# WHEAT YIELD RESULTS UNDER THE INFLUENCE OF N, P, K FERTILIZATION AND CLIMATIC CONDITIONS OF THE 2019-2020 FROM PECICA-ARAD

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***Abstract:*** *The aim of the work is to carry out a study on the influence of climatic conditions and fertilization with chemical fertilizers on wheat production, in the specific conditions of Pecica, county of Arad. A fundamental contribution to the increase in production per unit area is made by the level of N, P and K fertilisation and optimal soil and climatic conditions for exploiting the productive potential of the cultivated variety. The high ecological plasticity of wheat and its constant production means that farmers are still very interested in this crop. Growers are also interested in the crop with the highest yield per unit area. The aim of the paper is to highlight the production results of Ciprian wheat variety obtained in the soil and climatic conditions of the Pecica-Arad of 2019-2020, under the influence of nitrogen, phosphorus and potassium fertilization in order to determine the growers to choose the optimal wheat fertilization option. Wheat yield obtained was determined by nitrogen fertilizer application by difference from the control variant as follows: N30-485kg/ha, N60-584kg/ha, N90605kg/ha and N120kg/ha, at all four rates the differences are statistically assured as highly significant. With reference to the influence of climatic factors the greatest influence is had by the variable precipitation (Pp), followed by temperature, and N fertilizer has the greatest influence, followed by P-dose, K-dose.*

***Key words****: cultivars, fertilization, soil and climatic conditions, yield components*

## INTRODUCTION

Wheat is the most important, staple crop in temperate zones and is increasingly in demand in developing and industrialising countries. Wheat is cultivated in almost all countries of the world, ranking first with a total of 220 million hectares and an average production of 3,009 kg/ha (ROMAN et al., 2006).

Wheat is the most important agricultural crop, providing the raw material for the making of bread and of various pastry products, at the same time being a valuable and demanded product for export. (IMBREA, 2013)

The continuing increase in the world's population, regardless of the average annual growth rate, raises one of the most sensitive issues of our century - providing food for humanity. In the period 7000-6000 BC, the world's population was 5-10 million, at the beginning of our era it was 200-400 million, in 1960 it was almost 3 billion, in 1984 the world population was 4.7 billion, it is estimated that the world's population will be 6.1 billion in the year 2000 and will increase to 8.2 billion in 2025.

Wheat is currently grown in over 45 countries, ranking first in the world, and is an important source of trade, feeding 35-40% of the world's population. As the world's population has grown over the years, the area under wheat cultivation and wheat yields have been increasing (MUNTEAN L.S., et al., 2008). In recent decades, the area under cultivation has exceeded 200 million ha per year and yields have increased significantly as more productive varieties have been introduced and cultivation technologies have been improved. The variability of production in cereal crops has been linked to the availability of rainfall and temperatures during the growing season (YU et al., 2014). Rainfall during the growing season is a positive and most beneficial

factor in determining cereal production, while exposure to high maximum temperatures reduced cereal production.

## MATERIAL AND METHOD

The research was carried out in the 2019-2020 agricultural year in an experimental field in Pecica-Arad, a two-factor experiment was organized with the following description of the factors: factor A - a1 - P0K0; a2 - P40K0; a3 - P80K0; a4 - P40K40; a5 - P80K80 and factor B-nitrogen dose: b1 - N0; b2 - N30; b3 - N60; b4 - N90; b5 - N120. The cultivar was the Ciprian spring wheat variety.The technology applied was specific to spring wheat cultivation.

