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MAINTAINING OF THE QUALITY AFTER HARVESTING OF THE WHITE CABBAGE, DEPENDING ON NITROGEN FERTILISER DOSES APPLIED TO THE CROP

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Abstract

The purpose of this paper is to establish the influence of nitrogen fertilization of the cabbage crop on its preserving capacity. The paper presents the results obtained in the period 2014-2015 on quality maintaining of the white cabbage after harvesting. There were studied two varieties of cabbage: Gredana - summer, Danish variety and Buzoiana, autumn, Romanian variety. The culture was fertilized with nitrogen in the following doses: 100; 200; 300 and 400 kg active substance N/ha. Cabbage was kept in cold conditions (temperature = 0-2ºC, relative humidity = 85-90%) for a period of 50 days - summer variety or 110 days - autumn variety. After storage determinations were performed on the weight losses (expressed by evaporate-transpiration), the losses by conditioning (resulted by removing yellowed leaves, of diseased ones and of the spine) and the main biochemical components. Researches show that the influence of nitrogen fertilization on maintaining of the quality of white cabbage during the preservation period is negative only at high doses (over 200 kg active substance N/ha). In case of dosages of 300 and 400 kg active substance N/ha losses were recorded of up to over 30% after 110 days of preservation of autumn cabbage. Therefore, in the case of cabbage destined to preservation it is not recommended the use of fertilizers in dosages greater than 200 kg active substance N/ha. The value of the main biochemical components is not strongly influenced by the dose of fertilizer applied to the crop. However one can notice an increase in the protein substances and a slight decrease of the values of ascorbic acid, total sugars and cellulose, from variant control (unfertilized) to variant with 400 kg active substance N/ha.

Key words*: storage capacity, losses, biochemical components*

INTRODUCTION

The therapeutic virtues of cabbage - this so common aliment - are known since antiquity. Its qualities are undeniable; therefore cabbage can be used successfully in the prevention and treatment of a very large number of diseases, being a real natural pharmacy. White cabbage is rich especially in pro-vitamin A, vitamins C and E, vitamin B1, vitamin B2, vitamin PP and in fibers, elements that provides cells health, giving it valuable therapeutic properties. Cabbage is richer in vitamin C than oranges, has few calories and a lot of substances with antioxidant effect, contains large amounts of magnesium, potassium, calcium, iron, copper, phosphorus, sulfur. These features and many others recommend the cabbage as a natural remedy against a large number of diseases (Popoescu et Zavoianu, 2011; Bogoescu, 2015). It is an alkalizing, nutritional, energetical, remineralizing and tonic aliment, and it is preferable to be eaten raw, in order to keep intact its properties. The research conducted in the last 30 years (Salunkhe et al.,1985.) confirmed that a regular consumption of cabbage has a beneficial effect in the prevention of the colon cancer in particular, of stomach cancer, but also of lungs, esophageal and rectal cancer (researches conducted at

University of Minnesota and J. Hopkins from USA, in Greece, Israel, Japan, Norway). Storage capacity of the cabbage depends on the quality of raw material for storage, which is influenced by culture conditions and variety (Ciofu, 2011, Ciuciuc et Toma, 2007, Stoleru et al., 2011). The variety imprints to the plants a certain chemical, histological and cytological structure (Jelea et Jelea, 2007, Salunkhe et Kadam, 1998, Stoleruet al., 2011), detectable through different methods of analysis (Hura, 2006). As far as produce destined for long term storage are concerned, as it is the case for cabbage, respecting the technological links which influence the forming and maintaining of the quality and the storage capacity is of great importance because choosing the adequate type of cabbage for the storage spaces is of the essential importance when aiming to maintain the quality during storage. In order to achieve this goal the crops destined for storage must be kept under observation beginning with the growing periods, meaning the moment the crop is started.

The purpose of this paper is to evaluate the preserving storage capacity of summer white cabbage of the 'Gredana' variety and of autumn cabbage, 'Buzoiana' variety, depending on the doses of nitrogen fertilization during culture period.

MATERIALS AND METHODS

The researches were conducted during period 2014-2015, using summer and autumn white cabbage, obtained in a vegetable farm located in an area of the Romanian seaside.

