# THE IMPORTANCE OF AGROTECHNICAL METHODS FOR A HIGH WHEAT GRAIN YIELD

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## ABSTRACT

**Grain yield and yield components with different agrotechnical methods in Yugoslavia were investigated in three periods of three years. In all years of investigations the highest grain yield was obtained in the first sowing time (10th of October) and the optimal sowing depth was 4 cm. For a wheat grain yield of 5.0-7.0 t/ha, 120 kg/ha of nitrogen is enough. There is no positive interaction between late sowing time of wheat and high amounts of nitrogen. Simple coefficients showed that there is a very strong (r=0.88) positive correlation between plants number and grain yield. The direct effect is negative and very poor. Concerning yield dependence on spikes number, the analysis of simple correlation coefficients shows that there is a very strong connection (r=0.87**). The direct effect is medium (r=0.43**). Strong negative correlation was established between the coefficient of productive clustering and grain yield (r= -0.87**). The direct effect is negative and medium, too (r=-0.56). The influence of 1000 grains mass and hectoliter mass on the grain yield by this index is very poor. But, it can be seen that the direct effect is stronger than the total one.**

**Key words**: grain yield, sowing time, sowing depth, sowing density.

## INTRODUCTION

The realization of high wheat grain yields with the great number of plants per unit of area, under the conditions of intensive agrotechnical methods, becomes the general adopted knowledge and practice.

The new high yielding varieties have some common characteristics but they differ morphologically and physiologically, the differences being related to growing into a cluster, leaf position and size, vegetation period, stalk height and spike structure. In such different genotypes it is important to realize (for each of them) the optimal density, what represents the base of intensive production, so that from certain land area maximum grain production could be realized. Concomitantly with the productive variety, the adequate optimal production technology is necessary (sowing time, sowing depth, mineral nutrients amount, presowing land preparation and so on).

The aim of this study was to investigate the promising varieties, genetically different, high yielding, in interaction with sowing time, nitrogen nutrition level, sowing depth and density. Knowledges obtained by these investigations could be of a benefit for the more complete use of genetic potential of wheat varieties, especially in providing the optimal agrotechnical methods, with the aim of obtaining maximum yields.

## MATERIALS AND METHODS

Trials were conducted at the experimental field of the Institute "PKB INI Agroekonomik" during 1993-1995, on a hardy black soil. Preceding crop was sunflower in all three years. The methodology of trial setting was a split-plot system with five replications. The size of the basic plot amounted to 5 $m^2$. Basic tillage was performed in the mid of september. Sowing was performed manually, at the row spacing of 20 cm, with 600 germinativegrains in the trial with different sowing times and levels of nitrogen nutrients nutrition. Sowing times were: 01 of October, 10 of October, 20 of October, 01 of November, 10 of November and 20 November. The varieties "Žitnica", "NS-Rana-2" and "Jugoslavija", were used in trials with nitrogen amount of 0, 80, 120 and 160 kg/ha. Fertilizer application was performed in a way that the whole quantity of $P_2O_5$ and $K_2O$, and 1/3 of nitrogen were added into the basic tillage, and the rest of nitrogen was given in two top dressings in spring. In the trial with different densities and sowing depths, 8 varieties were used (Nizija, Partizanka, NS-Rana-2, Jugoslavija, Macvanka-2, Žitnica, Zvezda and Zelengora) and the agricultural technolology was usual for winter wheat in Yugoslavia. The size of the basic plot amounted to 5 $m^2$. Sowing was manual, in the mid of October in all years of investigation, with sowing density of 200, 400, 600 and 800 germinative grains/$m^2$, with row spacing of 20 cm.

The number of hibernated plants was established in spring, and the number of productive spikes before the harvest. The harvest was performed manually, at the stage of full maturity, and threshing by harvester thresher, after which 1000 grains mass, hectoliter mass and grain yield were established.

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Statistical data processing (variance analysis, path-coefficient analysis) was done at the computer center of the Institute for Economy, Faculty of Agriculture, Novi Sad. In the analysis, the following factors were taken: variety, sowing times, sowing density and sowing depth.

The results are presented as an average of three years for all investigated traits.

## RESULTS AND DISCUSSIONS

### Sowing time

It is known that the quality and sowing on time have the greatest influence over the wheat grain yield increase (Drezgic et al., 1975; Spasojevic et al., 1981; Ščepanovic et al., 1981).

