

SECTION 13. VEGETABLE GROWING

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13.1 The influence of plant densification on the yield of white-head cabbage in Southern Ukraine

Introduction

Among the wide assortment of species, the total number of which is 130-140 thousand, vegetable plants are represented by an average of 200 species. The annual consumption of vegetables per person in Ukraine is 146 kg, which ranges from 128 to 164 kg, depending on the region of the country. Before the war, about 500,000 hectares were set aside for growing vegetables in Ukraine. In the structure of sown areas, one of the leading places is occupied by cabbage, including cabbage. During the war years in Ukraine, there is a tendency to decrease the production of vegetable crops.

The purpose of our study was to experimentally substantiate some elements of the technology of growing white cabbage in the southern Steppe of Ukraine by choosing the best schemes for its planting. The object of our research was to determine the processes of growth and development of white cabbage plants, yield and the main indicators of crop quality depending on the planting scheme under drip irrigation conditions, and the subject of the study was the planting scheme of white cabbage seedlings. The research methods that were used in our experiment were as follows: field - to determine the optimal scheme for planting seedlings under drip irrigation, laboratory - used to control soil moisture under the crop, statistical - to calculate the error of the experiment and evaluate the results of the research.

The homeland of all types of cabbage, with the exception of Beijing and Chinese cabbage, is the European coast of the Mediterranean Sea, the English Channel and the Pas de Calais. Data from historical monuments show that cabbage was widely grown in the Mediterranean countries as early as 2000-3000 BC. First there was kale, from which later, as a result of long-term selection, white cabbage was created. This culture has been known in Egypt since the VI century. century BC, in Western Europe - from the 16th century. "In Ancient Greece and Ancient Rome, different types of cabbage

and leafy cabbage were grown. Cabbage from Rome came to Germany." According to Dekandol, "numerous varieties of cabbage have been formed mainly since the time of the ancient Greeks. He believed that wild cabbage was found on the rocks of the coast on the island of Lalande in Denmark, on the island of Heligoland, in the south of England, in Ireland, Normandy, on the islands of Jersey and Guernsey, in the department of Lower Charente in France."

13.1.1 Biological characteristics of culture

"White cabbage - *Brassica oleracea* L. var. *alba* DC. belongs to the cabbage family Brassicaceae Burnett, genus *Brassica* L. According to morphological and biological characteristics, it is close to red cabbage". "White cabbage is a biennial plant. The cabbage development cycle consists of several stages: seed germination and the emergence of seedlings, the initial growth of the rosette and roots, the accumulation of leaf mass and the further development of the root system, the formation of the fruit organ and the appearance of inflorescences, flowering, fruiting and ripening of seeds. On the 3rd-4th day, cabbage seeds germinate quickly under favorable growing conditions. Coarse seeds give better and stronger seedlings. More intensive growth of plants begins on the 20-40th day after planting, because the accumulation of leaf mass and the further development of the root system are carried out. At this time, the root system grows up to 60 cm wide and plants can form 1 to 5 leaves in five days. In the production of white cabbage, you should know the peculiarities that the formation of the head begins before the leaves of the rosette reach their maximum size. When it reaches a diameter of 7-8 cm, white-headed cabbage acquires a characteristic shape for a particular variety in terms of technical ripeness. At this stage of growth, the upper leaves of the head acquire a certain shine and change color. In the first year, a head is formed - an overgrown apical bud in which nutrients are stored. Over the course of 1.5-2.5 months, depending on the type of white cabbage, a head is formed. During this period, the outer cob thickens.

13.1.2 Agrotechnics of crop cultivation

The technology of growing white cabbage corresponded to the generally accepted technology for the steppe zone. The seedling method was used. Seedlings were grown in cassettes. Seedlings were dived in the phase of formation of the second true leaf. When the fourth leaf appeared, top dressing was carried out twice. Before planting white cabbage seedlings in the soil, the cassettes were well watered. The next morning, culture seedlings were taken from the moist soil of the cassettes, selecting the most developed white cabbage plants, and underdeveloped and damaged plants were also culled (Fig. 1).



