic impact on crop production of modern winter rye sorts. They showed great effectiveness of winter rye crop production within the Forest-Steppe in Ukraine. According to the level of productivity the variant of using intensive basic technology and intensive full of energy technologies appeared to be the most effective one (5,98 t/ha) [2].

National scientists consider the extension of areas under winter rye within the structure of acreages under all winter crops to be one of the ways of stabilizing the situation at the corn market in Ukraine [3].

Being the basis of productional process and finally crop yielding, the optimized level of nitrogenous nutrition and integrated protection of winter rye sowing while using the best variants of technology contribute to the improvement of phytometrical indices within the structure of plants. The increase of mineral loading of intensive technologies on account of rising mineral fertilizers norms against the background of integrated plant protection ensures growth of winter rye yielding [4].

Methods of the research. The sort of winter rye “Intensive 95” was grown on the podzolized heavy loamy black soil on research field of Uman National University of Horticulture during the period of 2010 – 2012. The experiment was carried out according to the scheme: 1) without applying fertilizers but including monitoring; 2) P60K60 – background (1); 3) K_{60} + N60(2); 4) P_{60} + N60(2); 5) background + N30(2); 6) background + N60(2); 7) background + N90(2); 8) background + N0(2) + N30(3); 9) background + N0(2) + N60(3); 10) background + N30(2) + N30(3); 11) background + N60(2) + N30(3); 12) background + N30(2) + N60(3); 13) background + N60(2) + N60(3). Phosphoric and potash fertilizers serving as background were applied in the process of main tillaging (1), nitrogenous fertilizers were introduced in spring (2) and during the period of intensive plant tillering (3). The general area of the experimental plot was 72 m², and accounting – 40 m². The experiment was carried out three times. The sections under the investigation were placed in consecutive order.

Crop yielding was defined by means of the method of direct combining. The content of protein in grain crops of winter rye was defined as well for obtaining qualitative assessment of crop capacity. It was done according to the SSTU (State Standards in Ukraine) 4117:2007.

Mathematical treatment of experimental materials was done with the help of the method of dispersive analysis of single factor field experiment using the package of the standard programme "Microsoft Exel 2003".

The results of the research. With the help of our experiments we established the fact that applying nitrogenous fertilizers essentially contributed to the growth of winter rye yielding. Thus, arithmetical mean for three years of investigating crop capacity on unfertilized plots of land was 2,63 t/ha, in the variant with the highest indices of nitrogenous fertilizers (background + $N_{60\ (II)}$+ $N_{60\ (IV)}$) was 4,69 t/ha or more on 78% (table 1). During the years of carrying out the experiments it changed greatly and in 2010 in the variant without fertilizers it was 2,42 t/ha and 4,69 t/ha or more on 90%; in 2011 it was 3,07 and 4,86 t/ha or more on 60%; in 2012 it was 2,39 and 4,51 t/ha or more on 88% which was essential in comparison with HIP_{05}=*0,29–0,32*.

1. Crop capacity of winter rye depending on the norms and time constraints of applying nitrogenous fertilizers t/ha

Variant of experiment	year of research			Avarage for three years
	2010	2011	2012	
Monitoring (without applying fertilizers)	2,42	3,07	2,39	2,63
$P_{60}K_{60}$ – background	2,91	3,55	2,83	3,10
K_{60}+ $N_{60\ (II)}$	3,75	3,84	3,57	3,72
P_{60}+ $N_{60\ (II)}$	3,92	4,01	3,74	3,89
Background + $N_{30\ (II)}$	3,56	4,02	3,61	3,73
Background + $N_{60\ (II)}$	4,04	4,26	3,96	4,09
Background + $N_{90\ (II)}$	4,23	4,35	4,08	4,22
Background + N_0 + $N_{30\ (IV)}$	3,27	3,82	3,22	3,44
Background + N_0 + $N_{60(IV)}$	3,49	4,04	3,35	3,63
Background + $N_{30\ (II)}$+ $N_{30\ (IV)}$	4,04	4,42	3,97	4,14
Background + $N_{60\ (II)}$+ $N_{30\ (IV)}$	4,41	4,57	4,24	4,41
Background + $N_{30\ (II)}$+ $N_{60\ (IV)}$	4,56	4,74	4,43	4,58
Background + $N_{60\ (II)}$+ $N_{60\ (IV)}$	4,69	4,86	4,51	4,69
HIP_{05}	*0,29*	*0,32*	*0,30*	–

But various time constraints of applying nitrogenous fertilizers influenced the quantity of winter rye yielding in a different way. Thus applying 30 – 90 kg/ha of nitrogenous fertilizers increased the crop capacity of winter rye to the level of 3,73 – 4,22 t/ha or more on 1,1–1,59 t/ha only during the 2nd phase of plant organogenesis.

