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PhD THESIS ABSTRACT

RESEARCH ON THE INFLUENCE OF VARIETY AND AGRICULTURAL TECHNOLOGY APLLIED ON CULINARY AND TECHNOLOGICAL QUALITY OF POTATO

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INTRODUCTION

Potato culture is one of the most important and common culture in the world, after wheat, maize and rice. From the total surface worldwide, in Europe are cultivated 51.4%, in Asia 33.8%, in North America 4.5%, in South America 5.5%, in Africa 4.5% and in Oceania 0.3%. Currently areawise, the potato is ranked thirteenth, and after the total accomplished production is ranked fourth after corn, wheat and rice. It is positioned second after cereals (DRAICA, 1996; 1999 cited by IANOŞI, 2002).

Globaly, potato crop areas have increased essentialy by the contribution of China, India and the developing countries from Africa and Asia (20 mil. ha in 2009), while in the European Union crop areas have decreased, still correlated with an increase in average production (35.7 t/ha in 2010) (CHIRU and OLTEANU, 2013).

Overall in Romanian agriculture, potato occupies between 1.4-3.1% of the arable area, respectively 228.000-300.000 hectares, achieving an average production of 12-13 t/ha, which is approximately 80% of the worldwide average production, but it is 3-4 times lower than the average production accomplished in countries like the Netherlands, Denmark, England, France, Germany, USA, etc. (Ianoşi, 2002).

Potato culture has a great potential of production, which can be achieved if ecological and technological conditions are ensured. Maintaining the culinary and technological qualities of the potato destined for consumption, for industry or for seeds, for a longer period of time after harvesting it is main purpose of all undertaken actions in the domain of potato (DONESCU et al., 2002).

Doctoral dissertation „Research on the Influence of Variety and Agricultural Technology Apllied on Culinary and Technological Quality of Potato" presents the results of the studies with the following aim: highlighting the qualitative and quantitative modifications of the production for two potato varieties, following differeciated base fertilization.

Researches took place between 2013 and 2015 in the experimental fields, laboratories and storage deposits of the National Institute of Research and Developement for Potato and Sugar Beet Brasov as well as in the laboratories of the University of Agricultural Science and Veterinary Medicine Cluj-Napoca.

Elaborating the present doctoral thesis was possible with a large collaboration and I want to give many thans to everyone who brought their contribution to it.

Many thanks for Mr. Prof. Dr. Ing. DUDA M. Marcel, scientific coordinator of the current doctoral thesis, for the collaboration on the elaboration of the doctoral thesis during the three years of doctoral studies.

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I give thanks to the administration board of the National Institute of Research and Developement for Potato and Sugar Beet Brasov, for the moral support and for the materials.

Many thanks to my family for the moral support and to all those who helped me while I was working on the doctoral thesis.

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CHAPTER 1.
HISTORY AND IMPORTANCE OF POTATO INDUSTRY

This chapter contains a brief presentation of the potato culture history from its origins to the present times and also the importance and evolution of this culture on global and national scale.

CHAPTER 2.
THE POTATO QUALITY DEFINITION AND THE FACTORS THAT INFLUENCE THE POTATO YIELD AND TUBERS QUALITY

In Chapter 2 of this thesis the term of quality potato is defined, term that brings together all the characteristics (properties) of the potato that makes it usable for all purposes of use. By appreciating and determinating these characteristics (properties), depending on the direction of revaluation, one can establishe the physical quality, culinary, technological and nutritional value of potato tubers. Factors that condition the production and the quality of potato tubers are presented in the second part of this chapter. These factors are biological, ecological and agrotechnical, between them is a strong interdependence. In conditions of using corresponding genetic material and ensuring favorable ecological requirements of the potato crop and application of culture technology, with the necessary technical endowment, one cand expect to obtain high yields and good quality, corresponding to the desired capitalization directions.

CHAPTER 3.
STATE OF THE ART OF POTATO QUALITY

Bibliographic studies have allowed realization of Chapter 3 that includes a presentation of the current state of researches on potato quality, with references to researches performed worldwide as well as on national level.

CHAPTER 4.
RESEARCH GOALS, BIOLOGICAL MATERIAL AND RESEARCH METHODS

4.1 OBJECTIVES AND ACTIVITIES OF RESEARCH

The purpose of researches was to assess the quantitative and qualitative modifications in production for two potato varieties, Christian and Roclas, after differentiated basic fertilization.

The main objective of the researches is achieving superior valuation of qualitative potential of potato varieties through fertilization. At the same time, our aim is to reduce the negative effects of unfavorable environmental conditions on the quality of tubers under climate change.

In the researches we looked for the following results:

♦ Determining the effects of the doses and reports of base fertilization with NPK over production and tubers quality for Christian and Roclas varieties, cultivated for different purposes of use.

♦ Improving methodology of assessment and determination of culinary quality and technological indicators, observation standardization and measurements.

♦ Researching the evolution of culinary quality and technological indicators at the end of the storage period for tubers coming from cultivation varieties in different agro-technical conditions.

Research conducted in the two years of study, 2013-2014 and 2014-2015 took place in the experimental field, cold store and laboratory of technology from N.I.R.D.P.S.B. Brasov as well as the laboratories of the U.A.S.V.M. Cluj-Napoca. Data from this study were subjected to processing and statistical analysis.

4.2. RESEARCH METHODS IN THE FIELD

Choosing of variances and observations proposed for field experimentation were made based on the knowledge acquired in the domain of fertilization, on a black earth soil from Brasov and according to current practices of fertilization in the region. In experimentation we

propose levels of fertilization and different NPK reports, for Roclas and Christian varieties, created at N.I.R.D.P.S.B. Brasov.

The chosen levels of nitrogen fertilization, of 100 and 200 kg N/ha are situated at the lower and upper limit of OSPA Braşov recommendations valid for autumn potato crops. These doses are recommended for production of 20 t/ha and 40 t/ha under non- irrigated conditions.

The variants were made with two complex fertilizers given before planting: C15-15-15, for NPK report of 1:1:1 and C5:10:22, supplemented with ammonium nitrate through which was realized NPK 1:0.9:2 report.

Researches are based on polifactorial experience by type 2A * 2B * 2 C * 4R with following factors and experimental graduations:

- Factor A – varity - a1. Christian
  - a2. Roclas.
- Factor B – NPK report of fertilization: - b1. 1:1:1 from C 15 :15 :15
  - b2. 1:0,9:2 from C 5:10:22 + ammonium nitrate.
- Factor C – nitrogen fertilization: - c1. 100 kg N/ha
  - c2. 200 kg N/ha.

The production obtained in the two experimental years was kept in cold storage of NIRDPSB Brasov, for about 180 days at a temperature of 3-4^{o}C.

Research methods in the field included observations and determinations during vegetation and harvest. Thus in the two years of study, we followed the growth dynamics of potato plants, production accumulation and starch content of tubers.

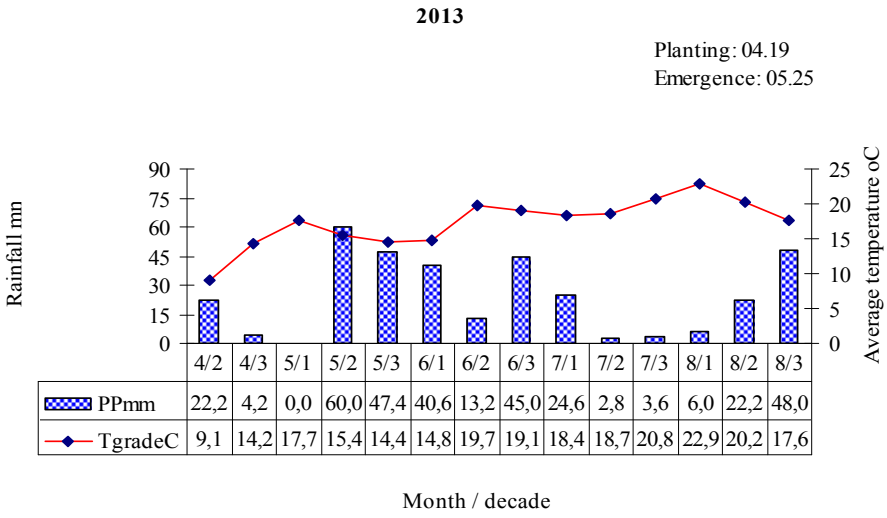
Alongside, noninvasive measurements were made, in dynamics, for determining the level of leaf chlorophyll using the portable device: Chlorophyll Meter SPAD 502 and measurements relating vegetation index NDVI (N*ormalized* D*ifference* V*egetation* I*ndices*).

At harvest we made qualitative and quantitative measurements of tubers production, on fraction size.

The experiment was done in Braşov on black earth soil in a non-irrigated crop, studied during 2013-2014. The research was conducted in two years with very different growth

conditions in terms of climate. During the observations, we followed decadal average temperatures and the precipitation amount.

In 2013 planting was done in the second decade of April (fig. 4.1). Once planted in April and early May, rainfall was reduced. Starting with May, rainfalls in each decade were frequent until the beginning of July. Thermohydric conditions of this period favored the emergence and growth of lush foliage. Decades two and three in July and early August were particularly dry. Due to the lack of rainfall and high temperatures foliage could no longer support itself, photosynthetic activity going into decline since the first decade of August and plants dried on an accelerated basis.



	4/2	4/3	5/1	5/2	5/3	6/1	6/2	6/3	7/1	7/2	7/3	8/1	8/2	8/3
PPmm	22,2	4,2	0,0	60,0	47,4	40,6	13,2	45,0	24,6	2,8	3,6	6,0	22,2	48,0
TgradeC	9,1	14,2	17,7	15,4	14,4	14,8	19,7	19,1	18,4	18,7	20,8	22,9	20,2	17,6

Figure 4.1. Average temperatures and decadal rainfall amount during the observation period in 2013

Climatic conditions in 2014 allowed planting in the first decade of April (fig.4.2). Thermohydric conditions in 2014 were very favorable for the development of potato plants by the end of July. Also, the high frequency of days with precipitation and high temperatures favored the more sensitive varieties (Christian) to develop infection with late blight. High temperatures and low rainfall in August led to plant maturation and vegetation stopping in mid-late and mid early varieties.

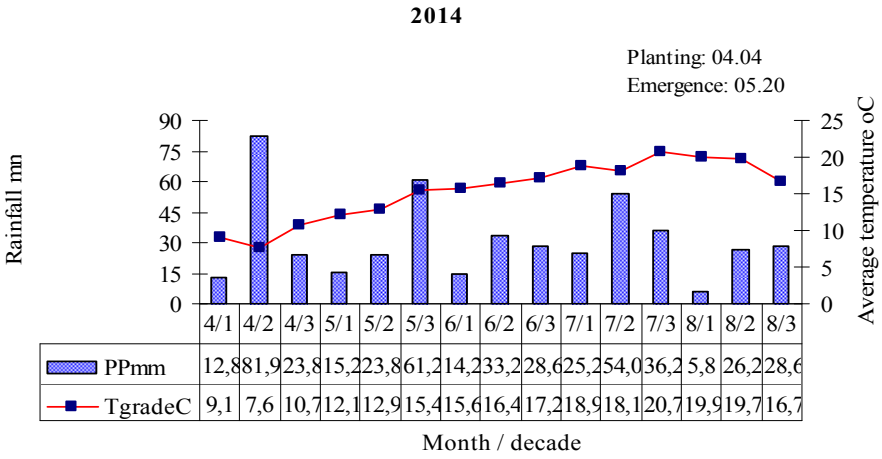


Figure 4. 2. Average temperatures and the amounth of decadal rainfall during the observation period in 2014

4.3 RESEARCH METHODS IN LABORATORY

Research methods in laboratory included analysis, qualitative and quantitative determinations designed for tubers using purpose. This permits multicriterial qualitative characterization of production from the studied fertilization variants.

After harvesting and before introducing tubers in storage into cold store, determinations wew made on experimental variations and repetitions, regarding tuber starch content, using the Polikeit balance. Also we determined the dry matter content of tubers by drying them in an oven at 105 ° C for 4 hours.

To establish the class usage of the tubers, first their culinary quality was determined, by sensorial appreciation, made with a panel of tasters using Lugt and Goodijk method (1959) and using the scheme for appreciation of potato culinary quality (CONSTANTINESCU, 1969, MUREŞAN, 1999).

We determined the pretability for processing into chips. Thus for each experimental variant and for the repetition we obtained chips by roasting potato rondelles at 160-170^{o}C and we calculated their efficiency during cleaning, mechanical processing and chips yield. After

that we gave notes for chips color, using a standardized color scale for chips quality evaluation, using notes from 1 to 9 (1 = dark color; 9 = light color).