Figure 1. White cabbage seedlings before planting on the experimental field, 2021.

Early potatoes were chosen as the precursor in the experiment to establish the scheme of the experiment. The layout of white cabbage plants was laid out according to the scheme of the experiment.

13.1.3 Biometric indicators of plants

Since white cabbage belongs to light-demanding plants, special attention should be paid to the area of culture nutrition in the production conditions of management.

Therefore, it is important to determine the optimal schemes for the placement of white cabbage plants, which will allow obtaining the maximum indicators of the productivity of the leaves of the crop, due to a larger area of the assimilation surface and, accordingly, a higher level of yield of white cabbage. Therefore, it is necessary to ensure optimal lighting conditions when growing crops. According to the results of the study, it was established that the size of the leaf area of white cabbage plants changed significantly depending on the scheme of placing the plants and the area of their nutrition, which are shown in the table. 1.

**Table 1 - Biometric parameters of white cabbage plants depending on
from thickening of plants, 2021**

Plant arrangement scheme, see	Number of plants, thousands of plants/ha	Leaf area	
		of one plant, m ²	per hectare, thousand m ²
70×60 – St	23,8	2,19	51,8
70×50	28,6	2,08	59,5
70×40	35,7	1,84	65,3
70×30	47,6	1,74	82,0

Thus, under the layout of 70×60 cm (control), the area of the leaves of one plant was the largest and was 2.19 m². However, with such a scheme of planting white cabbage, this indicator per unit area was the smallest at 51.8 thousand m², since the density of culture plants under sparse placement was 23.8 pcs./ha, which is almost half as much as compared to the dense scheme. When placing plants according to the scheme of 70x50 cm, the leaf area of one white cabbage plant was slightly smaller - 2.08 m², from one hectare this indicator increased due to a larger number of white cabbage plants to 59.5 thousand m². Indicators for the scheme of planting culture plants 70x40 cm provided for the formation of a leaf surface from one plant at the level of 1.84 m². The smallest area of white cabbage leaves was recorded in the thickened scheme of 70×30 cm and was 1.74 m² in the experiment. At the same time, the feeding area of each white cabbage plant was significantly reduced, and the leaves of the crop

were slightly smaller in size, and this, in turn, led to a decrease in the analyzed indicator.

13.1.4 Changes in morphological indicators of cabbage plants

Our own research data on the indicators of leaf formation in white cabbage showed that a greater number of them were formed according to the scheme of liquid placement of culture plants (70x60, 70x50 cm), since under such growing conditions each plant had a larger area of nutrition area, and accordingly maximally used this opportunity. It should also be noted that under these schemes they developed faster and grew more intensively. On the basis of two-year experimental studies, it was established that, in white cabbage, the most leaves at the end of the third decade of July were counted in the control, and it was 18 pcs. (Table 2).

Table 2 - The number of leaves in white cabbage depending on the scheme of planting seedlings, 2021

Plant arrangement scheme, see	The number of leaves on a plant, pcs.								
	date								
	30.07	10.08	20.08	30.08	10.09	20.09	30.09	10.10	15.10
70×60 – St	18	20	23	27	24	22	20	18	
70×50	17	20	22	26	23	21	19	17	
70×40	16	19	20	21	22	20	18	16	15
70×30	15	17	20	20	21	20	18	16	14

And according to the variant with the 70×50 cm culture placement scheme, 17 pieces were counted, according to another variant of the 70×40 cm leaf experiment, only 16 pieces were already formed. The smallest number of white cabbage leaves is 15 pcs. culture plants were formed according to the 70×30 cm variant of the experimental scheme. Later (data as of 30.08.) with the placement of 70×60 and 70×50 cm, the plants formed the largest number of leaves during the growing season - 27 and 26 pcs. In the case of the 70×40 and 70×30 cm scheme, which we consider to be

thickened, the maximum number of leaves per plant was formed, namely 22 and 21 pieces, observed after a decade (data 10.09).