In these investigations, the highest grain yield of 5.38 t/ha was realized in the first sowing time, than the tendency of yield decrease appeared so that in the sixth sowing time only 3.66 t/ha was obtained. Although in these four years of investigations the decrease of yield was established, statistical data pro- cessing showed that the sixth sowing time (sowing of 20th November) was significantly lower, while between the other sowing times significant difference was not established because of great LSD value (Table 1).

The yield always is determined by the variety, ecology conditions, and the agricultural production conditions (Mac Key, 1996; Borojevic and Cupina, 1969): The variety is on the first place, so it is necessary to have a good knowledge about it and to introduce it into production. In these investigations the variety Žitnica had the highest grain yield, what means that this variety has the biggest tolerance on saline soil, followed by Jugoslavija and Novosadska Rana-2, with the lowest yields and with the poorest tolerance. The differences in grain yield between varieties are highly significant (Table 1).

*Table 1.* Grain yield (t/ha) of investigated winter wheat varieties with different sowing times and nitrogen nutrition amount (3 years average)

| Variety (V) | Nitrogen amount kg N /ha | Sowing times (S) | | | | | | | $V_{\bar{x}}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | VI | VN | |
| Žitnica | 0 | 4.84 | 4.63 | 4.56 | 4.38 | 4.08 | 3.27 | 4.29 | 5.23 |
| | 80 | 6.17 | 5.74 | 5.72 | 5.36 | 5.12 | 4.26 | 5.39 | |
| | 120 | 6.44 | 6.15 | 5.94 | 5.60 | 5.24 | 4.57 | 5.66 | |
| | 160 | 6.26 | 6.01 | 6.07 | 5.60 | 5.34 | 4.28 | 5.59 | |
| | $SV_{\bar{x}}$ | 5.93 | 5.63 | 5.57 | 5.23 | 4.94 | 4.09 | | |
| NS-Rana-2 | 0 | 3.64 | 3.30 | 4.02 | 3.74 | 3.69 | 3.12 | 3.58 | 4.32 |
| | 80 | 4.77 | 4.14 | 4.69 | 4.63 | 4.50 | 3.58 | 4.38 | |
| | 120 | 5.20 | 4.52 | 5.10 | 4.85 | 4.65 | 3.89 | 4.70 | |
| | 160 | 5.16 | 4.50 | 5.04 | 4.82 | 4.52 | 3.75 | 4.63 | |
| | $SV_{\bar{x}}$ | 4.69 | 4.11 | 4.71 | 4.51 | 4.34 | 3.58 | | |
| Jugoslavija | 0 | 4.51 | 4.34 | 4.33 | 4.02 | 3.96 | 2.89 | 4.01 | 4.80 |
| | 80 | 5.58 | 5.36 | 5.31 | 4.69 | 4.82 | 3.34 | 4.85 | |
| | 120 | 6.03 | 5.77 | 5.73 | 5.08 | 4.94 | 3.47 | 5.17 | |
| | 160 | 5.97 | 5.77 | 5.66 | 5.10 | 5.03 | 3.53 | 5.18 | |
| | $SV_{\bar{x}}$ | 5.52 | 5.31 | 5.26 | 4.72 | 4.69 | 3.31 | Dx | |
| $NS_{\bar{x}}$ | 0 | 4.33 | 4.09 | 4.30 | 4.05 | 3.91 | 3.09 | 3.96 | 4.78 |
| | 80 | 5.51 | 5.08 | 5.24 | 4.89 | 4.81 | 3.73 | 4.88 | |
| | 120 | 5.89 | 5.48 | 5.59 | 5.17 | 4.94 | 3.98 | 5.17 | |
| | 160 | 5.80 | 5.43 | 5.59 | 5.17 | 4.96 | 3.85 | 5.13 | |
| | $SV_{\bar{x}}$ | 5.38 | 5.02 | 5.18 | 4.82 | 4.66 | 3.66 | | |

| Level of importance | | S | V | N | SV | SN | VS | NS | VN | NV | VNS | SNV | SVN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LSD | 5% | 0.93 | 0.23 | 0.14 | 0.57 | 1.04 | 0.36 | 0.98 | 0.25 | 0.32 | 1.17 | 1.17 | 0.61 |
| | 1% | 1.29 | 0.31 | 0.19 | 0.76 | 1.43 | 0.47 | 1.30 | 0.33 | 0.42 | 1.59 | 2.26 | 0.81 |

