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INFESTATION OF CARROT DEPENDING ON BIOLOGICAL AGE AT DIFFERENT STORAGE WAYS

Has been productivity investigated of five varieties of carrots for spring and summer sowing terms under conditions at lowland areas of Zakarpattya lowland areas (Vynohradiv district). Has been studied weight loss during prolonged storage. Identified pathogens and share rot in the roots of different ages for different ways of storage. Has been discovered attachment of exciters to the affection of different parts of a root.

Key words: carrot, roots, carrot verities, terms of sowing, storage, and infestation.

Introduction. Carrot is one of the most popular vegetables both in Ukraine and abroad**.** High value of carrot is conditioned by a significant volume of nutrients and possibility to use it both in raw and processed shape all year long. Besides providing a human body with vitamins, carrot possesses treatment features. Carrot roots are used for preventing and treating hypo- and avitaminosis, liver and kidney diseases, for improving sight, appetite, skin color [1, 2, 5].

Unfortunately volume of manufacture has been decreased due to low yield level because of failure to comply with the basic elements of cultivation, including the timing and optimal seeding [3, 4, 6].

Period while a consumer may use fresh carrot delivered directly from farm, is pretty short. Most of it comes after storage [8]. At the same time carrot belongs to the type of vegetable that has a high keeping quality. Its roots continue breathing, allocating carbon dioxide and moisture in storage.

Because of the high content of the water, during storage carrots are affected by fungal and bacterial diseases, and due to these losses reach 30–40% [7], or 80% of total losses [6].

Affection of plant by pathogens can take place in the field by plant residue, soil or seed infection. The source of additional infection may be agricultural machines, packing and packaging materials. Certain groups of microorganisms affect plants in the last stages of vegetation, mainly due to adverse conditions, but the harm provided occurs only during storage period. This facultative parasites that are able to affect weakened facilities and have a high pathogenicity. These include various types of *Fusarium*, *Phytophthora*, *Rhizoctonia* causing rot of roots; white pathogens (Sclerotinia sclerotiorum DB) and gray (Botrytis cinerea Pers. et Fr.) rot, black spot pathogen (Phoma rostrupii Sacc.). The degree of pathogens' affection was determined by the method of Hohriakov (1984). When stored in the first week due to cooling the number of microorganisms reduces, but then, especially in high temperatures – it increases. Adherence to storage conditions significantly reduces the loss of diseases [9].

The aim of research was to study the affection of root of all ages by rot fungal and bacterial etiology at different ways of storage**.**

Research Methodology. A three-year study (2012–2014) has been delivered regarding infestation of carrot by diseases after long-term storage (November–April). Carrots were grown in soil and climatic conditions of Vynohradiv district by conventional technology. [1] The objects of research were varieties of national (Nantska Kharkivska, Chervonyyi veleten) and foreign selection (Regulska, Koroleva oseni, Lange rote shtumpfe). Seeds were sown in two terms: the first week of April (spring sowing) and in mid-June (summer sowing). Root of the first sowing were collected in mid-October (vegetation period amounted to 174 days), and of the second sowing correspondingly – the first decade of November (the growing season – 123 days). Marketability was determined of the crop of each variety. Healthy marketable roots were stored in storage of natural ventilation and maintained at the optimum storage temperature 0 ... + 2 ºC and relative humidity of 88–90%. Carrots were kept in plastic boxes for vegetables, perforated plastic bags with a capacity of 5 kg and in boxes after previous claying. In the latter case, the roots immersed in thick slurry of clay and then dried and placed in boxes. The repeated experiments –

fourfold. Roots were kept for 6 months (about 180 days). In early May, there were determined mass loss, conducted the identification of pathogens, set the proportion of rot and their affinity to different parts of roots.

Results. Terms of carrots sowing during research greatly influenced its yield (Table. 1). According to the data received, total yield varieties of carrots surveyed, was within 30,6–43,1 t/ha for spring sowing period. The highest yield was obtained in the control variant (variety Nantska Kharkivska). Root marketability of this sort was at 77,0% for the spring sowing, and the value of marketable yield reached 33,2 t/ha, and was the highest for the specified seeding period.

During experiment the smallest yield, both general and marketable one, was obtained with spring seeding varieties of Chervonyyi veleten. At the same time, the share of marketable roots in this embodiment was 2% higher than the Nantska Kharkivska. Variety of German selection Koroleva oseni has formed the least amount of marketable root crops both at spring (68,2%), and summer (69,2%) seeding.

Within summer sowing the yield has noticeably changed, and in some varieties it has increased, in others – on the contrary. The largest increase in both overall (16,7 t/ha) and marketable (15,0 t/ha) yield was obtained in the variant with a sort of Chervonyyi veleten. Marketability for summer sowing root crops has grown with regard to all varieties. Marketability of roots of summer planting was growing in all grades, except for the control, where there was a slight decrease in this indicator.