Tubers content, from experimental variants, in sugars (glucose, fructose, maltose, sucrose) was determined by the chromatographic method using Shimadzu HPLC system.

For determining the evolution of some culinary quality and technological indicators at the end the storage period for 180 days at 3-4 ^{o}C, tubers coming from experimental variants were subjected to a new set of tests and analyzes of the dry matter content, starch and sugars, as well as the pretability for processing into chips.

4.4 STATISTICAL ANALYSIS OF DATA

Statistical analysis of obtained data was done using the statistical software package MSTAT-C, a tool for planning, management and statistical processing of data from the experimental field. The program allows concomitant comparison of many variables (NISSEN, 1983). For statistical analysis with ANOVA, Duncan test, Pearson correlations and regressions of measurements made in dynamic field and laboratory analyzes we used SPSS program (HUZSVAI, 2012).

CHAPTER 5.
THE RESULTS OF NPK FERTILIZATION EFFECTS ON PLANTS GROWTH DINAMICS AND STARCH TUBERS CONTENT

5.1 THE NPK FERTILIZATION EFFECTS ON PLANTS GROWTH DINAMICS

In the two years of study, 2013-2014, we followed the growth dynamics of potato plants, accumulation of production and that of starch content of the tubers (BĂRĂSCU şi colab., 2015). We performed 5 and 6 harvests in dynamic, for each variant of fertilization, beginning on the 25th day after plant springing in 2013 and on the 22nd day after plant springing in 2014.

Structure of biomass components calculated for each experimental variant, comparative in the two years for Christian and Roclas varieties is shown in figure 5.1. and figure 5.2.

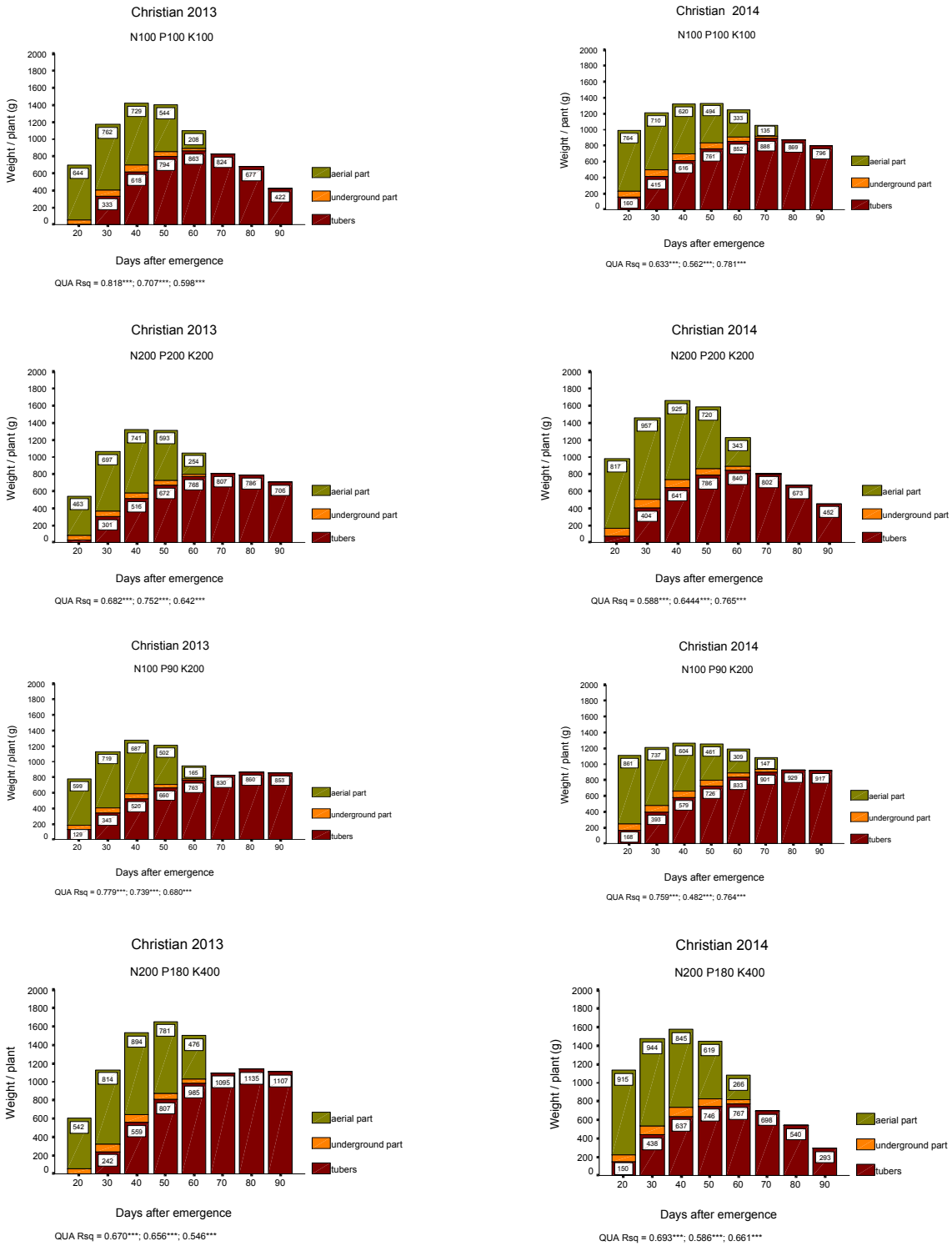


Fig 5.1. Dynamics of biomass components on fertilization variants of Christian variety 2013-2014

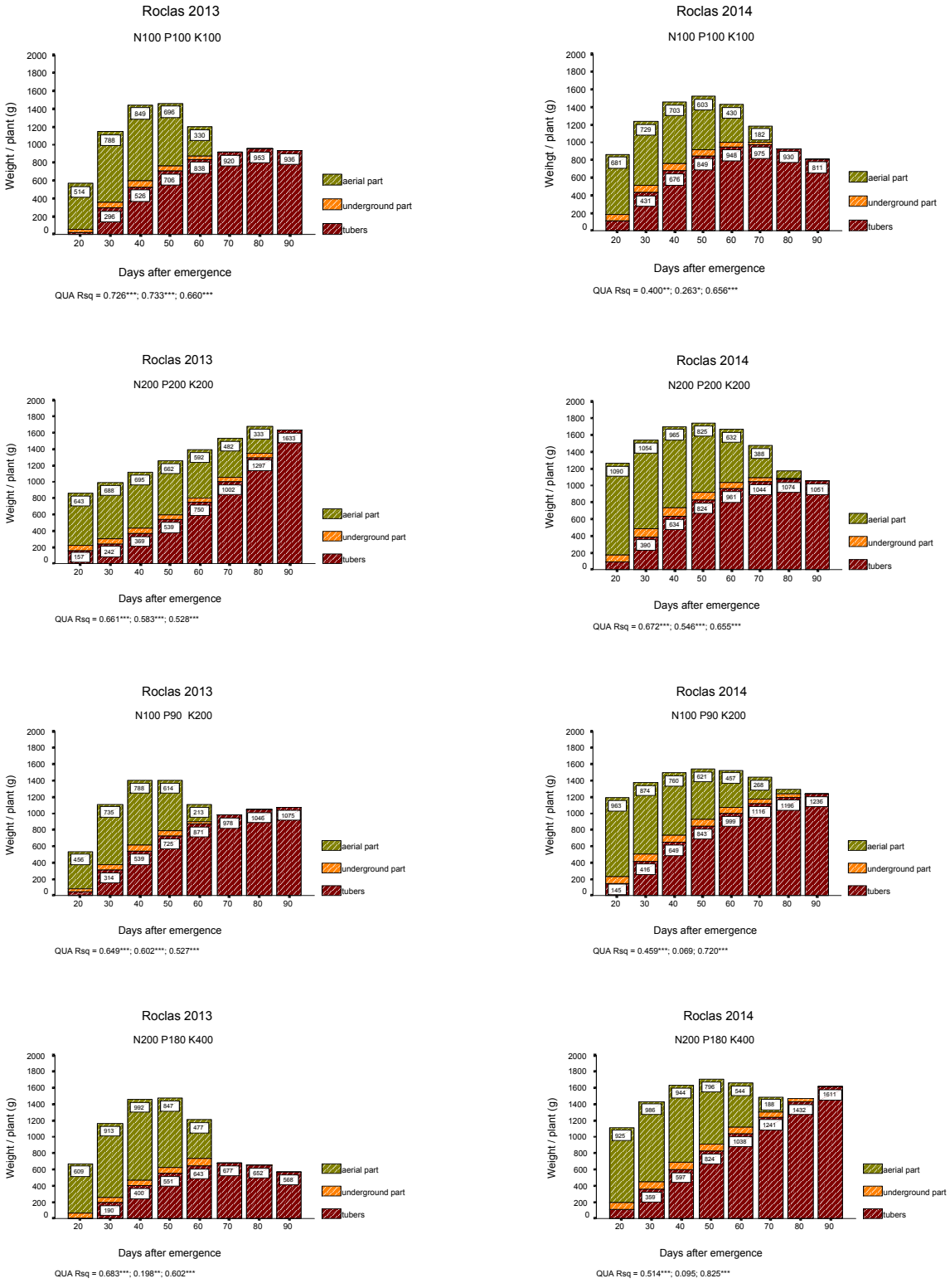


Fig 5.2. Dynamics of biomass components on fertilization variants of Roclas variety 2013-2014

In 2013 is ascertained in Christian variety the presence of foliage up untill 60-70 days of vegetation valid for all variants of fertilization. The accumulation of production continues for variants with favorable NPK in potassium reports. Fertilization with 200 kg/ha nitrogen on both reports NPK determined excessive growth of foliage, which, after 70 days of vegetation crashed, followed by the resorption of the accumulated production.

On variants with doses of 100 kg/ha nitrogen the foliage not being so developed was maintained for up to 80 days of vegetation and production still had a growth trend.

In 2013 for roclas variety dynamics of biomass components was similar to the christian variety, except variant N200:P200:K200. Year 2014 was more favorable from the thermohydric point of view for all variants so the foliage is maintained up to 90 days of vegetation, except variant N100:P100K. Maintaining foliage has led to higher production due to prolonged accumulation.

5.2. THE NPK FERTILIZATION EFFECTS OF STARCH TUBERS DINAMICS

Figure 5.3 presents second degree regressions in the dynamics of starch percentage in potato tubers derived from experimental variants during the observation period.

Through estimated curves, differences of concentration are observed for all studied factors. Besides the effect of the thermohydric conditions in the two years of study starch concentration of experimental variants were influenced by variety and fertilization variants. In the driest conditions in 2013, the tubers of Christian variety, for all variants have a high starch content compared to 2014, a year with higher moisture. The decrease was more pronounced for variants with high doses of nitrogen in particular variant N200:P180:K400.

In the two years, for Roclas variety, the maximum level of starch was recorded at the variant N100:P100:K100. Decrease of the starch content due to variations in fertilizations with higher doses of N were for both reports NPK.