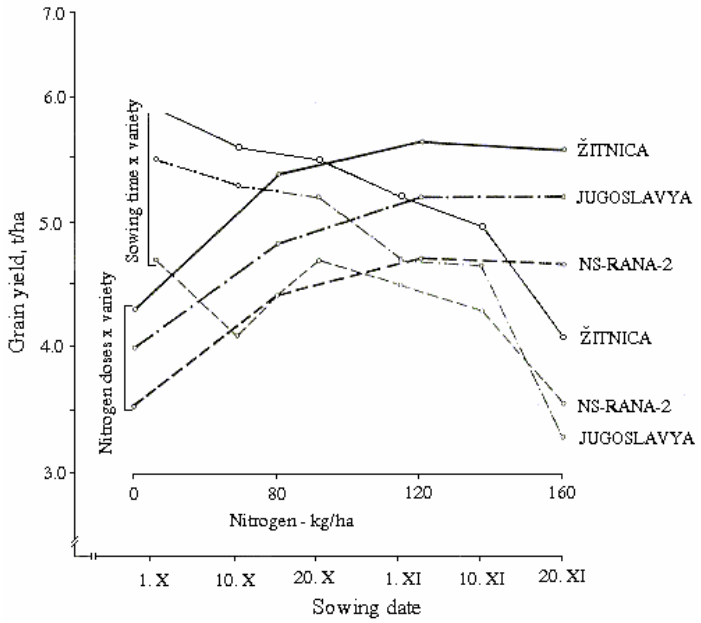


*Figure 1*. Effect of sowing date and nitrogen rate on grain yield of different wheat genotypes (4 years average)

With the other factors, the change of sowing time resulted in the same way, what means that with the later sowing the grain yield had a decreasing tendency. With all investigated varieties, the sixth sowing time (sowing of 20th November) had a highly significant lower grain yield. Such was the relation between sowing time with the same nutrient quantity and with the same variety and nutrient quantity. The variety Žitnica had the highest grain yield on all the levels of investigated factors (Table 1, Figure 1).

### The nitrogen rate

The unfertilized variant gave a highly significant lower grain yield than the fertilized variant, with the same sowing time, with all varieties (Table 1).

This means that the soils are, in spite of their sufficient humus content in the arable layer, insufficiently fertile and that they need fertilization with greater amounts of nitrogen fertilizers. The amount of 80 kg N/ha, in all sowing times, gave significantly lower yield than 120 and 160 kg N/ha. But, between these two greatest nitrogen amounts there were not significant differences. While the amount of 120 kg N/ha in the first two sowing times had greater grain yields, in the third, fourth and fifth sowing times yields were the same, and in the sixth somewhat lower. Because of this we can conclude that, on the saline soils of Banat, the rate of 120 kg N/ha, with appropriate amounts of phosphorus and potassium, is enough for obtaining 5-7 t/ha of wheat grains at the optimal sowing times (Table 1, Figure 1).

The wheat producers are convinced that, with the sowing delay, the amounts of mineral fertilizers have to be increased, but the investigations did not confirm positive interaction between late sowing and increased nitrogen nutrients amount. In other words, by the increased amounts of mineral fertilizers, yields decrease, which appears with late sowing times of wheat.

These finaings are in agreement with the results reported by Drezgic et al. (1975); Spasojevic et al. (1976, 1981), Jevtic et al. (1978) and Ščepanovic et al. (1995).

### Sowing density

On an average of three years, the greatest grain yield provided Zvezda (6.88 t/ha), followed by Jugoslavija and Zelengora (6.69 and 6.56 t/ha), Partizanka and Macvanka-2 (6.48 t/ha). NS-Rana-2 and Žitnica had approxi-

mately the same yield, but significantly poorer than Zvezda. Nizija had the lowest grain yield (6.14 t/ha) (Table 2).

*Table 2* Grain yield (t/ha) of different wheat varieties at different sowing densities (3 years average)

| Variety (V) | Grain density/m² (G) | | | | V $\bar{x}$ |
|---|---|---|---|---|---|
| | 200 | 400 | 600 | 800 | |
| Nizija | 5.19 | 6.16 | 6.53 | 6.71 | 6.14 |
| Partizanka | 5.45 | 6.47 | 6.87 | 7.14 | 6.48 |
| NS-Rana-2 | 5.39 | 6.43 | 6.92 | 7.04 | 6.44 |
| Jugoslavija | 5.50 | 6.57 | 7.06 | 7.20 | 6.58 |
| Macvanka - 2 | 5.55 | 6.58 | 6.96 | 6.94 | 6.48 |
| Žitnica | 5.42 | 6.59 | 6.86 | 7.00 | 6.46 |
| Zvezda | 6.22 | 6.78 | 7.19 | 7.36 | 6.88 |
| Zelengora | 5.55 | 6.64 | 6.76 | 7.30 | 6.56 |
| G $\bar{x}$ | 5.53 | 6.52 | 6.88 | 7.08 | 6.50 |
| Level of importance | V | G | VG | GV | |
| LSD 5% | 0.65 | 0.24 | 0.87 | 0.66 | |
| 1% | 0.91 | 0.31 | 1.19 | 0.89 | |

