Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 23, Issue 4, 2023
PRINT ISSN 2284-7995, E-ISSN 2285-3952

ANALYSIS OF THE INFLUENCE OF SOME TECHNOLOGICAL FACTORS AND COMPARATIVE EFFICIENCY OF THEIR APPLICATION ON YIELD POTENTIAL OF TWO ISOGENIC WHEAT LINES UNDER THE CONDITIONS OF SOUTHERN ROMANIA

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Abstract

In the conditions of southern Romania, on a chernozem type soil, without irrigation, for 3 years, 2 isogenic lines of wheat, M_1 and M_2, with different biological yield potential were analyzed. The analyzed factors were: Nitrogen fertilization doses, Phosphorus fertilization doses and sowing density. Concerning the influence of nitrogen on yield, all calculated average values differ significantly from each other, both for M_1 and for M_2, the highest average values being recorded at a dose of N150 kg a.s./ha. Regarding the influence of phosphorus on seed yield, both for M_1 and M_2, no significant differences are recorded between the two averages values calculated for the analyzed graduations. Related to the influence of density on seed yield, the average value recorded at 700 g.s./m^2, records significant differences compared to the value averages recorded at the density of 500 g.s./m^2, between the value averages recorded on 600 g.s./m^2 and the other value averages, no statistically differences being recorded. Concerning the trend models between Nitrogen doses and wheat yield, all the models are mathematically correct, what differs is the regression coefficient. The regression coefficient is higher under phosphorus fertilization and on high sowing density.

Key words: *Nitrogen, Phosphorus, doses, isogenic lines, yield, efficiency*

INTRODUCTION

Agriculture plays a central role in the economy of the Southern region of Romania. Here, modern crop technologies have come to provide record harvests on some farms, but sometimes agricultural production is highly dependent on weather conditions.

Hence, it appears the need to apply appropriate measures to protect producers in order to adequately exploit the existing national potential [8].

Globally, demand for wheat by 2050 is predicted to increase by 50 percent from present's levels, so identification of better genotypes with desirable traits is an important objective in every breeding programs.

Combining the physiological, chemical, and morphological traits responsible for inherent or environment-induced differences in the plant growth or yield requires thorough growth analysis [6].

Innovative plant improvement techniques respond in part to current challenges. So, improving the quality of the plants has been and is still a significant objective in the activity of breeders, who must create new varieties, which will yield higher yields of useful substances per hectare, with a better nutritional or commercial value.

A basic factor in improving the quality of cultivated plants is the value and diversity of biological material, which must be rich in quality genes or genotypes. The quality traits of the plants are genetic, determined monogenic or polygenic.

Wheat quality is as important as production capacity. The attention paid to improving the quality is highlighted by the numerous meetings and the large volume of research undertaken. They established that both protein and gluten content are heritable traits caused by quantitative physiological differences or as a result of processes of internal elements directed by a particular gene or combination of genes.

Considerable research in the past decade has been devoted to novel techniques and methodologies in wheat biotechnology. The integration of novel techniques and methods into wheat breeding programs is necessary to facilitate continued and accelerated progress in producing new wheat lines. In the past two decades, developments of in vitro culture techniques have enabled the production of large numbers of haploid plants, especially in cereals. Of these techniques, anthers culture and chromosome elimination in inter-generic crosses have been the most widely used. The production of DHs has been an important development in wheat breeding, because, after chromosome doubling to recover fertility, the recovery of homozygous lines can be achieved in a single generation. This can significantly reduce the time taken before advanced comparative trials can be made and new commercial cultivars identified.

Induction of mutations is another possibility to improve quality traits and a useful method to generate new wheat lines. Mutation breeding induces mutations, usually in the seed and includes exposure of seeds to ionizing radiation, ultraviolet radiation or chemical mutagens. The yield and quality of a wheat crop is determined by the complex interaction of water availability, nutrition, environment, pest and disease and genetic make-up [10]. Both chemical and organic fertilization in different technological variants is an important factor to increase wheat grain yield [1, 2, 7, 9, 12]. The establishment of yield performance and their correlation with some quality characteristics in some mutant/recombinant wheat lines was the purpose of this study. Nitrogen management is considered one of the most vital factors affecting wheat growth [4], phenology and grain yield. Nitrogen fertilizer, when supplied at appropriate rates, plays a significant role in enhancing crop productivity [3]. Good nitrogen fertilization practices, including recommended methods and rates, are extremely vital not only for increasing the crop productivity but also for preserving the soil and eco-friendly health [11].