The trial was organized as a bi-factorial experience, with following experimental factors:

- A - variety
  - a1 - Gredana (summer variety)
  - a2 - Buzoiana (autumn variety)
- B - fertilization level
  - b1 – control (unfertilized)
  - b2 – 100 kg active substance N/ha
  - b3 – 200 kg active substance N/ha.
  - b4 – 300 kg active substance N/ha. (for summer variety, only)
  - b5 – 500 kg active substance N/ha. (for autumn variety, only)

The storage was effectuated in refrigeration conditions (temperature = 0-2ºC; air relative humidity = 85-90%) for a period of 50 days (summer cabbage) and 105 days (autumn cabbage), thereupon the following determinations were effectuated:

- weight losses, resulted by evaporate - transpiration;
- losses by conditioning, resulted by removing yellowed leaves, of diseased ones and of the spine.
- identification of pathogens that caused the rot of the cabbage;
- main biochemical components (soluble solids, soluble sugars, titratable acidity, ascorbic acid, protein substances, cellulose).

The methods for determining the biochemical components were the following:

- the refractometric method, using the ABBE refractometer in order to determine the content of soluble dry substance;
- the Bertrand titrimetric method, for the determination of the content of soluble carbohydrates;
- the titrimetric method, for the determination of the titratable acidity;
- the spectofotometric method, for the determination of the ascorbic acid
- the gravimetric method, for the determination of the cellulose;
- Kjeldahl method, for the determination of the proteins.

During storage the hydro-thermal factors in the storage room were verified on a daily basis in order to ensure the respecting of the optimal conditions for the maintaining of the quality. Also, appreciations were made concerning the cabbage' capacity to maintain their quality during storage, as well as the possible occurrence and development of various specific diseases.

RESULTS AND DISCUSSIONS

1. Level of losses

Data presented in Table 1, on the preservation for short time of the summer cabbage, show that between the three graduations of fertilization with nitrogen that were studied, after 50 days of cold storage, there were no pronounced differences of the losses. It finds that weight losses recorded values very close to the three variants: from 4.8% in the case of fertilization b1 variant (unfertilized) to 5.3% in the case variant b3, with the dose of

fertilization of 200 kg active substance N/ha.

Table 1. Loses recorded by summer white cabbage after 50 days of cold storage

Variant	Fertilization level ((kg a.s. N/ha.)	Losses (%)		
		quantitative losses	qualitative depreciation	total
b1	unfertilized	4.8	5.0	9.8
b2	N 100	5.2	5.1	10.3
b3	N 200	5.3	5.5	10.8

Because of during storage period have not reported disease attacks, the conditioning consisted only in the removing of 1-2 yellowed leaves, which made that the conditioning losses be small (between 5.0% in the case of variant b1 and 5.5% in the case of variant b3). Total losses recorded values between 9.8% at the control variant and 10.8% at b3 variant.

Based on these results it can be considered that the fertilization with nitrogen in amounts up to 200 kg don't influence negatively the preservation capacity of summer cabbage, 'Gredana' variety, if it is storage a period of 55 days.

Analyzing the data presented in Table 2, on the preservation of long time of autumn cabbage, variety 'Buzoiana', it finds that after 110 days of refrigerated storing, weight losses increase proportionally to the dose of nitrogen: from 6.0% in the case of control, up to 10.8% in the case of variant b5, fertilized with 400 kg active substance N/ha.

Qualitative depreciation also increased proportionally with the dose of nitrogen applied to the crop. They are between 17.6% in the case of the control variant and 20.7% in the case of variant b5, but the differences are not significant compared to control only at variant b5.

Unlike summer cabbage, kept a short period, were there was no attack disease, at keeping for a long period of the autumn cabbage, there appeared various diseases and the conditioning losses resulted largely by removing rotting leaves.

Among the pathogens that caused the rot of outer leaves can mention: *Botrytis cinerea, Sclerotinia sclerotiorum, Alternaria brassicae* and bacteria of the genus *Pseudomonas*. The attack was emphasized at the cabbage of b4 and b5 variants. In addition, at variant b5 were found brownings of the inner leaves oh the heads.

Table 2. Loses recorded by autumn white cabbage after 110 days of cold storage

Variant	Fertilization level (kg a. s. N/ha.)	Losses (%)		
		quantitative losses	qualitative depreciation	total
b1-control	-	6.0	17.6	23.6
b2	N 100	6.9	17.8	24.7
b3	N 200	7.8*	18.7	26.5
b4	N 300	8.3**	19.1	27.4*
b5	N 400	10.8***	20.7*	31.5***
		DL 5%=1.70	DL 5%=2.33	DL 5%= 3.69
		DL 1%= 2.48	DL 1%=3.39	DL 1%=5.36
		DL 0.1%=3.72	DL 0,1%=5.09	DL 0,1%=8.05

Total losses ranged from 23.6% at the control variant to 31.5% at variant b5, differences between these variant being very significant. In case of variant b4 differences were significant, compared to the control.