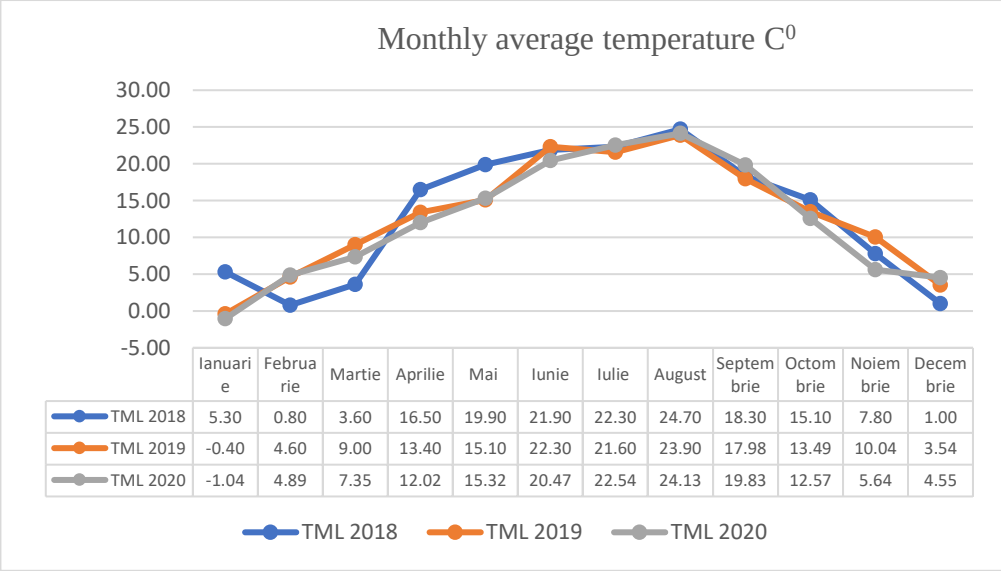
The obtained data were statistically processed using the analysis of variance.

From a climatic point of view, the microzone of the Didactic-Experimental Station is temperate continental moderate, falling within the moderate continental climate, at the interface between the climatic province sector with oceanic influence and the climatic province sector with sub-Mediterranean influences.

The annual average temperature is 10.7°C, with fluctuations from this multi-year average ranging from a few subunits to 1.0 - 1.2°C higher or lower.