However, insufficient application of synthetic fertilizers, mainly nitrogenous fertilizers, has a negative impact on the growth and yield of crops; it is expected that cumulative N fertilization may cause an enhancement of 23% - 60% of N2O emissions by 2030 [5].

MATERIALS AND METHODS

In the conditions of southern Romania, on a chernozem type soil, without irrigation, for 3 years, 2 isogenic lines of wheat, M_1 and M_2, with different biological yield potential were analyzed. Thus, M_1 is a line with high yield potential but with low gluten content, while M_2 is an isogenic line with a lower yield potential but with good high gluten content.

The analyzed factors were: nitrogen fertilization doses; Phosphorus fertilization doses; sowing density.

Nitrogen fertilization had 4 graduations: N0 - No Nitrogen fertilization; N50 – 50 kg a.s. N/ha; N100 – 50 kg a.s. N/ha; N150 – 50 kg a.s. N/ha.

Phosphorus fertilization had 2 graduations: No Phosphorus fertilization; 80 kg a.s. P_2O_5/ha.

Sowing density measured in germinable seeds/m^2 (g.s.): 500 g.s./m^2; 600 g.s./m^2; 700 g.s./m^2.

Among the pursued objectives of this paper it can mention:

(i) influence of nitrogen on seed yield;
(ii) influence of phosphorus on seed yield;
(iii) influence of density on seed yield;
(iv) influence of the interaction of the three factors on yield;
(v) analysis of the trend models between Nitrogen doses and wheat yield;
(vi) influence of phosphorus on the variation of the regression coefficients between nitrogen dose and seed yield.

RESULTS AND DISCUSSIONS

For the influence of nitrogen on yield, all calculated average values differ significantly from each other, both for M1 and for M_2, the

PRINT ISSN 2284-7995, E-ISSN 2285-3952

highest average values being recorded at a dose of N150 kg a.s./ha (Table 1).

Table 1. The Nitrogen factor influence on the seed yield (kg/ha)

N doses	M_1	M_2
N_0	3527.83^{d}	2634.5^{d}
N_{50}	4080.0^{c}	2976.0^{c}
N_{100}	5019.17^{b}	4010.17^{b}
N_{150}	6585.67^{a}	5629.5^{a}
LSD 5%	321.85	289.17

Source: Original data.

Related to the influence of phosphorus on seed yield, both for M1 and M_2, no significant differences are recorded between the two averages values calculated at the two graduations (Table 2).

Table 2. The Phosphorus factor influence on the seed yield (kg/ha)

P_2O_5 doses	M1	M_2
P_2O_5 0 kg a.s./ha	4685.5^{ns}	3717.67^{ns}
P_2O_5 80 kg a.s./ha	4920.83^{ns}	3907.42^{ns}
LSD 5%	341.22	278.22

Source: Original data.

Related to the influence of density on seed yield, the average value recorded at 700 g.s./m^2, records significant differences compared to the value averages recorded at the density of 500 g.s./m^2, between the value averages recorded on 600 g.s./m^2 and the other value averages, no statistically differences being recorded (Table 3).

Table 3. The density on sowing factor influence on the seed yield (kg/ha)

Density on sowing	M_1	M_2
500 g.s./m^2	4596.00^{b}	3672.37^{b}
600 g.s./m^2	4825.37^{ab}	3827.37^{ab}
700 g.s./m^2	4988.13^{a}	3937.87^{a}
LSD 5%	376.22	289.14

Source: Original data.

Related to the influence of the interaction of the three factors on yield, in general, Nitrogen is the factor that makes the statistical differentiation between the variants, the superior results being recorded by the variants fertilized abundantly with nitrogen.

The second factor that statistically influences the results is density.

At the same graduation with nitrogen, superior results are obtained by the variants with higher density compared to those at lower density.

Fertilization with Phosphorus influences the production results less, from a statistical point of view influencing those variants fertilized abundantly with nitrogen.

The highest average value is recorded by the variant fertilized with N150 and P_2O_5 80 kg a.s./ha at the density of 700 g.s./m^2, which is significantly different from all the other values recorded, except the values recorded for the N150 variant and P_2O_5 80 kg a.s./ha at the density of 600 g.s./m^2 (Table 4).