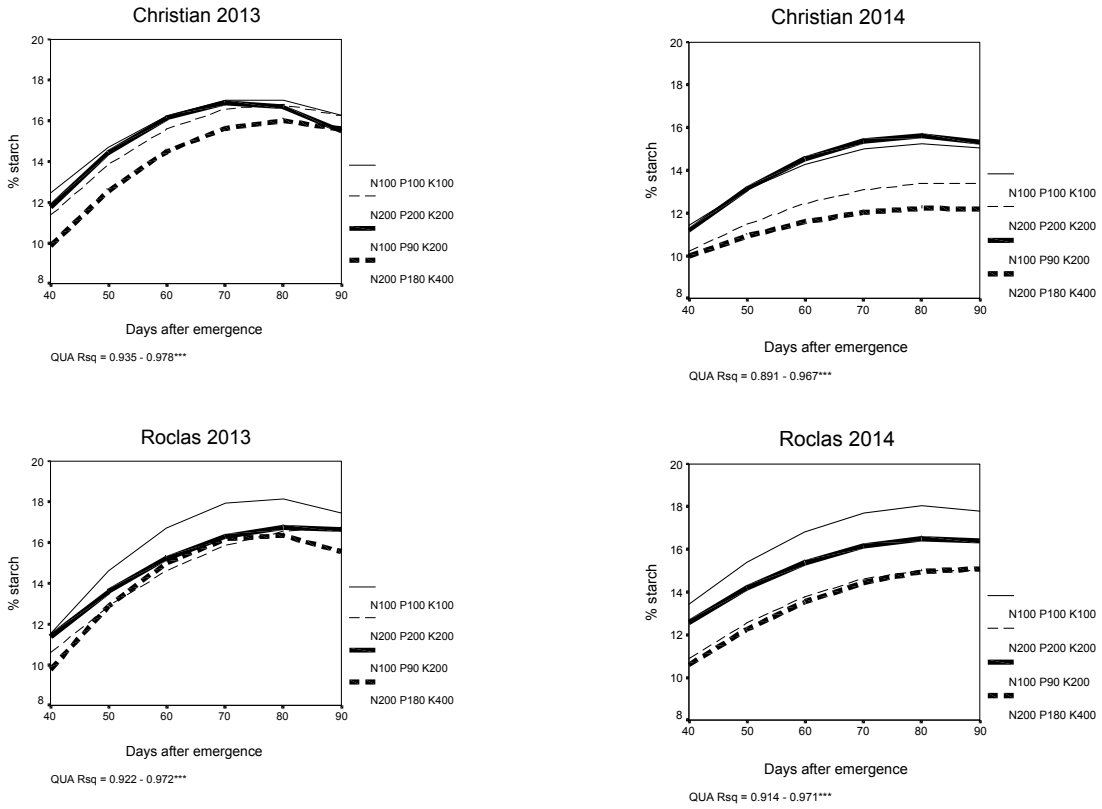


Fig. 5.3. Dynamics tuber starch content at different fertilization variants

5.3. THE NPK FERTILIZATION EFFECTS ON SPAD VALUES DURING VEGETATION PERIOD

Researches on the dynamic of values SPAD and NDVI on the foliage of potato plants were made with the purpose of specifying the moments of potato plants growth, in which these measurements can bring significant information about vegetation status and the nitrogen supply of the plant on different variants of fertilization.

In 2013 on average, SPAD values were significantly influenced by nitrogen supply, the maine influence of NPK reports being insignificant (fig. 5.4.).

For both varieties variants with different doses of nitrogen could be separated statistically by SPAD values throughout the observation period in NPK ratio 1:0.9:2.

The separation of nitrogen levels of the variants ratio NPK 1:1:1 was possible for all observations only at Roclas variety, while for Christian variety only after July 16.

On climatic conditions from 2014 statistical separation of SPAD values between variants with N200 as against N100 regardless of the report NPK was carried out during June 23-August 5.

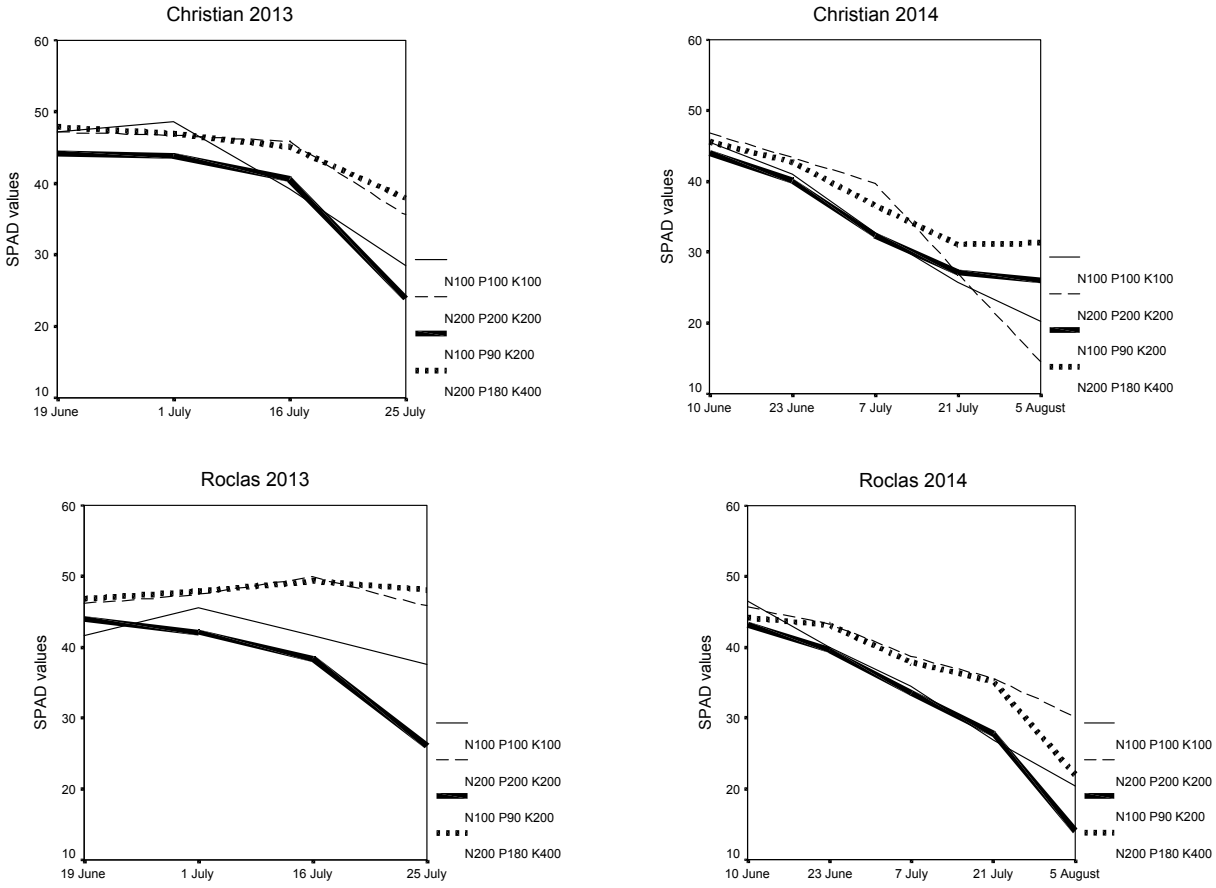


Fig. 5.4. Dynamics of average SPAD values - Christian and Roclas, Braşov 2013-2014

5.4 THE NPK FERTILIZATION EFFECTS OF NDVI VALUES OF VEGETATION PERIOD

Vegetation state of the plants indicated by the NDVI measurements is significantly different during the measurements done in 2013 and 2014 on the two varietis (fig. 5.5.).

At the beginning of vegetation period NDVI values, masured on fertilization variant plants are close and maintain the high level until mid July in both years.

At the end of the observation period, after differentiated loosing of foliage, NDVI values of the plants from the fertilisation variant have statistically separated depending on variety andnfertilisation variant.

Highest NDVI values have been registered at the end of vegetation period for Roclas variety in 2013 as well as 2014 at fertilization variant N200:P200:K200 (75.4 and 74.4). For Christian variety NDVI maximum values at the end of vegetation period has registered different variations N100:P100:K100 (69.6) in 2013 and in 2014 variance N200:P180:K400 (77.8).

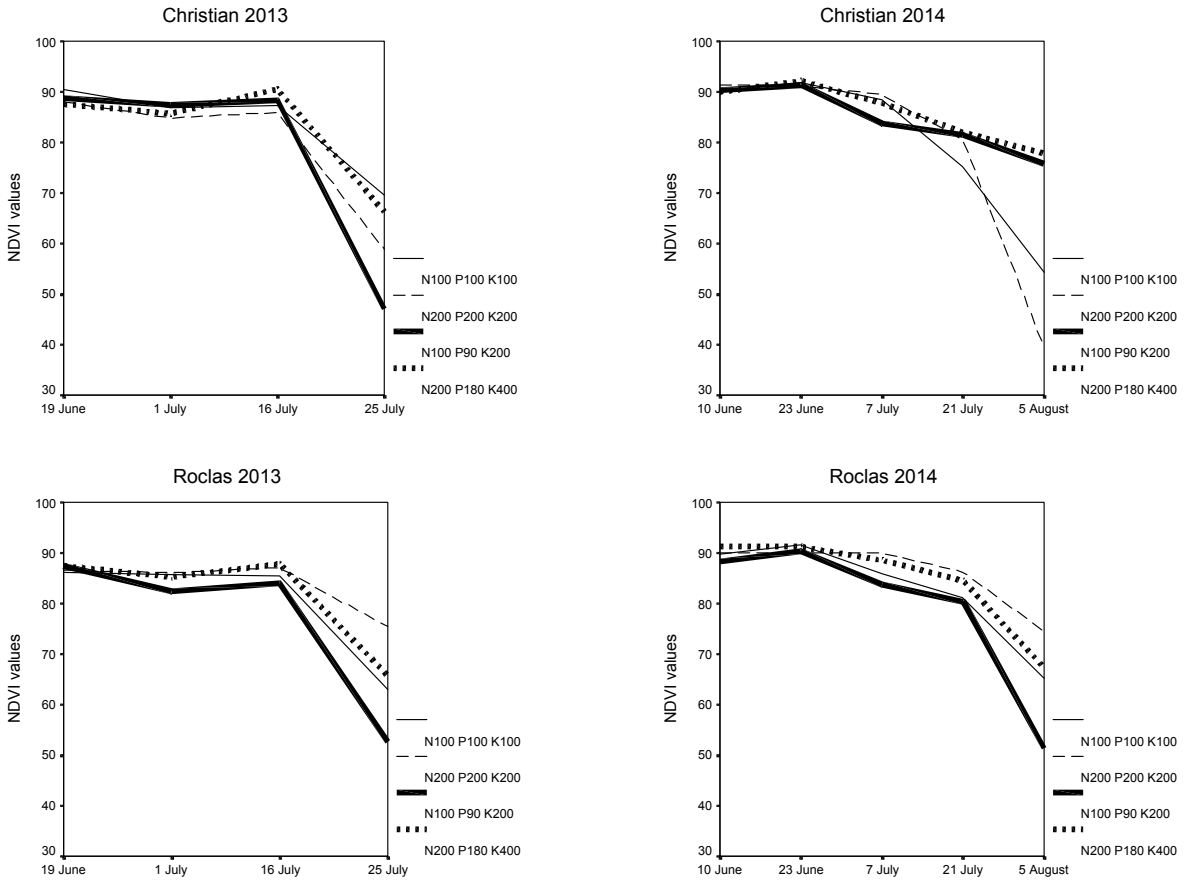


Fig.5.5. Dynamics of average NDVI values - Christian and Roclas, Braşov 2013-2014

Valorile NDVI cele mai ridicate, la sfârşitul perioadei de vegetaţie, au fost înregistrate la soiul Roclas, atât în 2013 cât şi în 2014, la varianta de fertilizare N200:P200:K200 (75.4 şi 74.4). La soiul Christian valorile NDVI maxime, la sfârşitul perioadei de vegetaţie au fost

înregistrate la variante diferite N100:P100:K100 (69.6) în anul 2013, iar în anul 2014 la varianta N200:P180:K400 (77.8).

5.5. CORRELATION BETWEEN PLANTS MEASUREMENTS AND SPAD AND NDVI VALUES

Comparing the correlation coefficients between the measurements of plant and SPAD values it is found that year 2014 had more favorable climate for potato growth and has significant correlations number which is higher than year 2013 (tab. 5.1.).

Tab. 5.1.

The correlation coefficients for dynamics of potato plants fertilization variants and dynamics SPAD values in 2013 - 2014 in Brasov

Measurement	U.M.	SPAD values			
		2013		2014	
		Christian	Roclas	Christian	Roclas
Main stems	No/ plant	0.108	0.142	0.546**	0.436**
Plant height	cm	0.205	0.194	-0.399**	-0.135
Median length leaf	cm	0.686**	0.203	0.263*	0.346**
Number of tubers	No/ plant	-0.068	-0.266*	0.262*	0.061
Aerial part weight	g / plant	0.805**	0.565**	0.724**	0.752**
Underground part weight	g / plant	0.750**	0.482**	0.549**	0.658**
Tubers weight	g / plant	-0.452**	-0.407**	-0.801**	-0.682**
Total biomass weight	g / plant	0.252*	0.131	0.271*	0.198

In both years components of biomass determined at harvesting in dynamics were significantly correlated with SPAD values measured on plants from fertilization variations (tab.5.2.).

During the two years the correlations of plant measurements with NDVI values measured on plants, joined from NPK variants with some distinctions, were similar with correlations of SPAD values.

Correlations components of biomass with NDVI values of plants were statistically assured (p = 0.01%) in both years for both varieties.

The number of mean stems was significantly correlated with NDVI values only in 2014. There was no correlation between plant height and NDVI measured values on adjacent plants. Correlations between length, median leaf and NDVI were very close for both varieties in 2013 and in 2014 for Christian variety. The correlation between the number of tubers per plant and NDVI values was significant only for Christian variety in 2014.

Tab. 5.2.