From the data presented up to now, it results that the effect of nitrogen fertilization on the storage capacity of the cabbage is negative only at high doses (over 200 kg a.s. N/ha). Until this dose there have not been reported the negative effect neither summer cabbage nor autumn cabbage, for which we can consider as limit to which we can apply nitrogen fertilizer without affecting the storage capacity of the cabbage is 200 kg a.s. N/ha.

2. Level of the biochemical components.

The analysis of the main biochemical components of the autumn cabbage (Table 3) reveals the fact that between the variants of nitrogen fertilization does not occur essential differences from this point of view, except protein substances that, from the value of 0.64% seen in variant b1, increase to 1.12% at variant b5.

It is observe a slight decrease in values of the ascorbic acid, total sugars and cellulose, from variant b1 to variant b5.

It also noted that during the storage of cabbage, the quantities of the biochemical components did not modify noticeable.

Table 3. The main biochemical components of autumn cabbage at the beginning and after the cold storage

Specification	M.U.	Moment of determ.	Variant				
			b1	b2	b3	b4	b5
Dry soluble substance	%	I*	6.4	6.3	6.0	6.0	6.0
		II**	6.5	6.4	6.1	6.1	6.1
Ascorbic acid	mg/ 100g	I	35.99	35.11	34.73	34.50	32.64
		II	35.15	34.80	33.45	32.30	30.40
Titratable acidity	%	I	0.15	0.15	0.15	0.15	0.14
		II	0.16	0.16	0.15	0.16	0.15
Total carbohydrates	%	I	3.68	3.58	3.68	3.42	2.94
		II	3.23	3.48	2.94	2.75	2.80
Proteins (Nx 6.25%)	%	I	0.64	0.71	0.76	0.80	1.00
		II	0.80	0.87	0.88	1.05	1.12
Cellulose	%	I	0.73	0.73	0.72	0.63	0.61
		II	1.17	0,96	0.85	0.78	0.88

* at harvest
** after 110 days of cold storage

This is explained by the fact that the cabbage was subjected to low temperature and so by the slowing of the metabolic process. Very small increases observed after storage in dry matter values, titratable acidity and cellulose, but content in ascorbic acid and total sugars decrease.

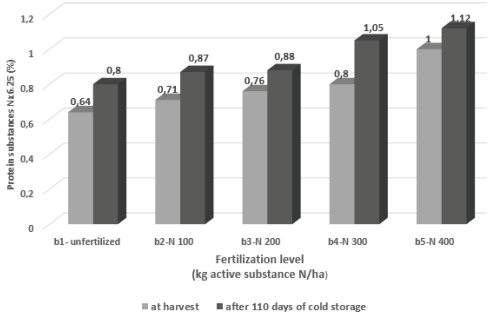

Figure 1. The proteins content of the autumn cabbage, fertilized with different nitrogen doses

CONCLUSIONS

Fertilization of the white summer and autumn cabbage with nitrogen fertilizer up to 200 kg active substances/ha not affect the preservation quality of the cabbage.

After 50 days of storage of the summer cabbage and after 110 days of storage of the autumn cabbage the total losses are insignificant compared to the control.

At higher doses of nitrogen fertilizers, 300 and 400 kg active substances N/ha, the capacity for storage of autumn cabbage was affected. After 110 days of storage total losses were over 30%.

Therefore, for the cabbage destined for preserving for long time is not recommended fertilizer doses greater than 200 kg N/ ha.

The value of the main biochemical components of the autumn cabbage is not strongly influenced by the dose of fertilizer applied to the crop.

In the case of different fertilization level, there are no essential differences in the values of the main biochemical components, beside the proteins. There was an increase in values at protein substances (0.64%-b1 variant, 1.00%-b5 variant) and a slight decrease in values of ascorbic acid, total sugars and cellulose, from control variant to variant b5 (400 kg active substances N/ha).

Because of cold storage, intensity of the metabolic processes decreased, for which, during storage, the biochemical component did not suffer major changes.

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