By the increase of sowing density, with the other factors, yield increased also. So, with the density of 200 grains/m² yield of 5.53 t/ha was established, by the density of 400 grains/m² – 6.52 t/ha, by the density of 600 grains/m² – 6.88 t/ha and by the density of 800 grains/m² – 7.08 t/ha. The difference in grain yield with the density of 200 grains in relation to yield with the density of 400, 600 and 800 grains/m², and 400 grains/m² in relation to 800 grains/m² is significant, while the difference between the density of 400 and 600 grains/m², 600 and 800 grains/m² is not significant (Table 2).

Increased sowing density with each investigated variety resulted in grain yield increase. This increase is not significant statistically and it stops at the level between 400 and 600 grains/m² (Table 2). These data are in agreement with the results obtained by Drezgic et al. (1971); Spasojevic et al. (1981); and Protic (1994).

There is a very high interaction between the sowing time and the depth (Table 3). If the same sowing depth is observed at different sowing times, in all the years and on an average for three years, it can be seen that the highest yield was realized in the first, considerably lower in the second, and much lower in the third sowing period.

*Table 3*. Interaction between sowing time and depth (SxD)

| Sowing time (S) | Sowing depth (D) | | Years 1994 | 1995 | 1996 | D $\bar{x}$ |
|---|---|---|---|---|---|---|
| 10. X | 2 cm | | 6.50 | 7.50 | 7.16 | 7.05 |
| | 4 cm | | 6.90 | 8.19 | 7.78 | 7.62 |
| | 6 cm | | 6.35 | 7.40 | 7.22 | 6.99 |
| 25. X | 2 cm | | 6.38 | 70.34 | 6.85 | 6.86 |
| | 4 cm | | 6.74 | 7.91 | 7.43 | 7.36 |
| | 6 cm | | 6.29 | 7.17 | 6.88 | 6.78 |
| 10. XI | 2 cm | | 5.76 | 6.64 | 6.25 | 6.23 |
| | 4 cm | | 6.14 | 7.26 | 7.02 | 6.81 |
| | 6 cm | | 5.65 | 6.53 | 6.31 | 6.16 |
| Level of importance (LSD) | 5% | SD | 0.30 | 0.30 | 0.50 | 0.11 |
| | 1% | | 0.40 | 0.40 | 0.70 | 0.15 |
| | 5% | DS | 0.50 | 0.30 | 0.60 | |
| | 1% | | 0.80 | 0.40 | 0.80 | |

In all sowing times and years, the highest wheat yield was realized with sowing of 4 cm, then of 2 cm, and the lowest of 6 cm depth. If the wheat yield in the late sowing (10th November) in all three years, is compared with sowing densities, it can be seen that the recommendation for late deeper sowing is not acceptable. In this sowing time the highest grain yield was realized with sowing at the depth of 4 cm, considerably higher than with the depth of 6 cm. Even in this time there was not the advantage of sowing at the depth of 6 cm, in relation to shallow sowing at 2 cm (Table 3).

## The relationship between grain yield and the investigated traits

By simple correlation coefficients between grain yield and five yield components included into the analysis, it can not be seen how large is the direct effect of certain variables. Because of that the path-coefficient analysis was applied. It divides the correlation

*Table 4*. The analysis of the direct and indirect effects of some characteristics to the wheat grain yield (3 years average)

| | | | | |
|---|---|---|---|---|
| $a_1$=-0.026 | $r_{12}a_2$= 0.403 | $r_{13}a_3$= 0.505 | $r_{14}a_4$=-0.037 | $r_{15}a_5$= 0.030 |
| $r_{21}a_1$=-0.024 | $a_2$= 0.434 | $r_{32}a_3$= 0.451 | $r_{24}a_4$=-0.029 | $r_{25}a_5$= 0.040 |
| $r_{31}a_1$= 0.023 | $r_{32}a_2$=-0.350 | $a_3$=-0.560 | $r_{34}a_4$= 0.014 | $r_{35}a_5$= 0.007 |
| $r_{41}a_1$= 0.005 | $r_{42}a_2$=-0.062 | $r_{43}a_3$=-0.036 | $a_4$= 0.203 | $r_{45}a_5$=-0.074 |
| $r_{51}a_1$=-0.005 | $r_{52}a_2$= 0.114 | $r_{53}a_3$=-0.027 | $r_{54}a_4$=-0.100 | $a_5$= 0.151 |
| $rx_1y$= 0.88 | $ry_2y$= 0.87 | $rx_3y$=-0.87 | $rx_4y$= 0.03 | $rx_5y$= 0.13 |
| Coefficient of regression determination $R^2$=0.91 | | | | |