The correlation coefficients for dynamics of potato plants fertilization variants and dynamics NDVI values in 2013 - 2014 in Brasov

Measurement	U.M.	NDVI values			
		2013		2014	
		Christian	Roclas	Christian	Roclas
Main stems	No / plant	0.156	0.052	0.743**	0.379**
Plant height	cm	0.007	-0.63	-0.210	0.006
Median length leaf	cm	0.667**	0.506**	0.405**	0.155
Number of tubers	No / plant	0.029	-0.214	0.226*	0.024
Aerial part weight	g / plant	0.728**	0.694**	0.728**	0.732**
Underground part weight	g / plant	0.761**	0.254*	0.642**	0.744**
Tubers weight	g / plant	-0.369**	0.516**	-0.704**	-0.585**
Total biomass weight	g / plant	0.269*	0.11	0.419**	0.311**

CHAPTER 6.

RESULTS CONCERNING BASIC NPK FERTILIZATION EFFECTS OVER QUANTITY AND QUALITY OF THE FINAL PRODUCTION TUBERS

6.1. THE NPK FERTILIZATION EFFECTS ON TUBERS YIELD

Very different growing conditions in the two experimental years determined big differences on production from year to year for all factors studied and for all interactions (table 6.1.). On average, in 2013, in experience was achieved a production of 26.9 t/ha, while in 2014 the average experimental production was 47 t/ha. The varieties differed significantly between them, production of Roclas variety being on average 39.2 t/ha superior to 34.8 t/ha achieved by Christian variety.

On average, over two years, NPK report with higher potassium level did not significantly affect the total production of Christian and Roclas varieties. It was observed weak growth in production of tubers diameter bigger than 60 mm due tuber yields of 35-60 mm.

The only significant effect of increasing the dose of nitrogen from 100 to 200 kg/ha was registered to 1:0.9:2 report which in 2013 caused decreased of total production from 30.2 t/ha to 22.4 t/ha. In 2014 by increasing nitrogen level, total production of tubers increased from 45.6 t/ha to 57.4 t/ha.

Tab. 6.1.

Effects of fertilization with different NPK reports and doses to the total yield varieties Christian and Roclas (Brasov 2013-2014)

Variety	Ratio NPK	N kg/ha	Total yield t/ha		
			2013	2014	**Media**
Christian	1:1:1	100	26.3 fg	44.3 cde	**35.3 abc**
		200	24.6 fg	45.3 bcd	**35.0 bc**
	1:0.9:2	100	29.2 fg	43.7 de	**36.4 abc**
		200	26.4 fg	38.4 e	**32.4 c**
Roclas	1:1:1	100	29.4 f	50.5 bc	**39.9 a**
		200	27.3 fg	51.0 b	**39.2 ab**
	1:0.9:2	100	30.2 f	45.6 bcd	**37.9 ab**
		200	22.4 g	57.4 a	**39.9 a**
Averages NPK ratio	**1:1:1**		**26.9 b**	**47.8 a**	**37.3**
	1:0.9:2		**27.1 b**	**46.2 a**	**36.6**
Averages doses	**100**		**28.8 b**	**46.0 a**	**37.4**
	200		**25.2 c**	**48.0 a**	**36.6**
Averages varieties	**Christian**		**26.6 c**	**42.9 b**	**34.8 -**
	Roclas		**27.3 c**	**51.1 a**	**39.2 ***
Averages years			**26.9**	**47.0 ***	

DL (year) 5% = 6.2 t/ha
DL (variety) 5% = 3.6 t/ha
DL (report) 5% = 2.1 t/ha
DL (dose N) 5% = 2.1 t/ha
LDS (year * variety) 5%= 5.1 t/ha
LDS (year *report) 5% =3.0 t/ha
LDS (year * dose) 5% = 3.0 t/ha
LDS (year * variety * report *dose) 5% = 6.0 t/ha

In 2013, due to rainfall deficit during accumulation period of production and high doses of nitrogen, it is found a small decrease of production, for all variants of fertilization and both varieties. In the year with favorable hydrothermic conditions (2014), except high potassium ratio for Christian variety we can observe tendencies of increases in production statistically insignificant.

In 2013 significant structural changes due to fertilization on researched varieties were not found. Production structure in both varieties significantly changed by increasing production of large tubers in favorable year, 2014 (fig. 6.1.). In this year for Roclas variety it is noted that production increasing was possible with the fraction's 35-60 mm contribution.

NPK report and the dosage of nitrogen did not influence in any year the small tuber production.

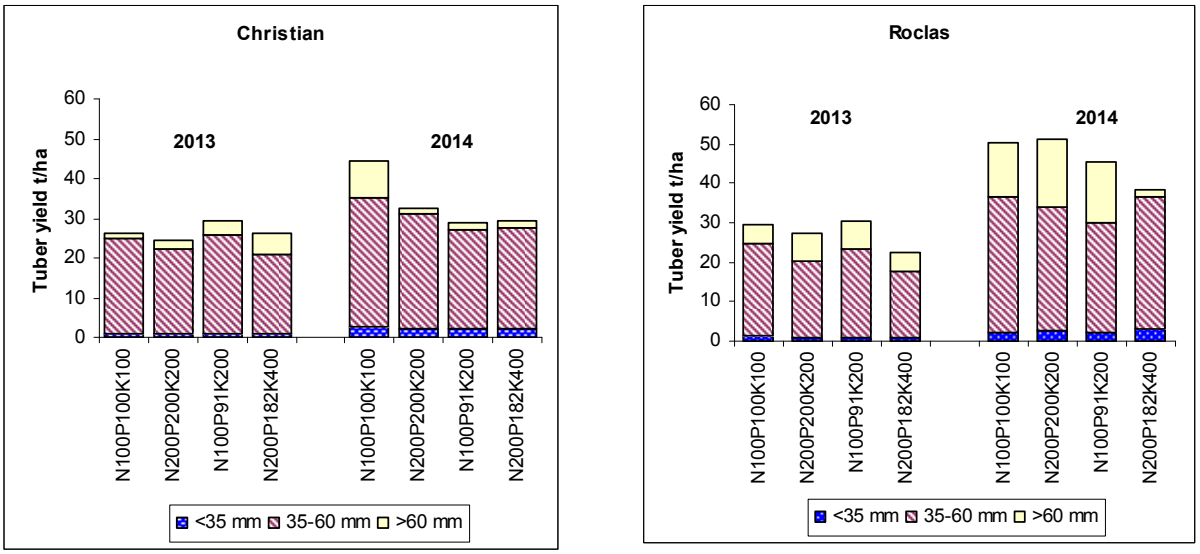


Fig. 6. 1.Yield size structure of Christian and Roclas varieties for different variants of fertilization

6.2. THE NPK FERTILIZATION EFFECTS OF STARCH CONTENT, DRY MATTER AND REDUCING SUGAR

On average, for the two experimental years, varieties differed in starch content, dry matter and reducing sugar before storage (Table 6.2.). In Christian variety there were recorded on average lower levels of starch, dry matter and reducing sugar (15.0%, 23.9% şi 0.18%) compared to the Roclas variety (16.5%, 24.8% şi 0.34%). Standard deviations indicate moderate variation of values calculated for starch and dry matter and high variation for reducing sugar.

Fertilization 1:0.9:2 as against report 1:1:1 had significant effect on reducing the starch content for both varieties, while the reducing of dry matter content is significant only for Christian variety. For both varieties there were no observed significant differences for reducing sugar. The NPK higher report and nitrogen dose of 200 kg/ha determined reduction of starch in the two years, on average 0.9-1.2%

Increasing dose of fertilizer from N100 to N200 determined decrease in starch content for both varieties, with no significant differences for dry matter. Although with increasing nitrogen level it can be noted decreases of the reducing sugar content; decrease was significant only for Christian variety.

Tab. 6.2.

Mean effects of different fertilization with NPK ratio and dozes on tubers starch, dry matter and reducing sugar content from Christian and Roclas varieties (Braşov 2013-2014)

Ratio NPK	Dozes N Kg/ha	Starch %		Dry matter %		Reducing sugar %	
		Christian	Roclas	Christian	Roclas	Christian	Roclas
1:1:1	100	16.1 a	17.7 a	24.6 a	25.5 a	0.21 ab	0.41 a
	200	14.9 ab	16.2 bc	24.5 a	24.8 a	0.10 b	0.28 a
1:0.9:2	100	15.2 ab	16.5 b	23.7 a	24.7 a	0.29 a	0.33 a
	200	13.9 b	15.6 c	23.0 a	24.2 a	0.13 b	0.32 a
Means							
Ratio 1:1:1		15.5	17.0	24.6	25.1	0.16	0.35
Ratio 1:0.9:2		14.6 o	16.1 o	23.3 o	24.4	0.21	0.33
N 100 kg/ha		15.7	17.1	24.1	25.1	0.25	0.37
N 200 kg/ha		14.4 o	15.9 o	23.8	24.5	0.12 o	0.30
Mean		15.0	16.5	23.9	24.8	0.18	0.34
Standard deviation		1.5	1.0	1.9	1.9	0.16	0.21
LDS(variante)5%		2.0%	1.0%	2.7%	2.8%	0.21%	0.31%
DL (raport) 5%		1.1%	0.7%	1.3%	1.4%	0.11%	0.15%
DL (doze N) 5%		1.0%	0.6%	1.4%	1.4%	0.10%	0.15%

As a result of multiple comparisons between variants using Duncan test it is noted that the lowest level of fertilization N100 NPK 1:1:1 ratio on which is recorded the highest starch content, 16.1% for Christian variety and 17.7% for Roclas variety, while for variant with the highest level of fertilization N200 1:0.9:2 report, the starch content for the two varieties decreased to 13.9%, for Christian and 15.6% la Roclas.

On average fertilization variants were not significantly differentiated for the varieties researched, as regards dry matter content.

The average content of reducing sugar of variants studied presented significant differences only for Christian variety. To this variety, for both fertilization reports passing from N100 at N200 strongly reduced the content of reducing sugar (from 0.21% to 0.10% for NPK 1:1:1 and from 0.29% to 0.13% for NPK 1:0.9:2).

The content of starch, dry matter and reducing sugar of tubers was significantly influenced by growing conditions.

Due to the more favorable climatic conditions hydric and thermic, alongside with higher yields for Christian variety accumulation of starch in tubers was significantly lower (16.2% as against 13.9%) in 2014 toward 2013 (Figure 6.2.). On average, for Roclas variety, was maintained the high starch content from tubers, there are no significant differences between the two years (16.8% and 16.2%).

The decrease in starch content from tubers of Christian variety with increasing potassium ratio and nitrogen dose is more evident and statistically significant in 2014. For Roclas variety there is the same tendency, differences between variants in the two years are lower.

In the case of the dry matter content differences due to experimental years are stronger and are manifested mostly for dose N200 both at Christian as well as the Roclas (Figure 6.3.).

For reducing sugar from tubers were found significant differences between the two years for both varieties (Figure 6.4.). To all variants of fertilization the content level of reducing sugar was lower in 2013. Differences of reducing sugar content between the two years for Christian variety were lower (0.12% in 2013 towards 0.25% in 2014) and for Roclas variety were determined average values of 0.18% in 2013 towards 0.49% in 2014.

