

YIELD AND QUALITY EVOLUTION OF STRAWBERRY CROP UNDER THE INFLUENCE OF MINERAL FERTILIZATION

Ana Maria DODOCIOIU, Gh. MATEI

University of Craiova, Faculty of Agricu Horticulture, Department of Horticulture and Food Safety, Craiova, 13 A.I. Cuza Street, 200583, Romania,

E-mail: matei.gheorghe@gmail.com

Abstract. *The use of different doses of fertilizers on the cambic chernozyom from Radovan (Dolj) had a benefic effect on the production of strawberries. The use of moderate doses of nitrogen on phosphorus and potassium background has resulted in getting the highest yields 21.6 t/ha and a production increase of 116%. The fertilizers used were directly influenced by the quality and attributes of strawberry fruits. Biggest fruits are obtained as a result of using N130P40K71 dose, as well as the highest content in total and soluble organic matter (12.9 to 10.3%). Total sugars and glucides content are higher when using N130P40K71 dose, respectively 8.55. The content of ascorbic acid and total acidity of the fruit are higher when using high doses of fertilizers N6P128K100 - 57.5%.*

Key words: *strawberry, mineral fertilizers*

INTRODUCTION

Between cultivated fruit species of economic interest in terms of profitability and outstanding food value of fruit, strawberries occupy the first places. Since some orchards centers and towns in southern Oltenia have favorable natural conditions for strawberries, there are prerequisites for a revival of the culture of this valuable species if action is methodically, targeting primarily increased interest to individual producers by improving technologies to make the maximum investments made with technical means of production (fertilizers, herbicides, irrigation, mechanization).

One of the basic factors which condition accomplishing these purposes is the development of technologies relevant to culture in which fertilization rings occupies a leading position. Reducing fertilizer loss, increased utilization factor of the active substance, are leading to high efficiency and rationalization of their use of energy.

Strawberry is a crop that has rapid growth and is highly influenced by fertilization. Due to its development speed, the plant needs to absorb sufficient macronutrients in order to meet its demand (MEDEIROS et al. 2015).

Mineral fertilization as well as cultivar, weather conditions, agronomic practice and water supply affect directly the quality of strawberry fruit (NESTBY ET AL. 2004). Optimal fertilization is conducive to obtaining high yield of good quality and high biological value (TREDER 2001).

In general, N and K are the most required nutrients and interact for the increment of production and improvement of plant nutrition (EPSTEIN, 1975; TAIZ & ZEIGER, 2013).

Potassium (K) is also highly demanded by the crop for directly favoring fruit quality and increasing the contents of total soluble solids and ascorbic acid, besides improving aroma, taste, color and firmness of fruits (PETTIGREW, 2008).

MATERIAL AND METHOD

The experience was placed in Radovan, in the center of Dolj county on a specific soil of this area - cambic chernozyom (Czcb) with the following agrochemical: texture: loamy, soil reaction: neutral, middle assured with nitrogen (0.17% N and 2.4% H), poorly supplied with phosphorus (36 ppm P), middle supplied with K (200 ppm K).

The researches were conducted both in field and laboratory.

In the field experience we analyzed the effect of fertilizers on fruit yield and quality of the variety Red Gauntlet. The experience included 11 variants in four repetitions as follows:

1. Mt unfertilized
2. N₁₀₀P₁₉₀K₁₂₀
3. N₆₅P₂₀K₇₁
4. N₁₃₀P₄₀K₇₁
5. N₁₉₅P₆₀K₂₁₃
6. N₆₅P₆₇K₈₈
7. N₁₃₀P₁₃₄K₁₇₆
8. N₁₉₅P₂₀₁K₂₆₄
9. N₈₀P₆₄K₅₀
10. N₁₆₀P₁₂₈K₁₀₀
11. N₂₄₀P₁₉₂K₁₅₀

In laboratory were carried out the following determinations:

Determinations carried out on fruits:

- mean weight of a fruit,
- total dry matter (%) through drying oven method (105°C),
- soluble dry substance (%) – refractometrically
- total carbohydrates (%) - Fehling-Soxhlet Method
- ascorbic acid (mg/100g fresh substance) by iodometric method
- total acidity (g malic acid/100g f.s.) by titrimetric method.

RESULTS AND DISCUSSIONS

Yield is one of the basic factors which determine profitability of production, although the quality of yield is also important. The quality of strawberry yield is a product of fruit size, firmness and chemical composition (PELAYO et al. 2003).

Average production in t/ha was different during the experimental years depending on the climatic conditions.

Strawberry production in 2012 ranged from 10.5 t/ha in fertilized and 22.5 t/ha when there was used N130P40K71.

The use of different doses of fertilizers led by default to increased production of strawberries per hectare. Thus using N80P64K50 dose was obtained the smallest increase production compared to unfertilized 0.9 t/ha, while using N130P40K71 dose was obtained the highest production growth of 12.5 t/ha. Productions increase particularly with the increase of nitrogen doses; at the dose N65P20K71 production is 13.4 tons, and at the dose of N100P90K120 reaches 17.5 t/ha and at N130P134K176 dose the production obtained is 21.5 t/ha. Phosphorus and potassium doses used do not increase strawberry production significantly.