The results of our own experiments show that the placement schemes of white cabbage quite clearly affect the rate of growth and development of the leaves of the crop, and should be taken into account by producers in the implementation of industrial production. According to observations on 20.09, most of them were formed in a row when the distance between plants increased, and the number was 22 pcs. According to the 70×50 cm culture placement scheme, it was slightly less by one and consisted of 21 pieces. The decrease was 4.5%. When the white cabbage plant was planted in rows up to 40 and 30 cm apart, the number of leaves decreased by 4.5% and amounted to only 20 pieces.

According to the following observations on September 30, according to the 70x60 cm culture placement scheme, the number of leaves was formed the most and amounted to 20 pcs., according to the 70x50 cm scheme, a decrease of 5% is also observed, and it is only 19 pcs. At least their number is 18 pcs. was formed by a white cabbage plant according to the last two variants of the experiment (70×40 - 30 cm). According to further observations in the experiment, which were at the end of the first decade of October, according to the scheme of placement of the culture of 70x60 and 70x50 cm, white cabbage plants formed the number of leaves of 18 and 17 pcs. Therefore, our own research results made it possible to draw the conclusion that the scheme of plant placement affects the results, so when white cabbage plants were thickened to 40 and 30 cm, the number of plant leaves decreased by 2 and 3, respectively. compared to the control version of the experiment (70x60 cm), which is from 4.5 to 5%.

We determined and analyzed the indicators of the increase in the head of white cabbage depending on the thickening of the plants, which are given in the table. 3. So, at the end of the first decade of August, the beginning of the formation of heads was observed only in the first two variants. According to observations and calculations carried out on 20.08 under different placement schemes, the size of the head of cabbage was within 8.5-10.1 cm. In further studies, in the third decade of August, when using

the experimental schemes of 70x60 and 70x50 cm, the diameter of the heads increased significantly to 13.3 and 12.5 cm.

Table 3 - Increase of the head of white cabbage depending on the thickening of the plants, 2021

Plant arrangement scheme, see	Number of plants, thousand of plants/ha	Diameter of the head, cm							
		date							
		10.08	20.08	30.08	10.09	20.09	30.09	10.10	15.10
70×60 – St	23,8	9,1	10,1	13,3	15,5	16,9	18,2	19,0	19,2
70×50	28,6	8,5	9,4	12,5	14,7	15,8	17,3	18,1	18,3
70×40	35,7	–	8,9	11,8	13,6	15,1	16,5	17,2	17,7
70×30	47,6	–	8,5	11,4	13,1	14,5	15,8	16,8	17,2

With a thickened scheme (70×40 and 70×30 cm), this indicator was reduced and amounted to 11.8 and 11.4 cm, respectively. In the subsequent observations, which were carried out at the end of the first decade of September, indicators were obtained that indicate the largest size of the food organ according to the control version - 15.5 cm, the smallest was according to the scheme of the experiment 70x40 and 70x30 cm - 13.6 and 13.1 cm respectively.

Somewhat different indicators were observed on the second version according to the 70x50 cm experiment scheme and were equal to 14.7 cm, which is 5.2% less than with the control version. On September 20, white cabbage plants placed according to the experimental scheme of 70x60 and 70x50 cm had head sizes of 16.9 and 15.8 cm, which is 9% and 1.9% more compared to the control variant. The use of planting schemes resulted in slightly lower diameter figures for the smaller diameter head (15.1 and 14.5 cm).