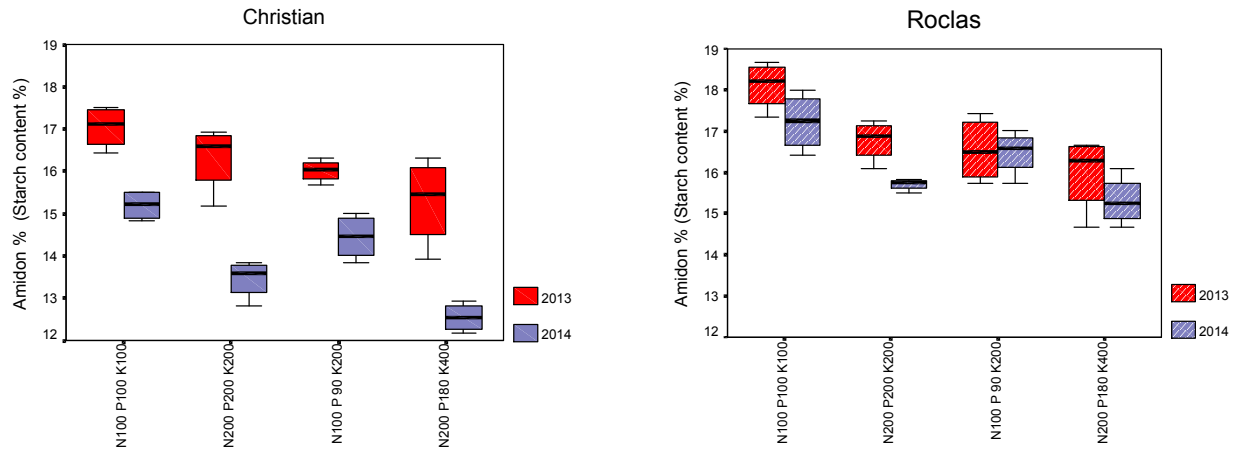


Fig. 6.2. Comparison of the average starch content of tubers for fertilization variants 2013-2014

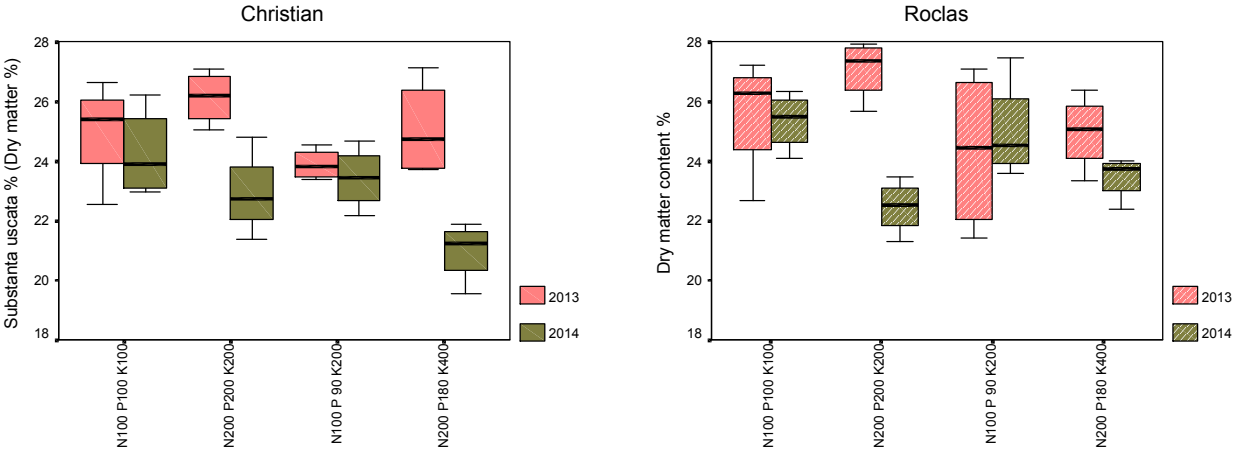


Fig. 6.3. Comparison of average dry matter content of tubers for fertilization variants 2013-2014

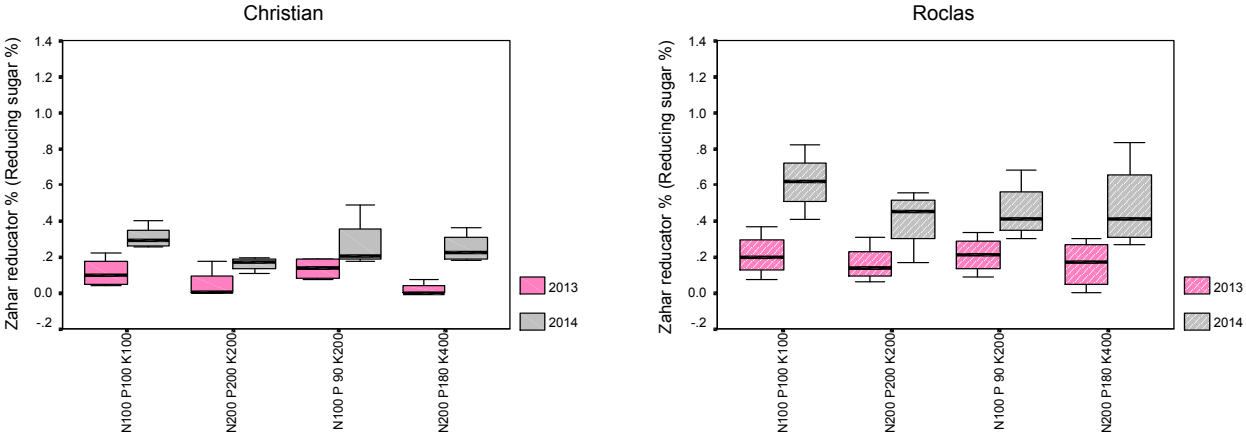


Fig. 6. 4. Comparison of average reducing sugar content of tubers for fertilization variants 2013-2014

For the two studied years, correlations were made between content of starch, dry matter and reducing sugar from tubers and total production from tubers. Pearson correlation coefficients for Christian and Roclas varieties are presented in Table 6.3.

Tab. 6.3.

Corelattion coefficients for total yield, starch, dry matter and reducing sugar content of tubers (2013-2014)

	Christian			Roclas		
	Starch	Dry matter	Reducing sugar	Starch	Dry matter	Reducing sugar
Starch	-	0.772**	-0.246	-	0.677**	-0.167
Dry matter	0.772**	-	-0.421*	0.677**	-	-0.331
Reducing sugar	-0.246	-0.421*	-	-0.044	-0.218	-
Total yield	-0.638**	-0.454**	0.488**	-0.315	-0.369*	0.689**
Yield >60mm	-0.720**	-0.449*	0.374*	-0.433*	-0.279	0.605**
Yield 35-60mm	-0.272	-0.278	0.439*	-0.135	-0.369*	0.633**
Yield <35mm	-0.564**	-0.383*	0.362*	-0.308	-0.453**	0.603**

For both varieties the correlation between content of starch and dry matter is positive and statistically assured (r = 0.772** for Christian and r = 0.677** for Roclas).

Correlations between reducing sugar, starch and dry matter for both varieties are negative. Only for Christian variety correlation between dry matter and reducing sugar content was statistically assured (r = -0.421*).

Correlations of total production with concentration of starch from tubers was significant for Christian variety (r = -0.638**). The sense of correlations indicates very strong decreases of starch content due production increases, especially in 2014.

Correlations between total production, production with tubers bigger than 60 mm with starch content and dry matter from tubers were negative and statistically assured, for Christian variety and for Roclas variety correlations were lower. Correlations of total production and productions on sizes with reducing sugar were for both varieties positive and statistically assured.

6.3 THE NPK FERTILIZATION EFFECTS ON TUBERS CONTENT OF SUGAR BEFORE STORAGE

The average content of fructose, glucose, sucrose, maltose and their correlations before storing tubers

In Table 6.4. are presented average effects of fertilization NPK on two experimental years over content of fructose, glucose, sucrose and maltose from tubers. For interpreting averages values we must take account of the very different level of vegetation period.

On average, during the two years, there were no significant differences in sugar content determined before storage, due to different NPK reports.

Tab. 6.4.

Mean effects of different fertilization with NPK ratio and dozes on tubers fructose, glucose, sucrose and maltose content from Christian and Roclas varieties (Brasov 2013-2014)

Ratio NPK	Dozes N Kg/ha	Fructose mg/100 g		Glucose mg/100 g		Sucrose mg/100 g		Maltose mg/100 g	
		Christian	Roclas	Christian	Roclas	Christian	Roclas	Christian	Roclas
1:1:1	100	44.5 ab	128.0a	164.4 ab	284.0 a	587.3 a	475.4 a	63.9 a	44.3a
	200	24.7 b	76.8 a	78.4 b	205.3 a	479.2 a	467.9 a	63.4 a	47.2 a
1:0.9:2	100	90.2 a	98.0 a	201.9 a	233.3 a	564.7 a	468.8 a	47.0 a	60.8 a
	200	38.5 b	98.9 a	94.3 ab	221.1 a	560.4 a	414.8 a	53.4 a	66.0 a
Means									
Ratio 1:1:1		34.6	102.4	121.4	244.7	533.2	471.7	63.6	45.8
Ratio 1:0.9:2		64.3	98.5	148.0	227.2	562.6	441.8	50.2	63.4
N 100 kg/ha		67.3	113.0	183.2	258.6	576.0	472.1	55.4	52.5
N 200 kg/ha		31.6 ^{o}	87.8	86.3 ^{o}	213.2	519.8	441.3	58.4	56.6
Mean		49.5	100.4	134.7	235.9	547.9	456.7	56.9	54.6
Standard deviation		50.1	57.4	112.3	155.8	276.5	229.9	30.7	40.3
LDS(variante)5%		47 mg	59 mg	108 mg	165 mg	295 mg	247 mg	32 mg	42 mg
DL (raport) 5%		35 mg	42 mg	82 mg	114 mg	60 mg	168 mg	27 mg	29 mg
DL (doze N) 5%		34 mg	41 mg	74 mg	113 mg	202 mg	168 mg	22 mg	30 mg

In Christian variety the level of nitrogen N200 kg/ha compared to N100 kg/ha had as effect a significant decrease in fructose content from 67.3 mg/100g to 31.6 mg/100g fresh

substance and of glucose content from 183.2 mg/100g to 86.3 mg/100g fresh substance. For Roclas variety, although there was observed the same tendency differences were not significant. The average content of the sucrose and maltose was not significantly influenced by nitrogen dose increasing.

In Figure 6.5. is presented the sugar contents on fertilization variants in the years 2013 and 2014, which have similar tendencies for the two varieties. In graphic is shown significantly higher levels of sugars, for all variants in 2014, compared to their level in 2013. This is due to different growth conditions in the two years. It is known that the production of tubers produced in years with hot and dry summers has a reducing sugar content lower than in the cooler years with wet summers (BEUKEMA, 1990).

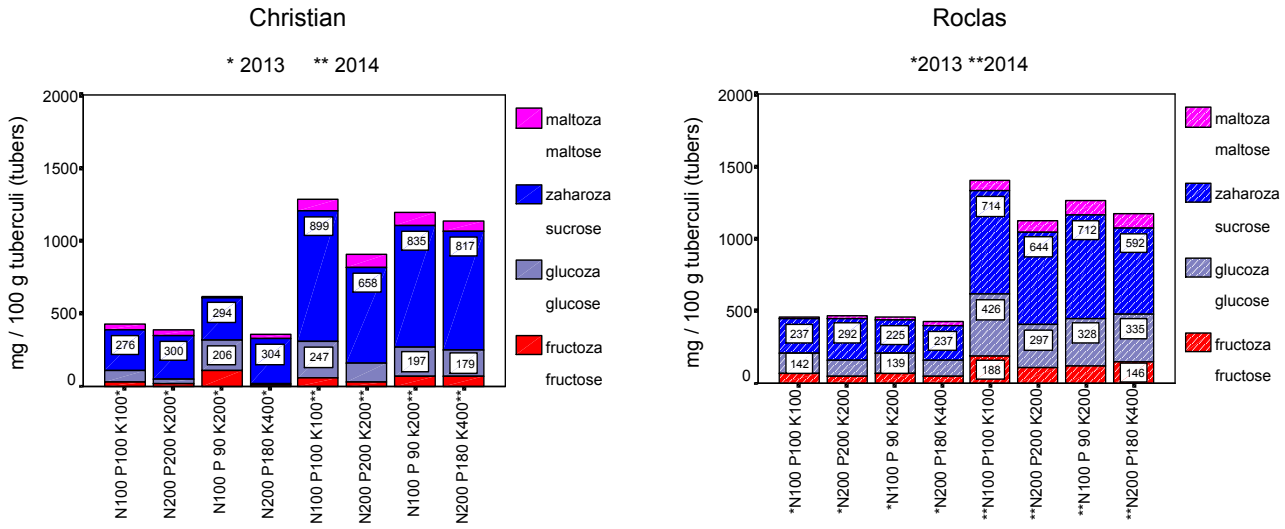


Fig. 6.5. Comparison of average tuber content of fructose, glucose, sucrose, maltose for the fertilization variants 2013-2014

As a result of multiple correlations for the variables: dry matter (DM), fructose, glucose, sucrose, maltose and total sugar (mg/100g fresh substance) made for Christian şi Roclas varieties from data of years 2013-2014 resulted correlation coefficients are given in Table 6.5.

The sense of the correlation coefficients of dry matter and sugars is negative for both varieties, differing by degrees of statistics assurance. For Christian variety sugars determined, except maltose significantly correlated with dry matter. For Roclas variety due to small differences in the dry matter of

the variants presented in subchapter 6.2.3, correlations with sugars are lower, the only significant correlation is that of the dry matter with fructose.

Regarding correlations between determined sugars, while for Roclas variety all the correlations between fructose, glucose, sucrose and maltose are distinct significant and positive, for Christian variety are significant only the relations between glucose, fructose and total sugar.