Table 4. The influence of the interaction of the three factors on yield variation

N dose	P_2O_5 dose	Density (on sowing)	M_1	M_2
N_0	P_2O_5 0 kg a.s./ha	500 g.s./m^2	3250^{l}	2589^{j}
		600 g.s./m^2	3542^{jkl}	2611^{j}
		700 g.s./m^2	3611^{jkl}	2638^{j}
	P_2O_5 80 kg a.s./ha	500 g.s./m^2	3421^{kl}	2601^{j}
		600 g.s./m^2	3621^{jkl}	2666^{lj}
		700 g.s./m^2	3722^{ijk}	2702^{lj}
N_{50}	P_2O_5 0 kg a.s./ha	500 g.s./m^2	3812^{hij}	2856^{hij}
		600 g.s./m^2	4058^{ghi}	2911^{hij}
		700 g.s./m^2	4122^{gh}	3012^{hi}
	P_2O_5 80 kg a.s./ha	500 g.s./m^2	4025^{ghi}	2896^{hij}
		600 g.s./m^2	4138^{g}	3056^{h}
		700 g.s./m^2	4325^{g}	3125^{h}
N_{100}	P_2O_5 0 kg a.s./ha	500 g.s./m^2	4725^{f}	3785^{g}
		600 g.s./m^2	4938^{e}	3901^{fg}
		700 g.s./m^2	5126^{de}	4102^{efg}
	P_2O_5 80 kg a.s./ha	500 g.s./m^2	4878^{ef}	3902^{fg}
		600 g.s./m^2	5126^{de}	4102^{efg}
		700 g.s./m^2	5322^{d}	4269^{e}
N_{150}	P_2O_5 0 kg a.s./ha	500 g.s./m^2	6136^{c}	5125^{d}
		600 g.s./m^2	6358^{bc}	5452^{cd}
		700 g.s./m^2	6548^{b}	5630^{bc}
	P_2O_5 80 kg a.s./ha	500 g.s./m^2	6521^{b}	5625^{bc}
		600 g.s./m^2	6822^{ab}	5920^{ab}
		700 g.s./m^2	7129^{a}	6025^{a}
LSD 5%			389.22	348.53

Source: Original data.

Concerning the trend models between Nitrogen doses and wheat yield, all the models are mathematically correct, what differs is the regression coefficient. Thus:

For the trend model between Nitrogen doses and wheat yield on 500 g.s./m^2 on P_2O_5 fertilisation, the regression coefficient between nitrogen dose and yield is equal with 16.108, which implies that for each kg of nitrogen a.s. applied, an additional 16.108 kg of wheat yield is obtained (Fig. 1).

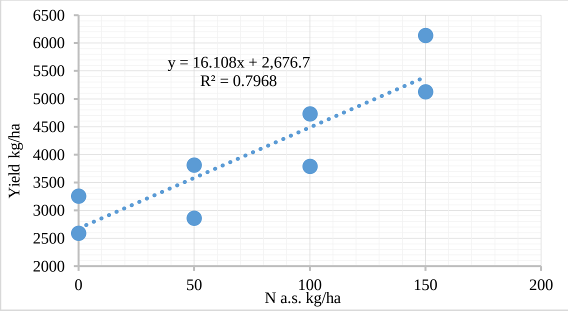

Fig. 1. Trend model between Nitrogen doses and wheat yield on 500 g.s./m^2 and no P_2O_5 fertilisation
Source: Original figure.

For the trend model between Nitrogen doses and wheat yield on 600 g.s./m^2 on no P_2O_5 fertilisation, the regression coefficient between nitrogen dose and yield is equal with 16.841, which implies that for each kg of nitrogen a.s. applied, an additional 16.841 kg of wheat yield is obtained (Fig. 2).

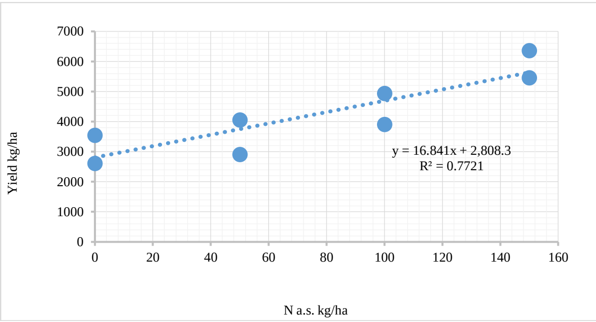

Fig. 2. Trend model between Nitrogen doses and wheat yield on 600 g.s./m^2 and no P_2O_5 fertilisation
Source: Original figure.