At the end of September, the largest heads were also in the 70x60 and 70x50 cm experimental schemes - 18.2 and 17.3 cm, and the smallest - in the variants with the 70x40 and 70x30 cm planting schemes - 16.5. and 15.8 cm. According to the results of the research of the first decade of October, according to the scheme of 70x60 cm of the

head, a pattern of cessation of growth and development was observed, but their size reached 19 cm, which was the largest, compared to its diameter according to other schemes. Thus, the largest diameter of the food organ was according to the scheme 70×60 and 70×50 cm, and was equal to 19.2 and 18.3 cm, respectively.

But it is worth noting the conclusion that when the distance between the white cabbage plants was reduced to 40 cm, this indicator was formed at the level of 17.7 cm, and according to the most thickened method of placing the culture plants (70x30 cm), the head was formed with the smallest diameter at the level of 17.2 cm.

With the increase in the feeding area of the late-ripening white cabbage hybrid, the productivity of one plant increased and the yield per unit area decreased. The concentration of plants in a row helped to increase the yield of heads due to an increase in the number of plants per unit area.

13.1.5 Productivity and marketability of harvested cabbage

According to the results of experimental studies, a direct dependence of the intensity of growth and development of Zoltan cabbage hybrid plants on the density of plant placement was found, which subsequently influenced the mass of the head of the crop (Table 4).

Table 4 - Weight of a head of white cabbage depending on plant density, 2021

Plant arrangement scheme, see	Weight of the head, kg	
	Weight of the head, kg	V, %±Sx, %
70×60 – St	3,35	6,4±1,8
70×50	3,12	6,0±1,7
70×40	2,21	6,6±1,8
70×30	1,66	6,8±1,9

The results of the experiment showed that the largest mass of heads of white cabbage was observed in the late-ripening hybrid Zoltan according to the scheme of plant placement 70x60 and 70x50 cm and it was 3.35 and 3.12 kg, respectively. Due

to the large size of plants in the Zoltan hybrid, the thickening of plants in a row did not lead to a further increase in the size and weight of the head. According to other schemes of the experiment, with a distance of plants in a row of 40 cm, this indicator was equal to 2.21 kg. According to the scheme of planting a culture of 70x30 cm, white cabbage plants had the opportunity to form heads weighing 1.66 kg.

On the basis of the obtained data, it was established that the placement scheme of white cabbage plants had a significant influence on the yield of the crop (Table 5).

Table 5 - Productivity of white cabbage depending on plant density, 2021

Plant arrangement scheme, see	Productivity, t/ha	Productivity increase, t/ha	Marketability, %
70×60 – St	83,5	-	95
70×50	94,6	+ 11,1	94
70×40	86,5	+ 3,0	90
70×30	86,5	+ 3,0	89
LSD ₀₅ , t/ha	4,3	-	-

The analysis of the obtained data shows that the mid-late hybrid Zoltan produced the highest yield in the 70×50 cm plant placement scheme – 94.6 t/ha, which is 11.1 t/ha higher than in the control.

The lowest yield of white cabbage was achieved in the control version - 70 × 60 cm - 83.5 t/ha. On the plants placed according to the 70x40 and 70x30 cm scheme, a yield of 86.5 t/ha was achieved, which is a slight excess compared to the control. The interrelationship between marketability and variants of the plant placement scheme is noted.

Thus, the schemes of 70 × 60 and 70 × 50 cm ensured the marketability of white cabbage at the level of 95 and 94%, respectively. Analyzing the presented one-year research results, we found out that the best conditions for the growth and development of plants, the process of formation of heads, and the achievement of the highest productivity of white-headed late-ripening hybrid Zoltan cabbage are provided by plant placement schemes - 70x50 cm.

Preliminary conclusion

The obtained one-year results of the field experiment give us the opportunity to draw a preliminary conclusion:

In order to obtain the maximum productivity of late-maturing cabbage of the white-headed hybrid Zoltan, it is necessary to plant seedlings of the crop according to the scheme of 70x50 cm. At the same time, the yield of the crop will be almost 95 t/ha. In order to issue recommendations to crop producers, a further field experiment according to this scheme is required.