Fig. 1 Mean annual temperature 2018-2020

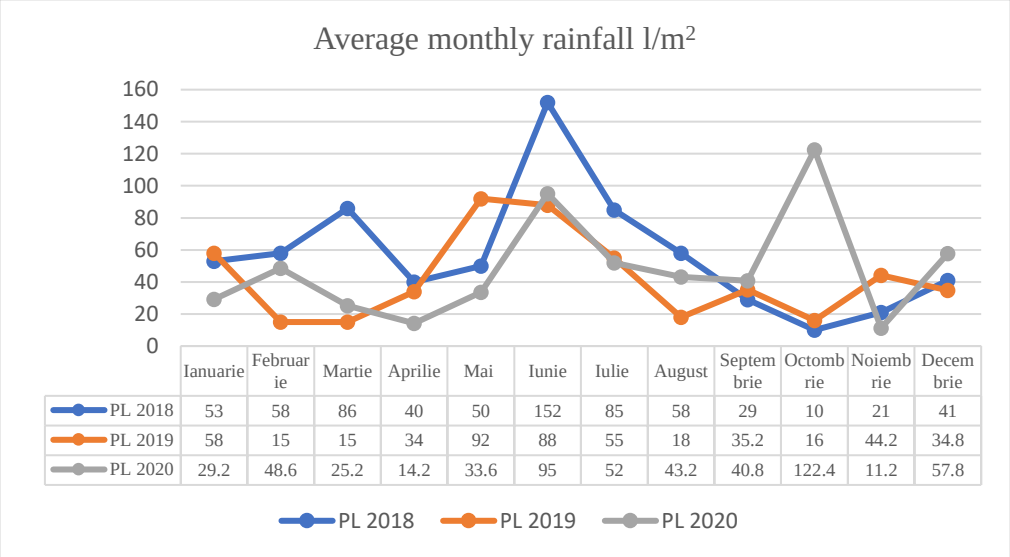
Source: Arad Meteorological Station




| | Ianuarie | Februarie | Martie | Aprilie | Mai | Iunie | Iulie | August | Septembrie | Octombrie | Noiembrie | Decembrie |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TML 2018 | 5.30 | 0.80 | 3.60 | 16.50 | 19.90 | 21.90 | 22.30 | 24.70 | 18.30 | 15.10 | 7.80 | 1.00 |
| TML 2019 | -0.40 | 4.60 | 9.00 | 13.40 | 15.10 | 22.30 | 21.60 | 23.90 | 17.98 | 13.49 | 10.04 | 3.54 |
| TML 2020 | -1.04 | 4.89 | 7.35 | 12.02 | 15.32 | 20.47 | 22.54 | 24.13 | 19.83 | 12.57 | 5.64 | 4.55 |

The multiannual average rainfall at the Arad Meteorological Station is 631 mm.

Climatic data recorded by the Arad Meteorological Station to which we refer by analogy, the temperature values in September was 17,98 C, a month warmer than the multiannual average. It can also be said about the analysis of the thermal regime, for the locality of Arad, for the warm months of the years presented, while in January 2020, an average value of -1.04 0C was recorded, data presented in fig.1.




| | Ianuarie | Februarie | Martie | Aprilie | Mai | Iunie | Iulie | August | Septembrie | Octombrie | Noiembrie | Decembrie |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PL 2018 | 53 | 58 | 86 | 40 | 50 | 152 | 85 | 58 | 29 | 10 | 21 | 41 |
| PL 2019 | 58 | 15 | 15 | 34 | 92 | 88 | 55 | 18 | 35.2 | 16 | 44.2 | 34.8 |
| PL 2020 | 29.2 | 48.6 | 25.2 | 14.2 | 33.6 | 95 | 52 | 43.2 | 40.8 | 122.4 | 11.2 | 57.8 |

Fig. 2 Average annual rainfall, Arad 2019-2020

Source: processed data from Arad Meteorological Station

In terms of rainfall, the multiannual average is 608 mm. The average rainfall during the experimental period was 16 l/mp in October and in spring only 15 l/mp in April. In terms of climate, the 2019-2020 agricultural year in the microarea where the field experiment was conducted is characterized as warmer than normal years and drier in the cold season and early spring, but with rainfall in the second part of spring and early summer.

## RESULTS AND DISCUSSIONS

### Influence of N, P and K fertilizers on wheat yield (kg/ha) in 2019

From Table 1, the F-test and analysis of variance shows that:

PK-factor A fertilizers and N-factor B doses have a very significant action on wheat yield.

The interaction of the two experimental factors AxB, have distinctly significant action. (ORMAN, 1982)

Table1.

Significance of N,P and K fertilizer application differences on wheat yield (kg/ha), 2019

| **Source of variation** | **SSP [SP]** | Grades of freedom | **Weighted sum of squares [$s^2$]** | Test F | | meaning |
|---|---|---|---|---|---|---|
| | | | | value | p | |
| PK | 4.892347E+06 | 4 | 1.223087E+06 | 20.44 | 0.000000 | *** |
| N | 5.740806E+06 | 4 | 1.435201E+06 | 23.99 | 0.000000 | *** |
| PK*N | 2.410883E+06 | 16 | 1.506802E+05 | 2.52 | 0.003855 | ** |
| Error | 4.487440E+06 | 75 | 5.983253E+04 | | | |
| Total | 1.753148E+07 | | | | | |

Significance for test F:ns $p>0.05$; * $p\leq0.05$; ** $p\leq0.01$;*** $p\leq0.001$
Factor A - P and K: $p<0.001$
Factor B- N dose: $p<0.001$
AxB- chemical fertiliser interaction with PK*N: $p<0.01$

Table 2.