Using 30 – 60 kg/ha of nitrogenous fertilizers as additional fertilizing during the 4th phase of plant organogenesis contributed to the corn capacity at the level of 3,44 – 3,63 t/ha or more on 0,81–1,0 t/ha.

The highest rates of winter rye yielding were achieved in *the variant* Background + $N_{60\ (II)}$+ $N_{60\ (IV)}$ – 4,69 t/ha on condition that nitrogenous fertilizers had been separately applied, the lowest rates of winter rye yielding were obtained in *the variant* Background + $N_{30\ (II)}$+ $N_{30\ (IV)}$ – 4,14 t/ha.

Application of phosphoric and potash fertilizers without introduction of any other ones increased crop capacity in 0,47 t/ha. In *the variant* K_{60}+ $N_{60\ (II)}$ і P_{60}+ $N_{60\ (II)}$ the index was for about 3,72 і 3,89 t/ha, which was less in 5–10% in comparison with *the variant* which presupposed applying phosphoric and potash fertilizers all together.

Our experiments showed that the content of protein in the corn was greatly influenced by weather conditions and nutrition of winter rye by applying nitrogenous fertilizers.

On carrying out the experiments we defined that in avarage for three years of our investigation the content of protein in the corn of winter rye in *the variant* without applying fertilizers was 8,0% and it increased to the level of 8,2–8,9% in *the variant* which presupposed applying $N_{30–90}$ in spring. In *the variants* which meant carrying $N_{30–90}$ as additional fertilizing at the beginning of the period of winter rye stalk-shooting the index was appropriately 8,4% and 8,8%, which was essentially higher in comparison with *the variants* where these norms were introduced in spring.

2. Influence of the norms and time constraints of applying nitrogenous fertilizers on the content of protein in the corn of winter rye%

Variant of experiment	year of research			Avarage for three years
	2010	2011	2012	
Monitoring (without applying fertilizers)	8,1	7,8	8,2	8,0
$P_{60}K_{60}$ – background	8,1	7,8	8,3	8,1
K_{60}+ $N_{60\ (II)}$	8,4	8,1	8,5	8,3
P_{60}+ $N_{60\ (II)}$	8,4	8,1	8,6	8,4
Background + $N_{30\ (II)}$	8,2	8,0	8,4	8,2
Background + $N_{60\ (II)}$	8,7	8,3	8,8	8,6
Background + $N_{90\ (II)}$	9,0	8,7	9,1	8,9
Background + N_0 + $N_{30\ (IV)}$	8,4	8,1	8,6	8,4
Background + N_0 + $N_{60(IV)}$	8,9	8,5	9,0	8,8
Background + $N_{30\ (II)}$+ $N_{30\ (IV)}$	8,7	8,3	8,9	8,6
Background + $N_{60\ (II)}$+ $N_{30\ (IV)}$	9,1	8,7	9,2	9,0
Background + $N_{30\ (II)}$+ $N_{60\ (IV)}$	8,8	8,3	9,0	8,7
Background + $N_{60\ (II)}$+ $N_{60\ (IV)}$	9,4	8,9	9,5	9,3
HIP_{05}	*0,5*	*0,4*	*0,6*	

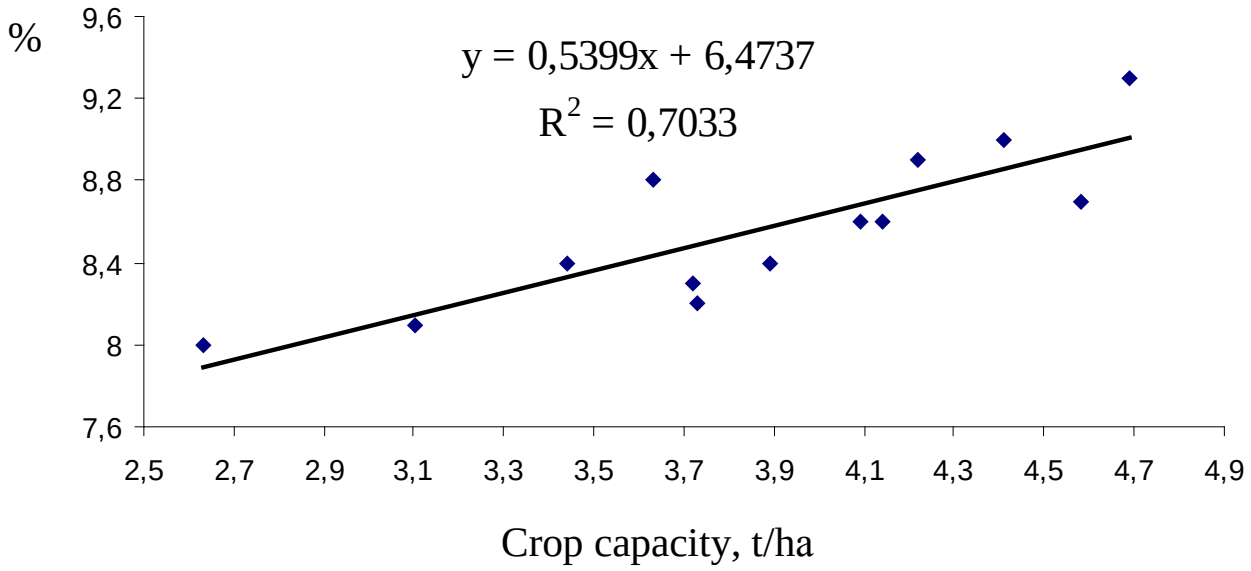
In case of separate introduction of nitrogenous fertilizers the content of protein was the biggest in *the variant* Background + $N_{60\ (II)}$+ $N_{60\ (IV)}$ and was 9,3%. Introduction of phosphoric and potash fertilizers contributed to the growth of protein to the level of 8,1%, and on applying K_{60}+ $N_{60\ (II)}$ і P_{60}+ $N_{60\ (II)}$ it grew to the level of approximately 8,3 і 8,4%.