coefficients to its components, what enables to separate the direct effect of one variable from the indirect effect of the other variables, from which it can be clearly recognized the contribution of each variable to the construction of wheat yield (Borojevic and Williams, 1982).

Simple correlation coefficients showed that there is a very strong (r=0.88) positive correlation between plants number and grain yield (Table 4 and Figure 2). From this correlation the direct effect is negative and very poor. The same case include the relation between plants number and number of spikes. Simple correlation coefficients between plants number and the coefficient of the productive growing into a cluster are total and negative, while by the part-correlation coefficient analysis poor but positive effect was established (Table 4 and Figure 2).

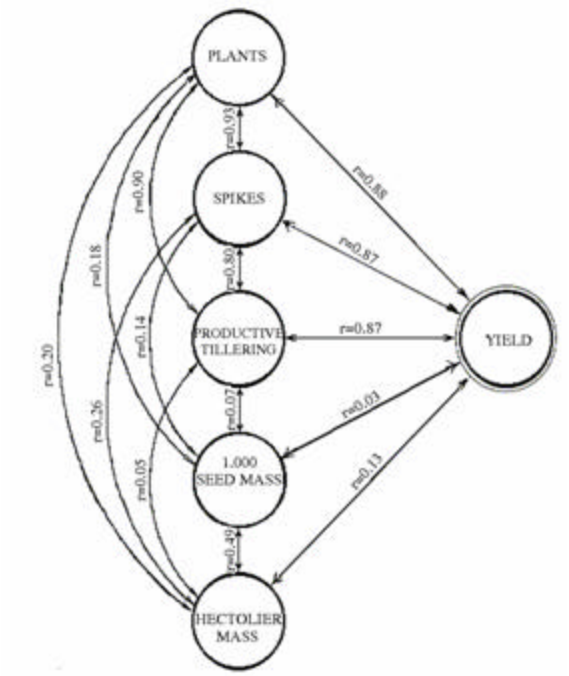


*Figure 2.* Simple correlation coefficients between grain yield and no. of plants, no. of spikes, coefficint of productive tillering, 1,000 seed mass, hectoliter mass and mutual correlations between the later parameters

Concerning the dependence of yield on the number of spikes, the analysis of part-correlation coefficients shows that there is a very strong connection (r= 0.87). The direct effect is medium (r=-0.434), (Table 4 and Figure 2).

Very strong negative correlation was established between the coeficient of the productive growing into a cluster and grain yield (r=-0.87**). The direct effect is also negative and medium (r=-0.56). The influence of 1000 grains mass and hectoliter mass is very poor through these indices (r=0.03 and 0.13), but it can be seen that the direct effect is somewhat stronger than the total one (r=0.20 and 0.15)

## CONCLUSIONS

The optimal sowing time for Žitnica and Jugoslavija is the first decade of October, and for Novosadska-Rana-2 from 15 to 25 October.

For obtaining reliable wheat grain yields at the optimal sowing times, 120 kg N/ha is enough. There is no positive interaction between late wheat sowing and high nitrogen amounts and with the increased fertilizer amounts the decrease of wheat yield with late sowing times can not be prevented.

The highest grain yield had Zvezda (6.88 t/ha), followed by Jugosalvija and Zelengora (6.58 and 6.56 t/ha). Partizanka and Macvanka - 2 were of the same yield (6.48 t/ha) NS-Rana-2 and Žitnica had approximately the same grain yields, but considerably lower than Zvezda. Nizija had the lowest grain yield (6.14 t/ha). The increased sowing density with each investigated variety has determined the grain yield increase. This increasing is not significant and it stops at the level between 400 and 600 grains/$m^2$.

In all years of investigations, the first sowing time ($10^{th}$ October) assured the highest grain yield and the optimal sowing depth was 4 cm.

Simple coefficients showed that there is a very strong (r=0.88) positive correlation between plants number and grain yield. Direct effect is negative and very poor. Concerning the yield dependence on spikes number, the analysis of correlation coefficients showed that there is a very strong connection (r=0.87). The direct effect is medium (r=0.43). Strong negative correlation was established between productive growing into a cluster coefficient and grain yield (r=-0.87).