Influence of phosphorus and potassium fertilization on wheat yield (kg/ha) obtained in 2019

| **Factor PK** | **yield** | | **Dif. kg/ha** | **meaning** |
|---|---|---|---|---|
| | **kg/ha** | **%** | | |
| **V1 – control (unfertilized)-P0K0** | **4690** | **100** | **mt** | |
| V2 – fertilized with -P40K0 | 4522 | 96.4 | -168 | 0 |
| V3 – fertilized with -P80K0 | 4850 | 103.4 | 160 | * |
| V4 – fertilized with -P40K40 | 5143 | 109.6 | 452 | *** |
| V5 – fertilized with -P80K80 | 5011 | 106.8 | 321 | *** |
| **DL 5% = 154 kg DL 1% = 204 DL 0.1% = 265** | | | | |

Compared to the unfertilized variant - P0K0 control a1, the following increases were obtained as shown in Table 2 , as follows:

- at P40K0 and P80K0 dose levels, a significant increase was recorded. It should be noted that at the P40K0 dose, a yield loss of 168 kg/ha is obtained. At the P80K0 dose the yield obtained exceeds the control by 160 kg/ha.

- By applying the P40K40 and P80K80 doses, the increase is assured to be very significant. The yield obtained at the two dose levels exceeds the control by a very significant 10% and 7% respectively. The difference in yield is 452 kg/ha and 321 kg/ha respectively compared to the control, very significant differences. (MARINESCU et all, 1984)

Table 3.

Influence of nitrogen fertilization on wheat yield (kg/ha) obtained in 2019

| **Factor N** | **yield** | | **Dif.** | **meaning** |
|---|---|---|---|---|
| | **kg/ha** | **%** | | |
| **V1 – control (unfertilized)-N0** | **4377** | **100.0** | **mt** | |
| V2 – fertilized with -N30 | 4862 | 111.1 | 485 | *** |
| V3 – fertilized with -N60 | 4961 | 113.3 | 584 | *** |
| V4 – fertilized with -N90 | 4982 | 113.8 | 605 | *** |
| V5 – fertilized with -N120 | 5033 | 115.0 | 656 | *** |
| **DL 5% = 154 kg DL 1% = 204 DL 0.1% = 265** | | | | |

From the table 3, it appears that very significant increases were obtained irrespective of the nitrogen dose used compared to the control b1[N0]. Yield gains ranged from 485 - 656 kg/ha. Each dose of nitrogen outperformed the control with increases between 11% - 15%.

Table 4.

Wheat yield results (kg/ha) under fertilizer interaction with P, K and N in 2019

| **Factor A** | **Factor B** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **a1-P0K0** | | | **a2-P40K0** | | | **a3-P80K0** | | | **a4-P40K40** | | | **a5-P80K80** | | |
| | yield | Dif. | Smf | yield | Dif. | Smf | yield | Dif. | Smf | yield | Dif. | Smf | yield | Dif. | Smf |
| **b1 – N0** | 4285 | mt | | 4226 | -59 | ns | 4051 | -234 | ns | 4751 | 466 | ** | 4572 | 287 | ns |
| b2 – N30 | 4485 | 200 | ns | 4336 | 51 | ns | 5206 | 921 | *** | 5010 | 725 | *** | 5270 | 985 | *** |
| b3 – N60 | 4774 | 489 | ** | 4666 | 381 | * | 4875 | 590 | ** | 5421 | 1136 | *** | 5070 | 785 | *** |
| b4 – N90 | 4867 | 582 | ** | 4600 | 315 | ns | 5039 | 754 | *** | 5191 | 906 | *** | 5215 | 930 | *** |
| b5 – N120 | 5040 | 755 | *** | 4779 | 494 | ** | 5080 | 795 | *** | 5340 | 1055 | *** | 4927 | 642 | *** |
| | **DL 5% = 344 kg DL 1% = 457 DL 0.1% = 592** | | | | | | | | | | | | | | |

The interaction of fertilizers with N, P and potassium is shown in Table 4, where we have:

- the highest yields were obtained on P40K40 variant, yields ranging from 466 -1136 kg/ha, yields statistically assured from distinctly significant P40K40N0 to highly significant at the other N rates, compared to the control P0K0N0 [a1b1];

- on P80K80, a non-significant increase of 287 kg/ha was recorded, P80K80N0, the rest of the increases were very significant and ranged between 642-985 kg.