In 2013 strawberry productions followed the same course as in 2012, being slightly higher due to favorable climatic conditions, yielding maximum production at doses of N130P40K71.

In 2014 strawberry productions are lower than 2012 and 2013 due to less favorable weather conditions but this time also the largest productions are obtained as a result of using doses of N130P40K71 - 19.7 t/ha.

The average for the three years of experimentation are obtained at the unfertilized productions of 10.0 t/ha. After using different doses of fertilizer, productions rose to 21.6 t/ha ie by 116% when using doses of N130P40K71. High yields are obtained in the situation of N130P134K176 doses (20.3 t/ha, increase of 103%), N160P128K100 (20.1 t/ha, production increase of 101%), but the use of these doses is not efficient. This highlights the fact that high doses of phosphorus and potassium do not lead to higher production increases and moderate doses of phosphorus and potassium P40K71 applied on a high dose of nitrogen (N130) give the highest production growth 11.6 t/ha, respective 116% production increase.

Table 1

Influence of complex fertilizers on strawberry production obtained in the period 2012-2014

Crt. no.	Experimental variant	Average yields t/ha				The difference from witness		
		2012	2013	2014	Average	t/ha	%	Signification
1	Mt unfertilized	10.5	10.8	8.9	10.0	-	100	-
2	N ₆₅ P ₂₀ K ₇₁	13.4	15.6	12.6	21.6	+3.8	138	xx
3	N ₁₀₀ P ₁₉₀ K ₁₂₀	17.5	18.2	17.4	17.7	+7.7	177	xxx
4	N ₁₃₀ P ₄₀ K ₇₁	22.5	22.7	19.7	21.6	+11.6	216	xxx
5	N ₁₉₅ P ₆₀ K ₂₁₃	18.5	18.7	17.0	18.0	+8.0	180	xxx
6	N ₆₅ P ₆₇ K ₈₈	11.4	17.8	16.0	15.0	+5.0	150	xxx
7	N ₁₃₀ P ₁₃₄ K ₁₇₆	21.5	20.4	19.2	20.3	+10.3	203	xxx
8	N ₁₉₅ P ₂₀₁ K ₂₆₄	14.6	16.6	16.4	15.8	+5.8	158	xxx
9	N ₈₀ P ₆₄ K ₅₀	11.4	10.9	13.6	11.9	+1.9	119	-
10	N ₁₆₀ P ₁₂₈ K ₁₀₀	19.8	21.0	19.5	20.1	+10.1	201	xxx
11	N ₂₄₀ P ₁₉₂ K ₁₅₀	17.2	16.6	15.6	16.4	+6.4	164	xxx

DL5% =2.2

DL1% =2.5

DL0,1%=3.8

Effect of mineral fertilization was followed also through the quality production (Table 2).

The average weight of a fruit (g) is an important indicator of their quality.

Fruits with the lowest average weight (10.5 g) were obtained from unfertilized variant, while those with the highest weight (14g) were obtained when the N130P134K176 dose was used.

Strawberries chemical composition highlights significant results in mineral fertilized variants (9.7% total dry matter – TDM at N65P67K213 variant and 13.6% TDM at N160P128K100 variant, at the unfertilized witness TDM recorded value of 8.5%).

Ascorbic acid content recorded the highest value of 57.5 mg/100g f.s. at N160P128K100 variant, while at the unfertilized witness ascorbic acid content was 20.2 mg/ 100g f.s.

Total sugar content in fruit varied between 6.3% at N65P67K88 variant and 8.5% f.s. at N130P40K142 variant, while the witness recorded a 6.1% content of fresh substance.

Total acidity of the fruits increased to 1.0 g malic acid/100 g f.s. at N130P134K176 variant, while at the unfertilized witness there was a low value of 0.380 g malic acid/100 g f.s.

Total glucides content varied between 6.1% at Mt and 8.5% at N130P40K142 - mineral fertilized variant.

It is ascertained that all variants fertilized with mineral fertilizers obtained good values of chemical indicators compared to the unfertilized witness who registered the lowest values of these indicators.

Quality production was followed as shown above by the average weight of a fruit and dry matter content, glucides and ascorbic acid. The results are the averages of the three years of experiments summarized in Table 2.