The direct effect is negative too and medium (r=-0.56). The influence of 1000 grains mass and hectoliter mass over the grain yield by these indices is very poor. But, it can be seen that the direct effect is stronger than the total one.

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Tab. 1 – Grain yield (t/ha) of investigated winter wheat varieties with different sowing times and nitrogen nutrition amount (3 years average)

| Variety (V) | Nitrogen (N) amount kg/ha N | Sowing times (s) | | | | | | | $V\bar{x}$ |
|---|---|---|---|---|---|---|---|---|---|
| | | I | II | III | IV | V | VI | VN | |
| Žitnica | 0 | 4.84 | 4.63 | 4.56 | 4.38 | 4.08 | 3.27 | 4.29 | |
| | 80 | 6.17 | 5.74 | 5.72 | 5.36 | 5.12 | 4.26 | 5.39 | |
| | 120 | 6.44 | 6.15 | 5.94 | 5.60 | 5.24 | 4.57 | 5.66 | 5.23 |
| | 160 | 6.26 | 6.01 | 6.07 | 5.60 | 5.34 | 4.28 | 5.59 | |
| | $SV\bar{x}$ | 5.93 | 5.63 | 5.57 | 5.23 | 4.94 | 4.09 | | |
| NS-Rana-2 | 0 | 3.64 | 3.30 | 4.02 | 3.74 | 3.69 | 3.12 | 3.58 | |
| | 80 | 4.77 | 4.14 | 4.69 | 4.63 | 4.50 | 3.58 | 4.38 | |
| | 120 | 5.20 | 4.52 | 5.10 | 4.85 | 4.65 | 3.89 | 4.70 | 4.32 |
| | 160 | 5.16 | 4.50 | 5.04 | 4.82 | 4.52 | 3.75 | 4.63 | |
| | $SV\bar{x}$ | 4.69 | 4.11 | 4.71 | 4.51 | 4.34 | 3.58 | | |
| Jugoslavija | 0 | 4.51 | 4.34 | 4.33 | 4.02 | 3.96 | 2.89 | 4.01 | |
| | 80 | 5.58 | 5.36 | 5.31 | 4.69 | 4.82 | 3.34 | 4.85 | |
| | 120 | 6.03 | 5.77 | 5.73 | 5.08 | 4.94 | 3.47 | 5.17 | 4.80 |
| | 160 | 5.97 | 5.77 | 5.66 | 5.10 | 5.03 | 3.53 | 5.18 | |
| | $SV\bar{x}$ | 5.52 | 5.31 | 5.26 | 4.72 | 4.69 | 3.31 | Dx | |
| $NS\bar{x}$ | 0 | 4.33 | 4.09 | 4.30 | 4.05 | 3.91 | 3.09 | 3.96 | |
| | 80 | 5.51 | 5.08 | 5.24 | 4.89 | 4.81 | 3.73 | 4.88 | |
| | 120 | 5.89 | 5.48 | 5.59 | 5.17 | 4.94 | 3.98 | 5.17 | 4.78 |
| | 160 | 5.80 | 5.43 | 5.59 | 5.17 | 4.96 | 3.85 | 5.13 | |
| | $SV\bar{x}$ | 5.38 | 5.02 | 5.18 | 4.82 | 4.66 | 3.66 | | |
| Level of importance | S V | N SV | SN | VS | NS | VN | NV VNS | SNV | SVN |
| LSD 5% | 0.93 0.23 | 0.14 0.57 | 1.04 | 0.36 | 0.98 | 0.25 | 0.32 1.17 | 1.17 | 0.61 |
| 1% | 1.29 0.31 | 0.19 0.76 | 1.43 | 0.47 | 1.30 | 0.33 | 0.42 1.59 | 2.26 | 0.81 |

Tab. 2 Grain yield (t/ha) of different wheat varieties at different sowing densities (3 years average)