-on P80K0 agroforestry, an insignificant increase was obtained by the contribution of P80K0N0, the rest of the increases are:

-distinctly significant at the N60 rate -590 kg/ha;

-very significant at the N30, N90 and N120 dose levels, with increases ranging from 754 kg - 921 kg/ha.

- P0K0 variant, resulted in an insignificant increase at N30 -200 kg/ha, the remaining increases are:

-distinctly significant by applying the two rates of N60 -489 kg/ha and N90-582 kg/ha.

-very significant at the highest applied rate of N120 -755 kg/ha. (MIHOC, 1980)

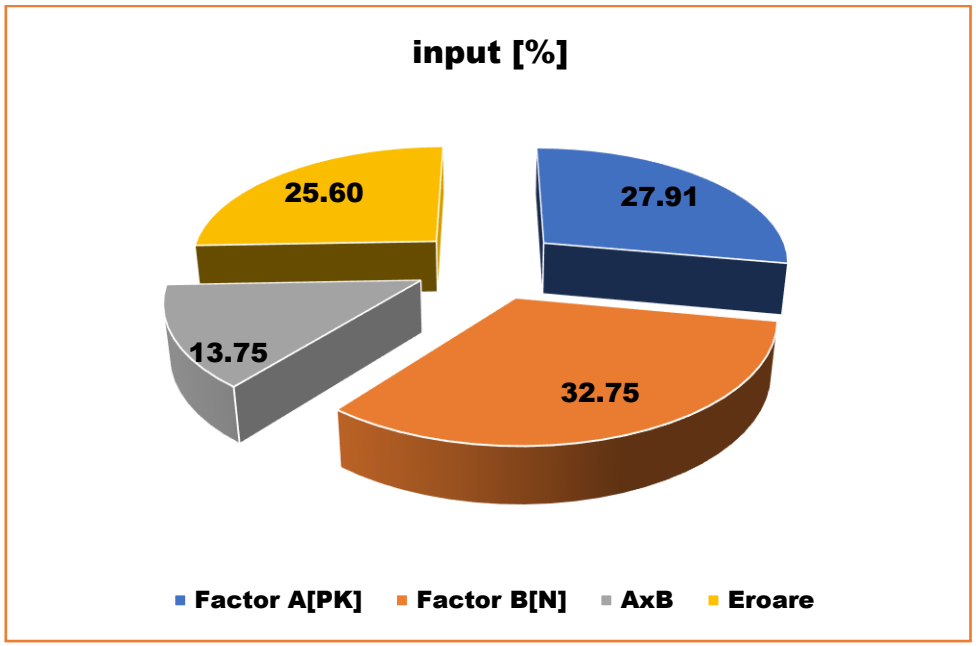



Figure 3. Contribution of factors and fertilisation interaction with P,K and N

From the data presented in Fig. 3, it is shown that phosphorus and potassium fertilizers contribute 27.91% of the yield and nitrogen fertilizers contribute 32.75% and the interaction of experimental factors 13.75%. (BAGHINSCHI, 1979)

**Multiple linear correlations and elasticity coefficients on wheat yield achieved as a function of climatic factors (temperature, precipitation) and P, K and N fertilization.**

Table 4.