Lack of moisture and high air temperature during the period of winter rye ripening in 2010 and in 2012 contributed to the growth of protein in corn content. That's why its content was higher than in 2011 and ranged between 8,1–9,5%. In 2011 it was 7,8% (without applying fertilizers) and in *the variant* Background + $N_{60\ (II)}$+ $N_{60\ (IV)}$ it was 8,9%.

With the help of correlative analysis we found out close correlative connection (r=0,79) between corn capacity of winter rye and the content of protein in it which is defined by means of such an equation of regression:

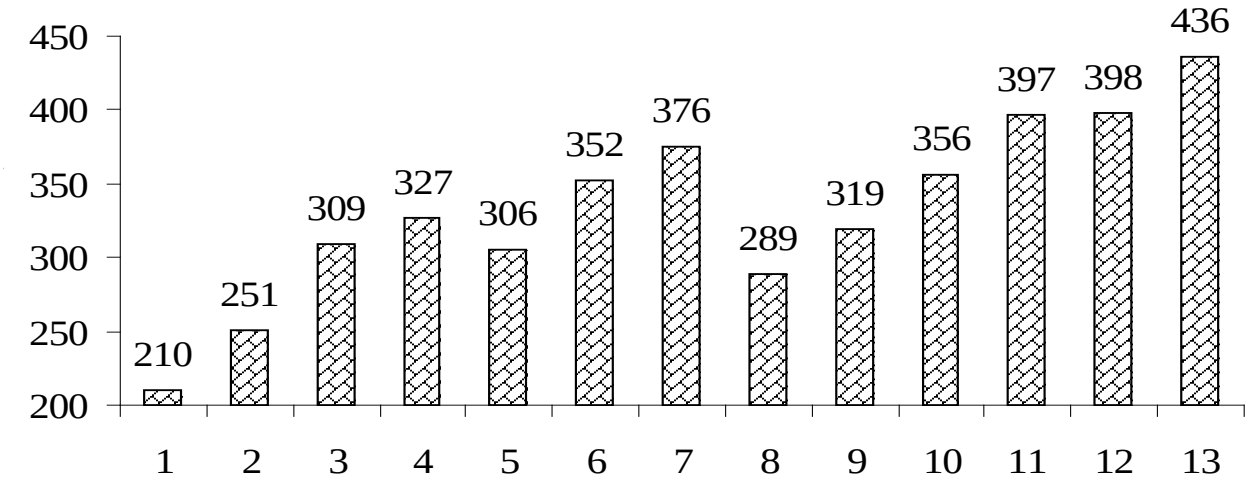
$$Y = 2{,}5026x + 45{,}962, \text{ where}$$

y – the content of protein, %;
x – corn capacity, t/ha (picture 1).



Pic. 1. Correlative connection between crop capacity of winter rye corn and the content of protein, 2010 – 2012

Protein output within crop capacity of winter rye ranged between 210 – 436 kg/ha (picture 2). On conditions that it was once applied the biggest protein output was formed in *the variant* Background + $N_{90\ (II)}$ – 376 kg/ha, but it got the highest rates in case of twice-repeated introduction of additional fertilizing in *the variant* Background + $N_{60\ (II)}$+ $N_{60\ (IV)}$ – 436 kg/ha.