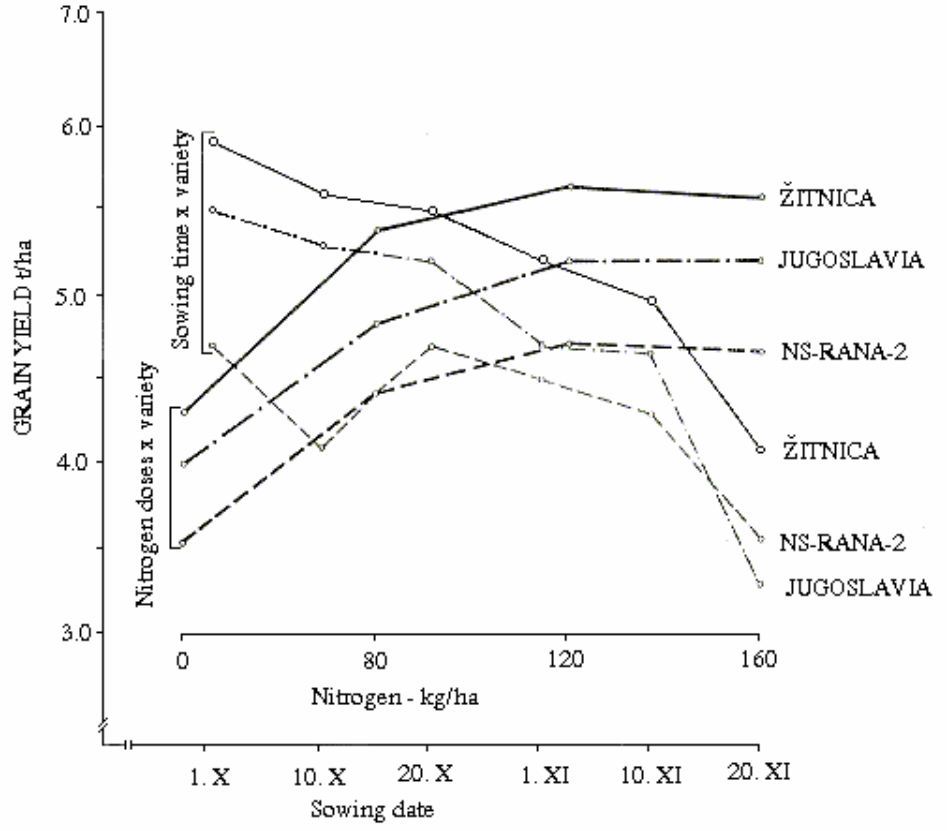
| Variety (V) | Grain density/m$^2$ (G) | | | | V $\overline{x}$ |
|---|---|---|---|---|---|
| | 200 | 400 | 600 | 800 | |
| Nizija | 5.19 | 6.16 | 6.53 | 6.71 | 6.14 |
| Partizanka | 5.45 | 6.47 | 6.87 | 7.14 | 6.48 |
| NS-Rana-2 | 5.39 | 6.43 | 6.92 | 7.04 | 6.44 |
| Jugoslavija | 5.50 | 6.57 | 7.06 | 7.20 | 6.58 |
| Macvanka 2 | 5.55 | 6.58 | 6.96 | 6.94 | 6.48 |
| Žitnica | 5.42 | 6.59 | 6.86 | 7.00 | 6.46 |
| Zvezda | 6.22 | 6.78 | 7.19 | 7.36 | 6.88 |
| Zelengora | 5.55 | 6.64 | 6.76 | 7.30 | 6.56 |
| G $\overline{x}$ | 5.53 | 6.52 | 6.88 | 7.08 | 6.50 |
| Level of importance | V | G | VG | GV | |
| LSD 5% | 0.65 | 0.24 | 0.87 | 0.66 | |
| 1% | 0.91 | 0.31 | 1.19 | 0.89 | |