Table for examining regression coefficients

| | Beta | Std.Err. of Beta | B [regression coef] | Std.Err. of B | t(294) | p-level | semnific |
|---|---|---|---|---|---|---|---|
| Intercept | | | -10023.3 | 760.8600 | -13.1737 | 0.000000 | |
| $^0$C | 0.275010 | 0.029191 | **640.1** | 67.9421 | 9.4211 | 0.000000 | *** |
| Pp | 0.814286 | 0.029191 | **23.7** | 0.8496 | 27.8951 | 0.000000 | *** |
| dose P | 0.041824 | 0.033026 | 2.2 | 1.7173 | 1.2664 | 0.206375 | ns |
| dose K | 0.034216 | 0.033026 | 1.7 | 1.6064 | 1.0360 | 0.301038 | ns |
| dose N | 0.079965 | 0.029191 | 2.9 | 1.0709 | 2.7394 | 0.006532 | ** |

**Table**

R = 0.87*** ; $R^2$ = 0.75

According to the t-test, it follows that all regression coefficients are statistically assured from distinct to highly significant, except the coefficients for P and K, which are not statistically assured.

Table 5.

Table of variances for examination of multiple correlation

According to the F-test the linear relationship between climatic factors- $^0$C, Pp and

| Source of variation | SPA | Grades of freedom (Gl) | Varianța $s^2$ | F(5, 294) | | |
|---|---|---|---|---|---|---|
| | | | | value | p-level | Semnific |
| Regress. | 544707826 | 5 | 108941565 | 175.9108 | 0.00 | *** |
| Residual | 182074228 | 294 | 619300 | | | |
| Total | 726782054 | | | | | |

fertilization with P, K, N, and yield is statistically assured. This relationship is highly significant. That is, the influence of temperature, precipitation (Pp) and fertilisation with P, K and N on yield is highly significant.The tabular value F0.01 ; 5 ; 294 = 3.11, is much lower than the value of F calculated from empirical data, Fcal = 175.9108, so the hypothesis that the regression between yield, $^0$C , Pp, P, K and N is linear is accepted.( ANDREI et. All)

Table 6.

Partial elasticity coefficients for the regression equation for wheat yield as a function of climatic factors ($^0$C, Pp) and fertilization with P, K and N

| Independent variable | **Regression coef** | **average [independent variable ]** | **yield [variable dependent] average [kg]** | | **coef elasticity** |
|---|---|---|---|---|---|
| **$^0$C** | **640.1** | 10.040 | 5642.213 | | **1.13900** |
| **Pp** | **23.7** | 376.333 | | | **1.58072** |
| **P** | 2.2 | 48.000 | | | 0.01850 |
| **K** | 1.7 | 24.000 | | | 0.00708 |
| **N** | 2.9 | 60.000 | | | 0.03120 |

E1 = 1.139, coefficient of elasticity of factor x1 [0C]. When increasing the temperature level by 1 percent, the yield increases by 1.14%.
E2 = 1.58072, coefficient of elasticity of factor x2 - Pp. When Pp is increased by 1%, production increases on average by 1.58%.
E3= = 0.0185, coefficient of elasticity of factor x3 - dose P. When increasing dose P by 1%, production increases on average by 0.02%.
E4= 0.00708, elasticity coefficient of factor x4 - dose K. When increasing the K dose by 1%, the yield increases on average by 0.007%.
E5 = 0.0312 elasticity coefficient of factor x5 - dose N. When increasing the dose N by 1 percentage point, the yield increases by 0.03%.

## CONCLUSIONS

In conclusion we can formulate the following recommendations: on the two agri-fonds fertilized with P40K40 and P80K80 fertilizers we obtained yield increases between 321-452kg/ha, both differences being statistically assured as very significant. At the P80K0 dose level, the yield increase is only statistically significant compared to the control. Wheat yield obtained was determined by nitrogen fertilizer application by difference from the control variant as follows: N30-485kg/ha, N60-584kg/ha, N90605kg/ha and N120kg/ha, at all four rates the differences are statistically assured as highly significant. (CIUCU, 1971)

With reference to the influence of climatic factors the greatest influence is had by the variable precipitation (Pp), followed by temperature, and N fertilizer has the greatest influence, followed by P-dose, K-dose according to the table of elasticity coefficients.

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