For the trend model between Nitrogen doses and wheat yield on 700 g.s./m^2 on no P_2O_5 fertilisation, the regression coefficient between nitrogen dose and yield is equal with 17.568, which implies that for each kg of nitrogen a.s. applied, an additional 17.568 kg of wheat yield is obtained (Fig. 3).

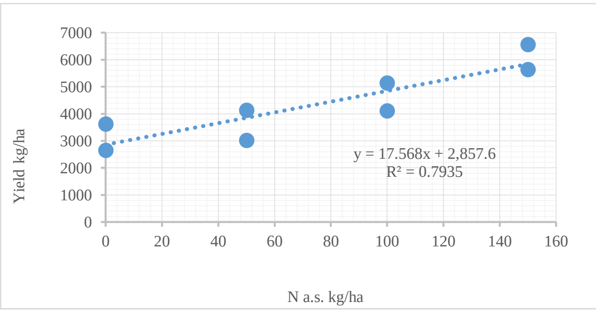

Fig. 3. - Trend model between Nitrogen doses and wheat yield on 700 g.s./m^2 and no P_2O_5 fertilisation
Source: Original figure.

For the trend model between Nitrogen doses and wheat yield on 500 g.s./m^2 and 80 P_2O_5 a.s. kg/ha fertilisation, the regression coefficient between nitrogen dose and yield is equal with 20.231, which implies that for each kg of nitrogen a.s. applied, an additional 20.231 kg of wheat yield is obtained (Fig. 4).

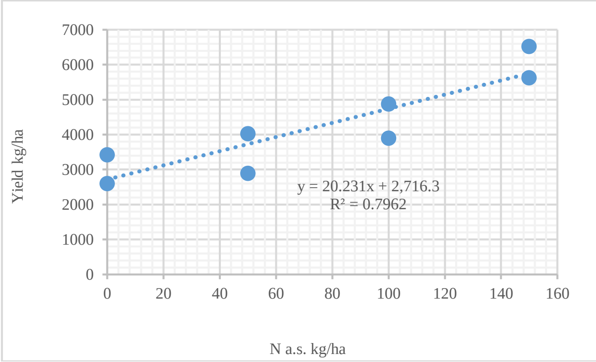

Fig. 4. Trend model between Nitrogen doses and wheat yield on 500 g.s./m^2 and 80 P_2O_5 a.s. kg/ha
Source: Original figure.

For the trend model between Nitrogen doses and wheat yield on 600 g.s./m^2 and 80 P_2O_5 a.s. kg/ha fertilisation, the regression coefficient between nitrogen dose and yield is equal with 21.399, which implies that for each kg of nitrogen a.s. applied, an additional 21.399 kg of wheat yield is obtained (Fig. 5).

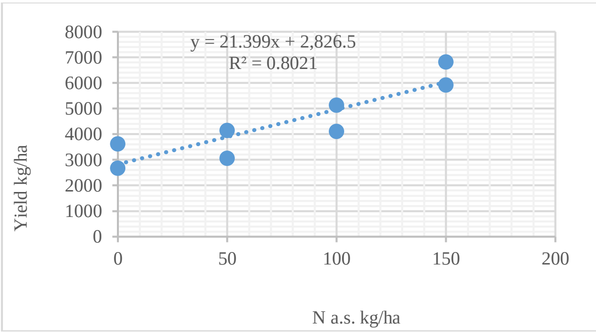

Fig. 5. Trend model between Nitrogen doses and wheat yield on 600 g.s./m^2 and 80 P_2O_5 a.s. kg/ha
Source: Original figure.

For the trend model between Nitrogen doses and wheat yield on 700 g.s./m^2 and 80 P_2O_5 a.s. kg/ha fertilisation, the regression coefficient between nitrogen dose and yield is equal with 22.331, which implies that for each kg of nitrogen a.s. applied, an additional 22.331 kg of wheat yield is obtained (Fig. 6).

Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 23, Issue 4, 2023
PRINT ISSN 2284-7995, E-ISSN 2285-3952

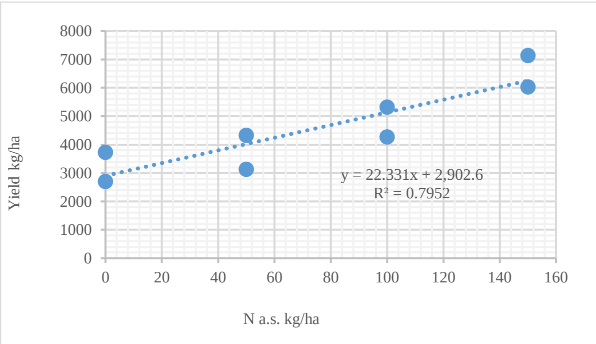

Fig. 6. Trend model between Nitrogen doses and wheat yield on 700 g.s./m^2 and 80 P_2O_5 a.s. kg/ha
Source: Original figure.