Tab. 6.5.

The correlation coefficients between dry matter (%) and sugar content (mg/100 g) of tubers before storing (2013 -2014)

	Christian						Roclas					
	DM	Fructose	Glucose	Sucrose	Maltose	Total sugar	DM	Fructose	Glucose	Sucrose	Maltose	Total sugar
DM	-	-0.405*	-0.407*	-0.495**	-0.285	-0.534**	-	-0.353*	-0.314	-0.252	-0.282	-0.319
Fructose	-0.405*	-	0.838**	0.236	0.004	0.529**	-0.353*	-	0.913**	0.702**	0.515**	0.879**
Glucose	-0.407*	0.838**	-	0.515**	0.305	0.773**	-0.314	0.913**	-	0.675**	0.510**	0.884**
Sucrose	-0.495**	0.236	0.515**	-	0.841**	0.939**	-0.252	0.702**	0.675**	-	0.793**	0.938**
Maltose	-0.285	0.004	0.305	0.841**	-	0.751**	-0.282	0.515**	0.510**	0.793**	-	0.763**
Total sugar	-0.534**	0.529**	0.773**	0.939**	0.751**	-	-0.319	0.879**	0.884**	0.938**	0.763**	-

6.4 THE NPK FERTILIZATION EFFECTS ON CULINARY QUALITY

Mean culinary quality traits and the corelations with tubers starch before storage

On average, over the two years 2013-2014, NPK reports effects on culinary quality traits of boiled tubers were different for the two varieties (Table 6.6). For Christian variety report is favorable to potassium, 1:0,9:2, had as result, obtaining tubers with consistency and lower mealiness. Variety Roclas at the same ratio, compared to NPK ratio 1: 1: 1 had a different behavior, less broken boiling, having a higher consistence and presenting a lower mealiness and higher moisture.

Tab. 6.6

The NPK fertilization effects on culinary quality– Braşov 2013 2014

Ratio NPK	Doze s N Kg/ha	Sensory appreciation of quality traits to boiling									
		Breaking at boiling		Consistence		Mealiness		Moisture		The structure of starch	
		Christian	Roclas	Christian	Roclas	Christian	Roclas	Christian	Roclas	Christian	Roclas
Interaction NPK report* dozes N											
1:1:1	100	1.6a	2.7a	2.0a	2.6a	1.9a	2.9a	2.1a	2.9a	1.7a	2.4a
	200	1.2b	2.0b	2.2a	2.1b	2.0a	2.3b	1.8a	2.2b	1.6a	2.0a
1:0.9:2	100	1.3ab	2.0b	2.3a	1.8b	2.2a	2.4b	2.2a	2.3b	1.7a	2.1a
	200	1.4ab	1.8b	2.1a	1.8b	2.2a	2.1b	2.1a	1.9b	1.6a	1.9a
Means											
Ratio 1:1:1		1.4	2.4	2.1	2.3	1.9	2.6	2.0	2.5	1.6	2.2
Ratio 1:0.9:2		1.3	1.9^{o}	2.2*	1.8^{o}	2.2*	2.2^{o}	2.2	2.1^{o}	1.6	2.0
N 100 kg/ha		1.4	2.4	2.2	2.2	2.1	2.6	2.2	2.6	1.7	2.2
N 200 kg/ha		1.3	1.9^{o}	2.1	2.0	2.1	2.2^{o}	2.0	2.0^{o}	1.6	1.9^{o}
Mean		1.3	2.1	2.2	2.1	2.1	2.4	2.1	2.3	1.6	2.1
Standard deviation		0.3	0.5	0.4	0.6	0.4	0.5	0.4	0.6	0.3	0.5
$DS_{(NPK)}$ 5%		0.5%	0.6%	0.7%	0.7%	0.6%	0.6%	0.5%	0.7%	0.4%	0.7%
$DL_{(Raport)}$ 5%		0.2%	0.3%	0.3%	0.4%	0.3%	0.4%	0.3%	0.4%	0.3%	0.3%
$DL_{(N)}$ 5%		0.2%	0.3%	0.3%	0.4%	0.3%	0.3%	0.3%	0.4%	0.2%	0.3%

Analyzing the average effects of nitrogen doses we found significant differences only for Roclas variety, to which with increasing nitrogen levels from N100 to N200 kg/ha,

boiled tubers qualities changes as follows: less crumbly, decreases mealiness, increase moisture and starch structure becomes finer.

Following Duncan test made for studied variants resulted that on average for two years, for Roclas variety tubers from variant with report NPK 1:1:1, with the lowest levels of fertilizer N100 it is breaking when boiling, consistency of the pulp is reduced, increases mealiness and decreases moisture from the rest variants.

Comparison of correlation coefficients for starch content and notes of appreciation of culinary quality traits of tubers boiled from the two experimental years is shown in Table 6.7.

There is positive significant correlation for both years for most of the pairs of variables. Thus, starch significantly correlated positively with notes of appreciation for breaking at boiling (0.433* and 0.769**), moisture (0.451** and 0.373*) and structure starch (0.405* and 0.660**).

Tab. 6.7.

Comparison of correlation coefficients between starch and notes of appreciation for culinary quality traits

	Year	Starch	Breaking at boiling	Consistence	Mealiness	Moisture	Structure of starch	Class
Dry matter	2013							
	2014							
Starch	2013	1						
	2014	1						
Breaking at boiling	2013	0.443*	1					
	2014	0.769**	1					
Consistence	2013	0.234	0.406*	1				
	2014	-0.182	0.028	1				
Mealiness	2013	0.229	0.636**	0.604**	1			
	2014	0.274	0.488**	0.526**	1			
Moisture	2013	0.451**	0.575**	0.460**	0.659**	1		
	2014	0.373*	0.360*	0.030	0.610**	1		
Structure of starch	2013	0.405*	0.678**	0.340	0.594**	0.354*	1	
	2014	0.660**	0.729**	0.245	0.691**	0.583**	1	
Class	2013	0.439*	0.862**	0.711**	0.880**	0.761**	0.727**	1
	2014	0.513**	0.708**	0.497**	0.899**	0.705**	0.876**	1

N = 32

** Correlation is significant for 0.01

* Correlation is significant for 0.05

Appreciation notes for breaking at boiling are positively significantly correlated with mealiness (0.636** şi 0.488**), moisture (0.575** şi 0.360*) and structure of starch (0.678** and 0.729**). Correlations that are distinct, positive, significant are recorded and between the

notes and consistence and mealiness (0.604** şi 0.526**) and corelations between appreciation notes of mealiness with moisture (0.659** şi 0.610**) and structure of starch (0.594** şi 0.691**), respectively moisture notes with starch structure (0.354* şi 0.583**).

For interpreting correlations take into account the purposes of these appreciation notes for culinary quality traits of evaluation steps shown in Table 4.7 in Chapter 4.3.2. .

6.5 THE NPK FERTILIZATION EFFECTS ON TECHNOLOGICAL QUALITY – VARIETIES PRETABILITY FOR CHIPS

Average suitability for processing into chips and correlations between dry matter, starch, reducing sugar, efficiency to processing into chips and chips color before storing tubers 2013-2014

For the two years, on average, chips yield, did not significantly differentiate; also average note for chips color did not differentiate significantly for two varieties researched.

The effects of fertilization variants on performance and chips color due to different growth conditions are illustrated in comparison for the two varieties in Figures 6.6 and 6.7.

Level of tuber efficiency to processing into chips , coming from the studied variants differs stronger for Christian variety compared to Roclas variety, differentiation with similar trends in the two years of study.

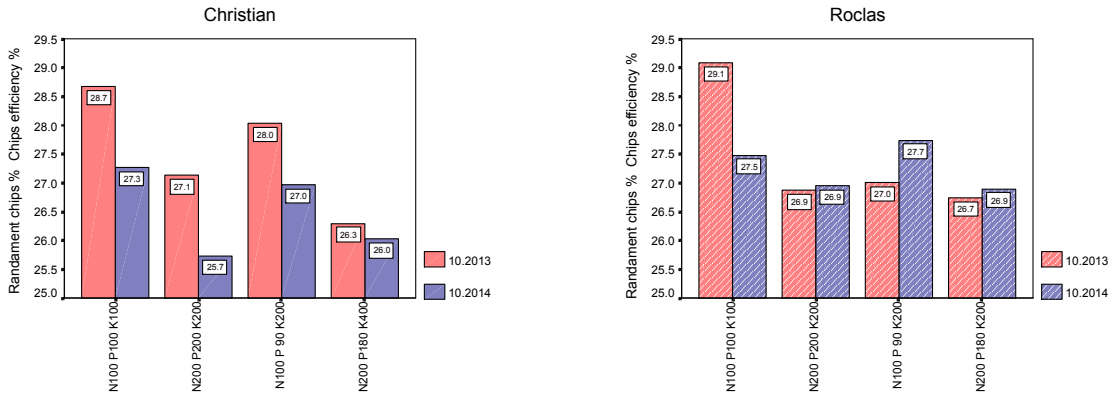


Fig. 6.6. Comparison of fertilization variants for chips yield before storage 2013-2014

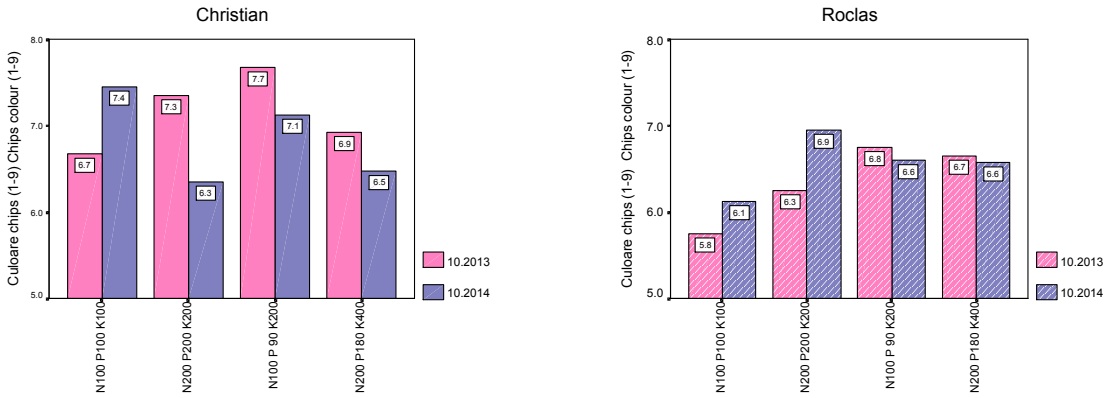


Fig. 6.7. Comparison of fertilization variants for chips color before storage 2013-2014

From graphs it can be seen the decrease of chips yield with increasing NPK ratio from 1:1:1 to 1:0.9:2, respectively with increasing nitrogen dose in combination of 100 to 200 kg N / ha. Notes for chips color have a decreasing trend, which indicates a darker chips color with increasing doses of nitrogen for variants with report 1:0.9:2 for both variety, in two experimental years.

Mean values for indicators of pretability for processing into chips on experimental cycle are presented in comparison for Christian and Roclas varieties in tab. 6.8.

Tab.6.8.

The coefficients for the correlations between dry matter, starch, reducing sugar, efficiency to processing into chips and color of chips before storage

	Variety	Dry matter	Starch	Reducing sugar	Efficiency to processing into chips	Color of chips
Dry matter	Christian	1				
	Roclas	1				
Starch	Christian	0.772**	1			
	Roclas	0.677**	1			
Reducing sugar	Christian	-0.421*	-0.246	1		
	Roclas	-0.331	-0.167	1		
Efficiency to processing into chips	Christian	0.406*	0.687**	0.232	1	
	Roclas	0.163	0.375*	0.181	1	
Color of chips	Christian	0.370*	0.420*	0.157	0.444*	1
	Roclas	-0.271	-0.381*	-0.069	0.125	1

N = 32
** Correlation is significant for 0.01
* Correlation is significant for 0.05

After studying the coefficients only Christian variety is established statistically significant positive correlations between dry matter from tubers and efficiency to processing into chips (0.406*) and between dry matter and notes of chips color (0.370*).

The starch content of the tuber is positive statistically assured correlated tubers efficiency to processing into chips, r = 0.687**, for Christian variety and r = 0.375* for Roclas variety. Correlations of starch content with notes of chips' color for two varieties had values of 0.420* and -0.381*.

No significant correlation was obtained between reducing sugar and color of chips tubers for data achieved in the years 2013-2014, before storage for studies varieties. The correlation between the efficiency to processing into chips and the color of chips was significant only for Christian variety (0.444*).