Picture 2. Protein output within corn capacity of winter rye depending on the norms and time constraints of applying nitrogenous fertilizers, 2010 – 2012, kg/ha
1 – Monitoring (without applying fertilizers); 2 – $P_{60}K_{60}$ – background; 3 – K_{60} + N_{60} (II); 4 – P_{60} + N_{60} (II); 5 – background + N_{30} (II); 6 – background + N_{60} (II); 7 – background + N_{90} (II); 8 – background + N_0(II) + N_{30}(IV); 9) background + N_0(II) + N_{60}(IV); 10 – background + N_{30}(II) + N_{30}(IV); 11 – background + N_{60}(II) + N_{30}(IV); 12 – background + N_{30}(II) + N_{60}(IV); 13 – background + N_{60}(II) + N_{60}(IV)

Thus in the result of our investigation we came to the conclusion that improvement of mineral nourishing conditions of winter rye contributes to the growth of crop capacity and protein in its content. But the highest rates of crop capacity and protein in its content are formed while applying nitrogenous fertilizers separately during the 2nd and 4th phases of organogenesis.

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Влияние азотных удобрений на продуктивность ржи озимой на черноземе оподзоленном

Современное состояние земледелия в Украине характеризуется незначительным увеличением возделывания зерновой продукции. Исследованиями С.М. Каленской установлено высокую эффективность выращивания зерна этой культуры в условиях Лесостепи Украины.

Исследованиями установлено, что разные сроки внесения азотных удобрений по разному влияло на величину урожайности зерна озимой ржи. Так, внесения 30 – 90 кг/га д.в. азотных удобрений только на II этапе органогенеза растений повышало урожайность зерна озимой ржи до 3,73 – 4,22 т/га или на 1,1 – 1,59 т/га. Перенесения внесения 30 – 60 кг/га д.в. азотных удобрений в подкормку на IV этапе органогенеза способствовало формированию урожайности зерна на уровне 3,44 – 3,63 т/га, что было на 0,81 – 1,0 т/га больше.

Наивысшая урожайность зерна озимой ржи за дробного внесения азотных удобрений была у варианте фон + $N_{60(II)}$+ $N_{60\ (IV)}$ — 4,69 т/га, найменшую урожайность получено у варианте фон + $N_{30(II)}$+ $N_{30\ (IV)}$ — 4,14 т/га.

В среднем за три года исследований количество белка в зерне озимой ржи у варианте без удобрений становил 8,0% и увеличивался до 8,2 – 8,9% у вариантах с внесением N_{30-90} по мерзлоталой почве. У вариантах с перенесением N_{30} і N_{60} у подкормку вначале выхода растений в трубку этот показатель становил соответственно 8,4% и 8,8%.

Выход белка с урожая зерна озимой ржи колебался в пределах 210 – 436 кг/га. За одноразовой подкормки наибольший выход белка формировался у варианте фон + $N_{90\ (II)}$ — 376 кг/га, но наибольшим он был при двукратной подкормки у варианте фон + $N_{60(II)}$+ $N_{60\ (IV)}$ — 436 кг/га.

***Ключевые слова**: рожь озимая, азотные удобрения, урожай, этапы органогенеза.*

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Effect of nitrogen fertilizer on productivity of winter rye on ashed black soil

The present state of agriculture in Ukraine is characterized by a slight increase of grain products cultivation. The research of S.M. Kalenskaya defined high efficiency of grain production of this crop under the conditions of forest-steppes of Ukraine.

Research has established that different time limits of nitrogen fertilizing differently affected on the amount of grain yield of winter rye. Thus, the introduction of 30 – 90 kg / ha of nitrogen fertilizer only at the second stage of plants organogenesis increased the grain yield of winter rye to 3,73 – 4,22 t / ha or to 1,1 – 1,59 t / ha. Transferring of introduction 30 – 60 kg / ha of nitrogen fertilizer in top-dressing at the IV stage of organogenesis ensured grain yield formation at the level of 3,44 – 3,63 t / ha which was more on 0,81 – 1,0 t / ha.

The highest grain yield of winter rye at fractional introduction of nitrogen fertilizers was in variant of background + $N_{60(II)}$ + $N_{60\ (IV)}$ — 4.69 t / ha, the lowest yield was obtained in the variant of background + $N_{60(II)}$ + $N_{60\ (IV)}$ — 4 14 t / ha.

In average within three years of study the grain protein content of winter rye in the variant without fertilizers was 8.0% and increased to 8,2 – 8,9% in variants with the introduction of N_{30-90} *on thawed soil. In embodiments of the transfer of N30 and N60 in feeding of early exit of plants in the tube, this index was accordingly 8.4% and 8.8%.*

Yield of protein from grain yield of winter rye ranged from 210 – 436 kg / ha. For single-feed the highest yield of protein formed in the variant of background + $N_{90(II)}$ *— 376 kg / ha, but the highest it was at double feeding in a variant of background +* $N_{60(II)}$ *+* $N_{60(IV)}$ *— 436 kg / ha.*

Keywords*: winter rye, nitrogen fertilizers, yield, stages of organogenesis.*