Concerning the R values between nitrogen doses and yields, the highest value was recorded on 700 g.s./m^2 and 80 P_2O_5 a.s. kg/ha fertilization, which statistically surpass all the other values, except the value recorded on 600 g.s./m^2 on no P_2O_5 fertilisation. The first 3 ranked values statistically surpass the last 3 ranked values (Fig. 7).

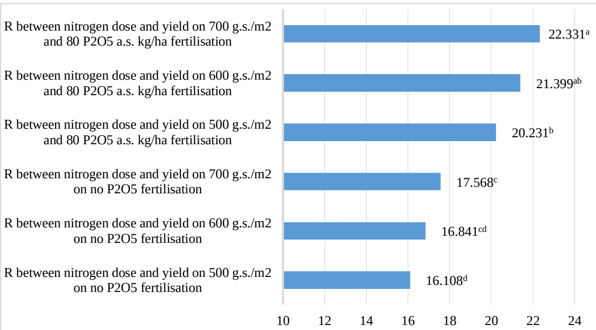

Fig. 7. The R values between nitrogen dose and yields variation. LSD 5%=1.143
Source: Original figure.

Depending on the density on sowing, it was analyzed the influence of phosphorus on the variation of the regression coefficients between nitrogen dose and seed yield.
Thus, on the density on sowing of 500 g.s./m^2, regression coefficient calculated under conditions of phosphorus fertilization recorded a difference of 4.123 compared to the one calculated for conditions without phosphorus fertilization, which implies that, in the case of phosphorus fertilization, for each kg of nitrogen fertilizer, a yield increase of 4.123 kg is obtained compared to the yield increase recorded for each kg of nitrogen fertilizer a.s., but without phosphorus fertilization. From economic efficiency, at an average price of 280 euros/t wheat and 30 euros/50 kg of ammonium nitrate (approx. 1 euro/kg a.s. N), in conditions of fertilization with phosphorus, compared to non-fertilization with phosphorus, at each kg of nitrogen a.s. fertilizer, an additional profit of 1.15 euros is obtained without taking into account the cost of phosphorus (Fig. 8).

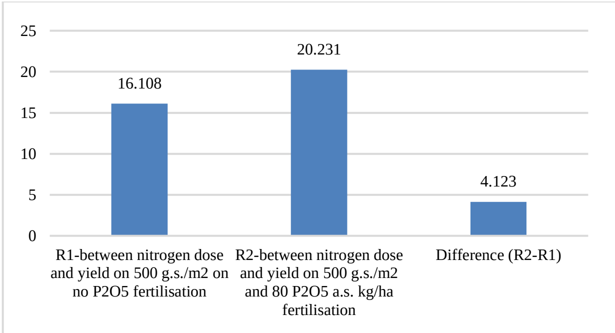

Fig. 8. The influence of phosphorus on the variation of the regression coefficient between nitrogen dose and yield on a density on sowing of 500 g.s./m^2
Source: Original figure.

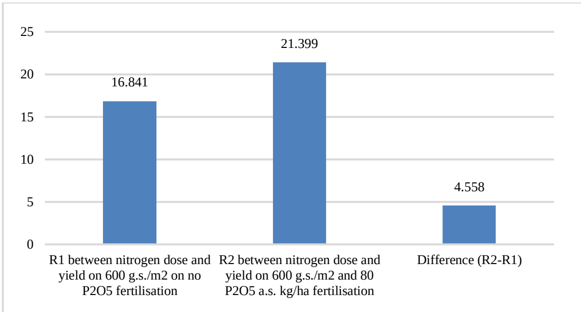

Fig. 9. The influence of phosphorus on the variation of the regression coefficient between nitrogen dose and yield on a density on sowing of 600 g.s./m^2
Source: Original figure.