CHAPTER 7.
RESULTS REGARDING THE FERTILIZATION EFFECTS WITH NPK ON TUBER PRODUCTION QUALITY AFTER STORAGE PERIOD

7.1. THE EFFECTS OF FERTILIZATION ON THE AVERAGE STARCH CONTENT, DRY MATTER AND REDUCING SUGARS IN POTATO TUBERS AFTER STORAGE PERIOD

In table 7.1. are shown compared for the two varieties the different environmental effects of fertilization with different reports and doses of NPK on starch content, dry matter and reducing sugars in the tubers after a storage period of 180 days.

For both varieties is maintained the downward trend of starch content, dry matter and reducing sugar at nitrogen dose of 200 kg N/ha, compared to the dose of 100 kg N/ha, found before storage. But negative differences statistically significant were obtained only for Christian variety of starch and dry matter content.

At the end of the storage period, only for Christian variety was observed a significantly decrease to the starch content ratio 1:0.9:2 (15.73%) compared to the ratio of

1:1:1 (16.59%). Roclas variety has not significant differences in starch content after storage, between the two reports.

Experimental variants for both varieties at the end of storage period differed significantly among themselves after the Duncan test, for tuber starch content and dry matter. Significant differences between variants for reducing sugar was observed only at Roclas variety. For Christian variety the lowest content of starch and dry matter was registered at variant NPK ratio 1:0.9:2 and dose N200 kg/ha (14.89% and 23.10%, averaged over the two years).

Tab. 7.1.

Mean effects of fertilization with different NPK ratio and dozes on tubers starch, dry matter and reducing sugar content after storage period (Braşov 2014-2015)

Ratio NPK	Dozes N Kg/ha	Starch %		Dry matter %		Reducing sugar %	
		Christian	Roclas	Christian	Roclas	Christian	Roclas
1:1:1	100	17.00a	18.35a	24.75ab	26.73a	0.69a	0.81a
	200	16.17a	17.25bc	24.06ab	23.97b	0.58a	0.77ab
1:0.9:2	100	16.57a	18.02ab	25.08a	24.08b	0.60a	0.66ab
	200	14.89b	17.03c	23.10b	23.99b	0.60a	0.60b
Means							
Ratio 1:1:1		16.59	17.80	24.41	25.35	0.64	0.79
Ratio 1:0.9:2		15.73^{o}	17.53	24.09	24.04	0.60	0.63
N 100 kg/ha		16.79	18.18	24.92	25.41	0.65	0.73
N 200 kg/ha		15.53^{o}	17.14	23.58^{o}	23.98	0.59	0.68
Mean		16.16	17.66	24.25	24.69	0.62	0.71
Standard deviation		1.12	0.93	1.76	1.97	0.19	0.20
LDS(variants)5%		1.18%	1.16%	2.40%	2.39%	0.28%	0.27%
DL (ratio) 5%		0.75%	0.67%	1.28%	1.36%	0.14%	0.13%
DL (dozes N) 5%		0.67%	0.56%	1.19%	1.14%	0.14%	1.35%

For Roclas variety starch content was significantly reduced in both reports with increasing dose to N200 kg/ha (17.03%, 17.25%) and dry matter content was significantly higher than the rest of variants (26.7%) and was registered at variant NPK ratio 1:1:1 and nitrogen dose N100 kg/ha in parallel with a significantly higher content of reducing sugars (0.81%).

In figures 7.1, 7.2, 7.3 are illustrated in comparison for the two years, the average of starch, reducing sugar and dry matter from tubers of fertilization variants after the storage period at investigated varieties.

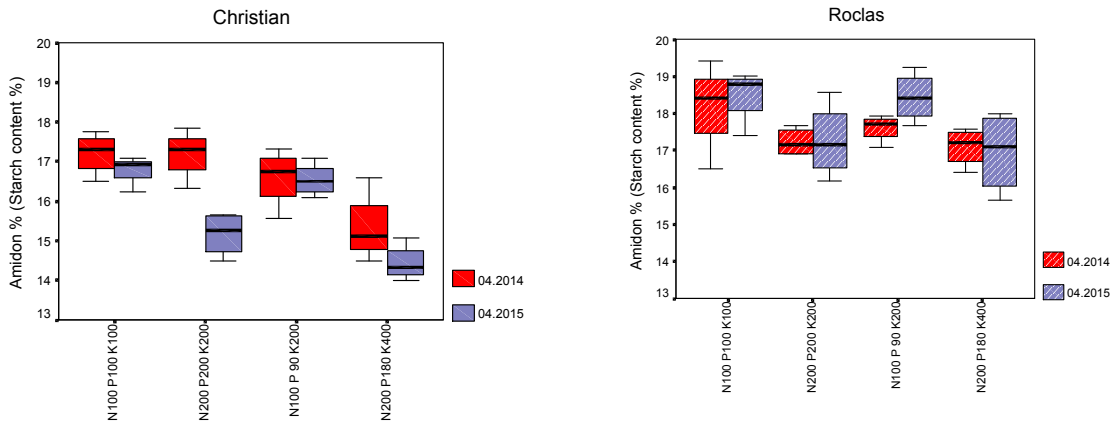


Fig. 7.1. Comparison of the average starch content of tubers for fertilization variants after storage period 2014-2015

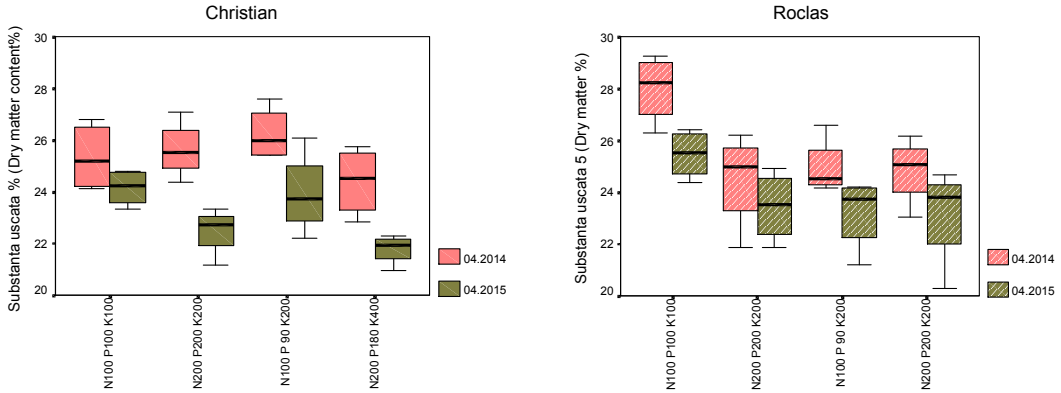


Fig. 7.2. Comparison of average dry matter content of tubers for fertilization variants after storage period 2014-2015

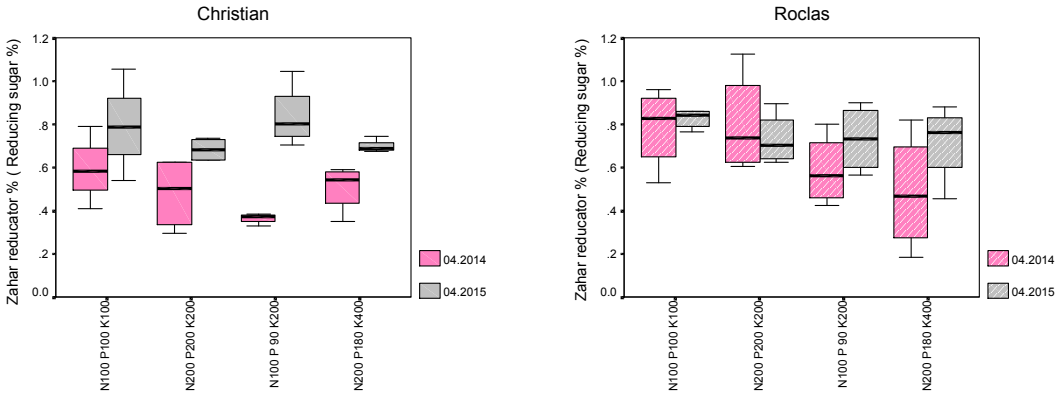


Fig. 7.3. Comparison of average reducing sugar content of tubers for fertilization variants after storage period 2014-2015

After correlating the content of starch, dry matter and reducing sugars at the end of the storage period (tab. 7.2.) it is found that after the storage period, similar with the

correlations before storage period, correlation coefficients between starch and dry matter are positive, significantly distinct for Christian variety (0.729 **) and signifcant for Roclas variety (0.446 *). Between reducing sugar content and the content of starch there are no significant correlations, and the correlation between reducing sugar an dry matter is negative and only distinctly significant for Christian variety.

Tab. 7.2.
Corelattion coefficients for starch, dry matter and reducing sugar content of tubers after storage period (2014-2015)

	Christian			Roclas		
	Starch	Dry matter	Reducing sugar	Starch	Dry matter	Reducing sugar
Starch	-	0.729**	-0.184	-	0.446*	0.031
Dry matter	0.729**	-	-0.513**	0.446*	-	-0.178
Reducing sugar	-0.184	-0.513**	-	0.031	-0.178	-

7.2. THE EFFECTS OF FERTILIZATION ON SUGAR CONTENT IN POTATO TUBERS AFTER THE STORAGE PERIOD.

After the ANOVA calculations performed on varieties for sugar test results conducted on fresh tuber at the end of storage periods (2014-2015) were not found, on average, significant differences due to different doses of nitrogen (tab. 7.3.).

NPK reports studied had a significant effect only on the content of fructose and glucose, for Roclas variety, to which increasing the level of potassium in NPK ratio of 1:1 1 to 1:0.9:2 caused a significant decrease in the fructose content from 387 mg/100 g to 318 mg/100 g, and the glucose from 399 mg/100 g to 311 mg/100 g.

Between fertilization variants studied only for the fructose content were found significant differences in Roclas variety. At this variety the fructose content of tubers at variant fertilized with NPK ratio 1:1:1 and nitrogen rate of 100 kg/ha is significantly higher, 399 mg/100 g, compared with NPK ratio 1:0.9:2 and nitrogen rate of 200 kg nitrogen/ha with an average of 299 mg/100 g fructose.

Correlation coefficients performed for dry matter and sugars from tubers at the end of the storage period show differences between varieties investigated (tab.7.4). Christian

variety, where the effects of growing conditions and fertilization variants were more pronounced all the correlations between dry matter and sugars were statistically significant.

Tab. 7. 3.

Mean effects of fertilization with different NPK ratio and dozes on tubers fructose, glucose, sucrose and maltose content after the storage period (Braşov 2014-2015)

Ratio NPK	Dozes N Kg/ha	Fructose mg/100 g		Glucose mg/100 g		Sucrose mg/100 g		Maltose mg/100 g	
		Christian	Roclas	Christian	Roclas	Christian	Roclas	Christian	Roclas
1:1:1	100	377a	399a	315a	407a	198a	166a	34a	23a
	200	318a	375ab	264a	391a	230a	197a	30a	38a
1:0.9:2	100	312a	337ab	293a	322a	202a	223a	38a	38a
	200	346a	299b	257a	300a	197a	240a	41a	43a
Means									
Ratio 1:1:1		347	387	289	399	214	181	32	31
Ratio 1:0.9:2		329	318^{O}	274	311^{O}	199	231	39	41
N 100 kg/ha		344	368	303	365	200	194	36	31
N 200 kg/ha		332	337	260	345	213	218	35	41
Mean		338	353	282	355	207	206	36	36
Ab.standard		86	83	113	121	71	118	18	22
LDS(variants)5%		124mg	111mg	168mg	171mg	105mg	173mg	27mg	32mg
DL (ratio) 5%		62mg	55mg	83mg	83mg	51mg	84mg	13mg	16mg
DL (dozes N) 5%		63mg	60mg	81mg	89mg	52mg	86mg	13mg	16mg

For Roclas variety, where the effects of the growth for the two years investigated and the effects of fertilization variants were weaker on the dry matter content and sugars, there were no significant correlations between dry matter content and sugar components from tubers. The correlation coefficients of fructose, glucose, sucrose, maltose and total sugar indicates status differences in which were the two varieties tubers at the time of analysis.

Tab. 7.4.