Table 2

The effect of applied fertilizers on fruit quality during 2012-2014

Variant	Average weight (g)	T.D.M. %	T.S.S. %	Total sugars g % f.s.	Ascorbic acid mg/100g f.s.	Total acidity G %	Glucides %
Mt unfertilized	10.5	8.5	7.0	6.1	20.2	0.38	6.1
N ₆₅ P ₂₀ K ₇₁	11.5	10.8	9.1	6.1	26.4	0.58	6.1
N ₁₀₀ P ₁₉₀ K ₁₂₀	11.0	10.2	9.5	7.3	28.6	0.72	7.3
N ₁₃₀ P ₄₀ K ₇₁	13.4	12.9	10.3	8.5	43.8	0.85	8.5
N ₁₉₅ P ₆₀ K ₂₁₃	12.3	11.4	10.5	7.3	23.9	0.72	7.3
N ₆₅ P ₆₇ K ₈₈	11.4	9.7	8.0	6.3	21.8	0.57	6.3
N ₁₃₀ P ₁₃₄ K ₁₇₆	14.0	12.3	10.2	7.4	43.5	1.0	7.4
N ₁₉₅ P ₂₀₁ K ₂₆₄	11.2	10.7	9.1	7.9	36.9	0.90	7.9
N ₈₀ P ₆₄ K ₅₀	10.7	10.8	8.5	6.3	28.6	0.78	6.3
N ₁₆₀ P ₁₂₈ K ₁₀₀	13.8	13.6	10.8	8.4	57.5	0.82	8.4
N ₂₄₀ P ₁₉₂ K ₁₅₀	11.3	11.4	9.3	7.4	43.8	0.92	7.4

Analysis of these results highlights the following:

The average weight of a fruit was between 10.5 and 14 g. The lowest values (10.5 g) are recorded at unfertilized witness and the highest when using N130P134K176 dose (14.0 g). High values of strawberries weight are obtained when using N160P120K100 (13.8 g) and N130P40K71 (13.4 g) doses. The average weight of a strawberry fruit is correlated directly with the production of strawberries per hectare.

The content of total dry matter (TDM %) and soluble solids (TSS%) are in direct correlation with each other; and they vary depending on the fertilizer dosages used.

At the unfertilized witness, dry matter content is 8.5 and 7.0% and at the application of small doses of fertilizer, it increases to 10.8 and 9.1%, while at moderate and high doses of fertilizers, content of total dry matter and soluble solids reaches quite high values of 13.6% and 10.8% at N160P128K100 dose, 12.9 and 10.3% at N130P40K71 dose.

The content of total sugars (g f.s. %) is influenced like other quality indicators, by the doses of fertilizers used directly, increasing once with their use and with increasing fertilizer rates. At low doses of fertilizers, especially reduced phosphorus and potassium, sugar content is the same as at the unfertilized witness 6.1%. Increasing the dose of nitrogen, phosphorus and potassium N130P40K71 is obtained the highest content in sugars 8.5%. Excessive doses of fertilizers have a negative effect on growth in total sugars content, thus at N195P201K264 total sugars content drops to 7.9%.

Ascorbic acid content increases with the use of different doses of fertilizers. At a moderate dose of fertilizer N100P90K12, the amount of ascorbic acid increased by 8.6 mg/100 g f. s. compared to the unfertilized witness. At a high dose of N160P128K100 is obtained the highest ascorbic acid content of 2.85 times as high as that of unfertilized, 57.5 mg/100g f.s. to 20.2 mg/100g f.s. The high content of ascorbic acid is obtained by using fertilizer N130P40K71 in a moderate dose (43.8 mg/100g f.s.). It may be noted that increasing ascorbic acid content is determined by using nitrogen and phosphorus. Using potassium in excess K176, K213 leads to lower ascorbic acid content.

Total acidity is also favorably modified by the fertilizer dosages. At the unfertilized witness this quality indicator has lower values 0.38%, increasing from the use of fertilizers doses to 0.58 to 1%, potassium and phosphorus having a decisive role in this increase. Thus as a result of using N195P201K264 and N130P134K176 doses are obtained the highest values of 0.90 and 1% of total acidity. High values of this indicator are obtained as a result of using moderate doses of fertilizer 0.85% at a dose of N130P40K71.

Glucides content (%) has low values at the unfertilized witness or when using low doses of fertilizers 6.1% both at the unfertilized witness and after using N65P20K71 dose.

The use of moderate doses of nitrogen on phosphorus and potassium background results in obtaining the highest values of 8.5% glucides content. High doses of nitrogen - phosphorus or potassium influences negatively the glucides content.

CONCLUSIONS

- The use of different doses of fertilizers on the cambic chernozom from Radovan (Dolj) had a benefic effect on the production of strawberries. The use of moderate doses of nitrogen on phosphorus and potassium background has resulted in getting the highest yields 21.6 t/ha and a production increase of 116%.

- The fertilizers used were directly influenced by the quality and attributes of strawberry fruits.
- Biggest fruits are obtained as a result of using N130P40K71 dose, as well as the highest content in total and soluble organic matter (12.9 to 10.3%).
- Total sugars and glucides content are higher when using N130P40K71 dose, respectively 8.55.
- The content of ascorbic acid and total acidity of the fruit are higher when using high doses of fertilizers N6P128K100 - 57.5%.
- The content of ascorbic acid and total acidity is directly influenced by phosphorus and potassium use.

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