On the density on sowing of 600 g.s./m^2, regression coefficient calculated under conditions of phosphorus fertilization recorded a difference of 4.558 compared to the one calculated for conditions without phosphorus fertilization, which implies that, in the case of phosphorus fertilization, for each kg of nitrogen fertilizer, a yield increase of 4.558 kg is obtained compared to the yield increase recorded for each kg of nitrogen fertilizer a.s., but without phosphorus fertilization. From economic efficiency, at an average price of 280 euros/t wheat and 30 euros/50 kg of ammonium nitrate (approx. 1 euro/kg a.s. N), in conditions of fertilization with phosphorus, compared to non-fertilization with phosphorus, at each kg of nitrogen a.s. fertilizer, an additional profit of 1.275 euros is obtained without taking into account the cost of phosphorus (Fig. 9).

On a density on sowing of 700 g.s./m^2, regression coefficient calculated under conditions of phosphorus fertilization recorded a difference of 4.763 compared to the one calculated for conditions without phosphorus fertilization, which implies that, in the case of phosphorus fertilization, for each kg of nitrogen fertilizer, a yield increase of 4.763 kg is obtained compared to the yield increase recorded for each kg of nitrogen fertilizer a.s., but without phosphorus fertilization. From economic efficiency, at an average price of 280 euros/t wheat and 30 euros/50 kg of ammonium nitrate (approx. 1 euro/kg a.s. N), in conditions of fertilization with phosphorus, compared to non-fertilization with phosphorus, at each kg of nitrogen a.s. fertilizer, an additional profit of 1.333 euros is obtained without taking into account the cost of phosphorus (Fig. 10).

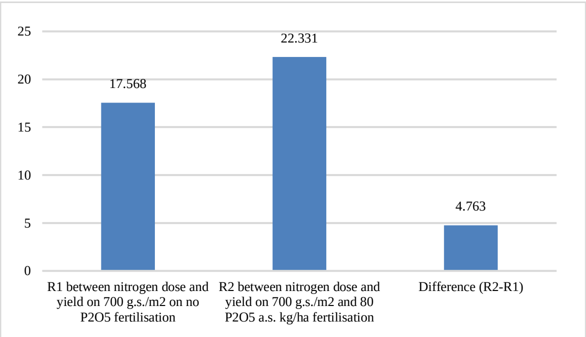

Fig. 10. The influence of phosphorus on the variation of the regression coefficient between nitrogen dose and yield on a density on sowing of 700 g.s./m^2
Source: Original figure.

CONCLUSIONS

Concerning the influence of nitrogen on yield, all calculated average values differ significantly from each other, both for M1 and for M_2, the highest average values being recorded at a dose of N150 kg a.s./ha.

Regarding the influence of phosphorus on seed yield, both for M1 and M_2, no significant differences are recorded between the two averages values calculated at the two graduations.

Related to the influence of density on seed yield, the average value recorded at 700 g.s./m^2, records significant differences compared to the value averages recorded at the density of 500 g.s./m^2, between the value averages recorded on 600 g.s./m^2 and the other value averages, no statistically differences being recorded.

Related to the influence of the interaction of the three factors on yield, in general, Nitrogen is the factor that makes the statistical differentiation between the variants, the superior results being recorded by the variants fertilized abundantly with nitrogen.

The second factor that statistically influences the results is density. At the same graduation with nitrogen, superior results are obtained by the variants with higher density compared to those at lower density.

Fertilization with Phosphorus influences the production results less, from a statistical point of view influencing those variants fertilized abundantly with nitrogen.

Concerning the trend models between Nitrogen doses and wheat yield, all the models are mathematically correct, what differs is the regression coefficient. The regression coefficient is higher under phosphorus fertilization and on high sowing density.

Regarding the influence of phosphorus fertilizer on the variation of the regression coefficients between nitrogen dose and seed yield, on a density on sowing of 500 g.s./m^2, in conditions of fertilization with phosphorus, compared to non-fertilization with phosphorus, at each kg of nitrogen a.s. fertilizer, an additional profit of 1.15 euros is obtained without taking into account the cost of phosphorus fertilizer. On a density on sowing of 600 g.s./m^2, in conditions of fertilization with phosphorus, compared to non-fertilization with phosphorus, at each kg of nitrogen a.s. fertilizer, an additional profit of 1.275 euros is obtained without taking into account the cost of phosphorus fertilizer. On a density on sowing of 700 g.s./m^2 in conditions of fertilization with phosphorus, compared to non-fertilization with phosphorus, at each kg of nitrogen a.s. fertilizer, an additional profit of 1.333 euros is obtained without taking into account the cost of phosphorus fertilizer.

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