The correlation coefficients between dry matter (%) and sugar content (mg/100 g) of tubers after the storage period (2014 -2015)

	Christian						Roclas					
	DM	Fructose	Glucose	Sucrose	Maltose	Total sugar	DM	Fructose	Glucose	Sucrose	Maltose	Total sugar
DM	1	-0.522**	-0.477**	0.659**	0.577**	-0.272	1	0.016	-0.297	0.206	0.131	-0.043
Fructose	-0.522**	1	0.869**	-0.562**	-0.432*	0.889**	0.016	1	0.824**	-0.316	-0.128	0.814**
Glucose	-0.477**	0.869**	1	-0.624**	-0.603**	0.864**	-0.297	0.824**	1	-0.564**	-0.472**	0.642**
Sucrose	0.659**	-0.562**	-0.624**	1	0.717**	-0.230	0.206	-0.316	-0.564**	1	0.681**	0.281
Maltose	0.577**	-0.432*	-0.603**	0.717**	1	-0.238	0.131	-0.128	-0.472**	0.681**	1	0.198
Total sugar	-0.272	0.889**	0.864**	-0.230	-0.238	1	-0.043	0.814**	0.642**	0.218	0.198	1

7.3. THE NPK FERTILIZATION EFFECTS ON SUITABILITY FOR PROCESSING INTO CHIPS AND CORRELATIONS BETWEEN DRY MATTER, STARCH, REDUCING SUGAR, EFFICIENCY TO PROCESSING INTO CHIPS AND COLOR CHIPS AFTER THE STORAGE PERIOD

Analyzing, the two years in averege, the effects of fertilization on indicators of suitability for chips processing at the end of the storage period is found at the two varieties significant differences in different directions due to reports of fertilizing when yields cleaning and mechanical processing.

For Christian variety, the ratio 1:0.9:2 led to a significant increase in yield of cleaning and mechanic processing compared to a ratio of 1:1:1, while at Roclas variety the tubers resulting from fertilization with this ratio had significant yields lower. Fertilization with different NPK ratios did not cause significant differences in yield of chips and chips color. On average, in two years the different nitrogen rates did not lead to significant differences at the end of the storage period, on the indicators of suitability for chips processing.

Tab. 7.5.

Mean values for indicators of suitability for processing into chips after the storage period, Braşov 04.2014-04.2015

Ratio NPK	Dozes N Kg/ha	Efficiency to peeling %		Efficincy to mechanical processing %		Efficiency to processing into chips %		Note for chips color (1-9)	
		Christian	Roclas	Christian	Roclas	Christian	Roclas	Christian	Roclas
1:1:1	100	79.3b	83.1a	75.7c	80.6a	27.2a	28.1a	5.5a	5.1a
	200	81.0b	82.7a	77.9b	80.1a	27.2a	27.0a	5.7a	5.5a
1:0.9:2	100	83.1a	81.4a	80.6a	78.4b	29.1a	27.0a	6.2a	5.3a
	200	83.8a	81.2a	81.7a	78.5b	27.8a	27.0a	5.3a	5.2a
Means									
Ratio 1:1:1		80.2	82.9	76.8	80.4	27.2	27.6	5.6	5.3
Raport 1:0.9:2 Ratio 1:0.9:2		83.5 *	81.3 o	81.2 *	78.4 o	28.4	27.0	5.7	5.2
N 100 kg/ha		81.2	82.2	78.2	79.5	28.1	27.5	5.9	5.2
N 200 kg/ha		82.4	82.0	79.8	79.3	27.5	27.0	5.5	5.4
Mean		81.8	82.1	79.0	79.4	27.8	27.3	5.7	5.2
Standard deviation		2.5	2.1	3.1	1.8	1.9	1.2	1.0	0.8
LDS(variante)5%		2.7	2.9	3.1	2.2	2.6	1.7	1.5	1.1
DL (raport) 5%		1.4	1.4	1.6	1.1	1.3	0.9	0.7	0.5
DL (doze N) 5%		1.8	1.5	2.2	1.3	1.4	0.9	0.7	0.5

The correlation coefficients calculated at the two varieties for correlations of dry matter, starch, reducing sugar, chips yield and chips color at the end of the storage period, show significant distinct positive relationship between dry matter and starch (0.729** for Christian variety and 0.677** for Roclas variety), dry matter and chips color (0.653** for Christian variety and 0.462** for Roclas variety) positive and significant relationship between starch and chips color (0.438* for Christian variety and 0.361* for Roclas variety).

After the correlations performed only at Christian variety was found a negative correlation, significantly distinct between dry matter and reducing sugars (-0.513**), respectively reducing sugar and chips color (-0.548 **).

Tab.7.6.
The coefficients for correlations between dry matter, starch, reducing sugar, efficiency to processing into chips and chips color after the tubers storage period (Braşov 2014-2015)

	Variety	Dry matter	Amidon Starch	Reducing sugar	Efficiency to processing into chips	Chips colour
Dry matter	Christian	1				
	Roclas	1				
Starch	Christian	0.729**	1			
	Roclas	0.677**	1			
Reducing sugar	Christian	-0.513**	-0.184	1		
	Roclas	0.093	0.098	1		
Efficiency to processing into chips	Christian	0.174	0.158	-0.190	1	
	Roclas	0.220	-0.118	-0.106	1	
Chips colour	Christian	0.653**	0.438*	-0.548**	0.118	1
	Roclas	0.462**	0.361*	0.202	0.275	1

N = 32
** Correlation is significant for 0.01.
* Correlation is significant for 0.05

After the storage period on the Christian variety with NPK ratio 1:1:1 there are strong declines on yield chips in April 2015 than in April 2014, while the NPK ratio 1:0.9:2 notes higher values on yield chips in April 2015. For Roclas variety all fertilization variants have the tendency of decrease in the yield of chips in 2015 compared to 2014, the greatest difference between the two years is the variant N200P180K400.

Regarding the chips color, it is strongly altered in April 2015 to all variants of Christian variety, the lowest value for the chips color being registered at variant N200P180K400. At Roclas variety the differences between years are smaller except the

variant N200P180K400 where there is also the biggest decrease regarding the note of appreciation for chips color from 6.4 to 4.

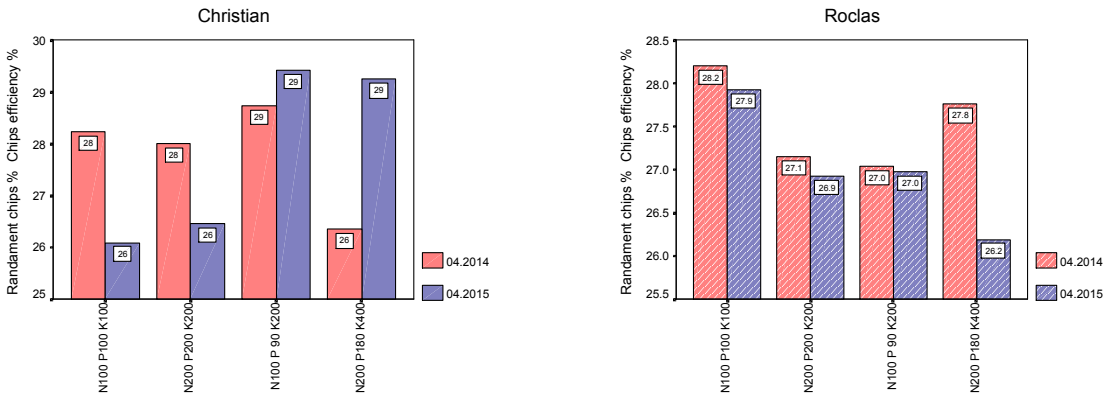


Fig. 7.4. The comparison of the fertilization variants for the efficiency to processing into chips after storage period 2013-2014

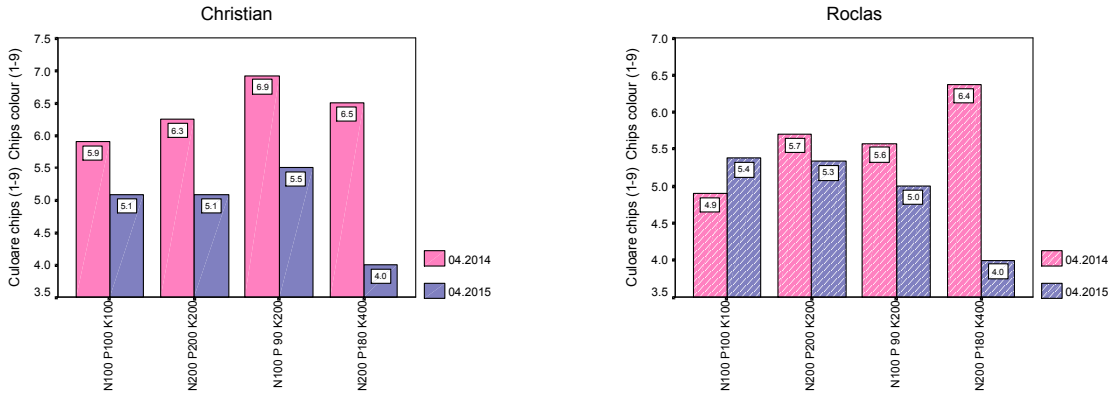


Fig. 7.5. The comparison of the fertilization variants for the chips colour after storage period 2014-2015

CONCLUSIONS

1. Maximum aerial mass accumulated by Christian and Roclas varieties was recorded in these two years on variants with nitrogen dose of 200 kg/ha, in 2013 with NPK ratio at 1:0.9:2 and in 2014 with ratio 1:1:1.

2. SPAD and NDVI measurements performed on Christian and Roclas varieties, in the two years were significantly correlated with distinct components of biomass measured on dynamics.

3. In 2013, with deficit moisture on yield accumulation period, production results were not significant changed by the ratio of NPK fertilization from 1:1: 1 to 1:0.9:2, respectively of nitrogen doses duplication from 100 to 200 kg/ha.

4. In 2014, the most favourable from hydrothermal point of view, increases yield of Christian variety have not justified the increases in levels of fertilization, while concerning Roclas variety, the most high yield (57.4 t/ha) was achieved with fertilization NPK ratio 1:0.9:2 at a dose of 200 kg nitrogen/ha.

5. Very different growth conditions in those two years determined high yield differences from one year to another, and the accumulation of starch and dry matter in tubers was significantly low in 2014 comparing with 2013.

6. On average, in both varieties, the highest starch content, was accumulated by the variants with fertilization N100: P100: K100.

7. On average, on those two years, the differences due fertilization variants were not provided statistical for dry matter content of tubers. For 2014 fertilization variants with high nitrogen level led to significant decreases in dry matter content to both fertilizing reports, on both varieties.

8. Only in 2014 the content of sugars, has significant differences between varieties at all components, except for maltose. On both varieties the content of reducing sugar was significantly higher in 2014 comparatively with 2013.

9. The varieties studied were in close use classes, Christian variety falling within class A/B, and Roclas variety in the class B. Comparing variants of fertilization, on Roclas variety, tubers from variant with N100 P100 K100 louder crashed on boiling pulp consistency is more reduced, are more farinaceous and moisture toward the rest of variants

For both years, tubers starch contents positively significantly correlate with appreciation notes for milling, moisture and starch structure.

10. With the increase ratio from NPK 1:1:1 to 1:0.9:2 respective with increasing nitrogen dose combinations from 100 to 200 kg N/ha the decline in yield is found in chips. Notes for the chips' color have a tendency to decrease, which indicates a darker color of chips with increasing doses of nitrogen on variants with ratio 1:0.9:2, on both varieties and both experimental years.

11. The starch content of tubers correlates positively, assured yield statistically in chips of the tubers, r = 0.687 * - Christian and r = 0.375 at Roclas variety. There were no significant correlations between reducing sugar from tubers and chips color for the data obtained in the years 2013-2014 before storage.

12. After a storage period of the tubers at 3-4 °C (180 days), in the two years studied, in both varieties, maintains the tendency of decrease in starch content, dry matter and reducing sugar on nitrogen dose of 200 kg N/ha, compared to the dose of 100 kg N/ha, found before storage.

At the end of storage period the lowest starch content and dry was found on Christian variety on variant with NPK ratio 1:0.9:2 and dose N200 kg/ha (14.89% 23.10%, respectively, the average of two years).

13. At the end of storage period, the increase in potassium level on NPK ratio of 1:1: 1 to 1:0.9:2 has resulted in a significant decrease in fructose and glucose content in Roclas variety. On average there were, no significant differences due to different doses of nitrogen. On Christian variety all correlations between dry matter and sugars were significant statistically, and in the case of Roclas, there were no significant correlations between dry matter content and sugar components of the tubers.

14. On average, in two years time, different doses of nitrogen have not led to significant differentiations, at the end of the storage period, for pretability level indicators for chips processing. The correlation between dry matter and starch, dry matter and chips color were distinctly positive, and correlation between starch chips color were significant positive for both varieties. On Christian variety were found significant negative correlations between dry matter and reducing sugar (-0.513 **), respectively reducing sugar and chips color (0.548 **).

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