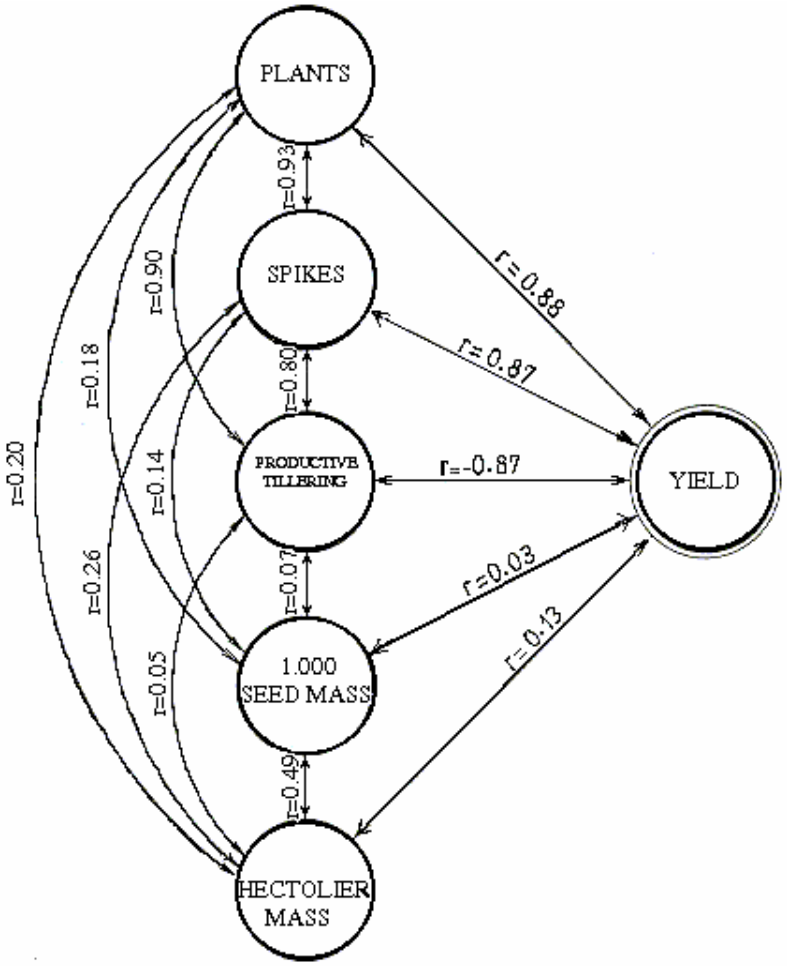
Tab. 3 Interaction between sowing time and depth (SxD)

| Sowing time (S) | Sowing depth (D) | Years | | | D $\overline{x}$ |
|---|---|---|---|---|---|
| | | 1994 | 1995 | 1996 | |
| 10. X | 2 cm | 6.50 | 7.50 | 7.16 | 7.05 |
| | 4 cm | 6.90 | 8.19 | 7.78 | 7.62 |
| | 6 cm | 6.35 | 7.40 | 7.22 | 6.99 |
| 25. X | 2 cm | 6.38 | 70.34 | 6.85 | 6.86 |
| | 4 cm | 6.74 | 7.91 | 7.43 | 7.36 |
| | 6 cm | 6.29 | 7.17 | 6.88 | 6.78 |
| 10. XI | 2 cm | 5.76 | 6.64 | 6.25 | 6.23 |
| | 4 cm | 6.14 | 7.26 | 7.02 | 6.81 |
| | 6 cm | 5.65 | 6.53 | 6.31 | 6.16 |
| Level of importance | 5% SD | 0.30 | 0.30 | 0.50 | 0.11 |
| | 1% | 0.40 | 0.40 | 0.70 | 0.15 |
| | 5% DS | 0.50 | 0.30 | 0.60 | |
| | 1% | 0.80 | 0.40 | 0.80 | |

Tab. 4 The analysis of the direct and indirect effects of some characteristics to the wheat grain yield (3 years average)

| | | | | |
|---|---|---|---|---|
| a1=-0.026 | r12a2=0.403 | r13a3=0.505 | r14a4=-0.037 | r15a5=0.030 |
| r21a1=-0.024 | a2=0.434 | r32a3=0.451 | r24a4=-0.029 | r25a5=0.040 |
| r31a1=0.023 | r32a2=-0.350 | a3=-0.560 | r34a4=0.014 | r35a5=0.007 |
| r41a1=0.005 | r42a2=-0.062 | r43a3=-0.036 | a4=0.203 | r45a5=-0.074 |
| r51a1=-0.005 | r52a2=0.114 | r53a3=-0.027 | r54a4=-0.100 | a5=0.151 |
| rx1Y=0.88 | ry2y=0.87 | rx3y=-0.87 | rx4y=0.03 | rx5y=0.130 |
| Coefficient of regression determination $R^2$=0.91 | | | | |


7.0
6.0
5.0
4.0
3.0
GRAIN YIELD t/ha
Sowing time x variety
Nitrogen doses x variety
ŽITNICA
JUGOSLAVIA
NS-RANA-2
ŽITNICA
NS-RANA-2
JUGOSLAVIA
0
80
120
160
Nitrogen - kg/ha
1. X
10. X
20. X
1. XI
10. XI
20. XI
Sowing date


PLANTS
SPIKES
PRODUCTIVE TILLERING
1.000 SEED MASS
HECTOLIER MASS
YIELD
r=0.93
r=0.90
r=0.18
r=0.20
r=0.80
r=0.14
r=0.26
r=0.07
r=0.05
r=0.49
r=0.88
r=0.87
r=-0.87
r=0.03
r=0.13