Marketability roots obtained from spring and summers sowing were laid for storage. Carrots were kept in plastic boxes for vegetables, plastic bags after previous claying. The biggest loss of roots was observed during storage in boxes (tab. 2). According to the data within spring sowing carrot gets increased both natural weight and share of sprouted roots and absolute shortage. The largest natural weight loss for the winter-spring marked the German variety Koroleva oseni, both for older root (7,0%) and for younger physiological age (6,4%). Such kinds as Nantska Kharkivska, Regulska and Chervonyyi veleten got lower loss in natural weight. Among older physiological root proportion was 5,4–5,8%, and among younger – 4,6–5,1%. The highest absolute shortage at the end of long-term storage of root crops (above 3%) was recorded for the variety of German selection Lange rote shtumpfe for physiologically older and younger root vegetables; the

same is true for a variety of a domestic kind Kharkiv Nantes in the first case. Total losses were at 16,1–31,3%. The highest level characterizes German kind Koroleva oseni. The maximum output of marketable products were obtained at the end in control variant (81,2–83,5%) and Chervonyyi veleten (82,7%) which were sowed during the summer period.

In late April – early May roots of different physiological age stored in various ways were analyzed to study the prevalence by pathogens (Table. 3).

Among the diseases that affected carrots were such diseases as white, gray, black rot, fomosis, bacterial rot. In some cases there were roots affected by several pathogens. In this case they were included to mixed disease group. The most often such pathogens white mold were faced (Sclerotinia sclerotiorum d. By.). Most of roots affected by the disease were discovered in storage boxes, where the proportion ranged from 4.2 to 34,2%. Significantly lower rates were studied when stored in plastic bags (2,0–26,0%) and storage of carrots with previous claying (0,2–0,5%). Table 2 shows that in addition to the method of storage the age also influenced the infestation by pathogens. Thus, the specific percentage of rot was always higher in variants with senior root vegetables.

The highest resistance to white rot pathogen was noted in Regulska Polish variety, and amongst samples of domestic selection value of this feature was within the average value of the experiment.

Gray mold (*Botrytis cinerea Pers.)* has affected the most often varieties of German breeding Koroleva oseni and Lange rote stumpfe. When stored in boxes share of rot in these grades ranged from 9,2 to 15,4%, in plastic bags – from 5,9 to 7,8%. Clayed roots were affected the least – 1,0–3,1%.

Varieties Nantska Kharkivska, Koroleva oseni and especially Regulska have been affected much stronger by fomosis pathogen (Phoma rostrupii Sacc.), than by gray rot. While storing Regulska varieties carrot in boxes share of this rot on older root reached 23,2%, on the younger – 18,7%. It significantly decreased for other ways of storage, though remained higher than other grades (Table. 2).

Varieties Chervonyyi veleten and Koroleva oseni were least effected by black rot amongst pathogens of mushroom etiology (mycoses) – Alternaria radicina MD et E.

The largest share of bacterial rot (Erwinia carotovora Hall.) was noticed on the roots of all ages of Regulska variety. When stored in boxes older roots have been affected by that rot on 4,3%, younger – by 3,8%. In plastic bags bacterial rot percentage reached respectively 2,1 and 1,2%, and among clayed roots these diseases accounted for 1,3 and 0,6%. The maximum relative proportion of mixed infections was fixed on a sort of German kind Koroleva oseni.

When analyzing carrot diseases attention was paid to the withdrawal in the intensity of their development in different parts of roots. In particular, white and gray rot often affected roots in the root zone, except for varieties of German kind, which were strongly infected by white rot in the area of the neck. An average degree of infection of this area was noted for the Polish variety Regulska. Pathogens of black rot and fomosis have developed mainly on roots, although in varying degrees were met on other parts. The exception was for the sort of Chervonyyi veleten, and in relation to fomosis still Nantska Kharkivska showed up, where no cases of destruction tail roots were revealed by agents. Bacterial rot often developed in areas of the neck and root of the Nantska Kharkivska and Koroleva oseni. At the same time intensity of infecting these parts on the Chervonyyi veleten and Lange rote stumpfe by specified disease was average.

Conclusions. The terms of seeding carrots significantly affected the value of both the general and marketable yield. Highest marketable yield for spring sowing period was sort of Nantska Kharkivska (33,2 t/ha), and in summer – the kind of Chervonyyi veleten (39,2 t/ha). The share of marketable roots increased in total yields in most varieties within sowing summer term.

For long term storage the all varieties in varying degrees were infected by rot. At the same time the smallest share of affected the Regulska variety root by white and gray rot was noted, by black rot – the varieties of Chervonyyi veleten and Koroleva oseni, by fomosis or brown rot – Nantska Kharkivska, Chervonyyi veleten, Lange rote stumpfe. Bacterial rot accounted for the smallest share in the overall share of rot for the Chervonyyi veleten, Koroleva oseni and Lange rote stumpfe. Carrots of Regulska kind were affected by complex pathogens less likely than other varieties.

The differences were revealed in the intensity of pathogens development in parts of roots. In particular, the root part was mostly in white and gray rot. Black rot and fomosis developed intensively in most cases at the heads of root crops and bacterial rot of medium or strong intensity infected neck and root part.

Analysis of younger and older roots, stored for a long time (October-April) the first totally confirmed the benefits for long-term storage. The best among the studied methods of storage was method of claying roots. In all sorts of carrots for this method of storage specific percentage of various rots was the lowest.

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Г.Б. Попович

Поражение корнеплодов моркови болезнями в зависимости от их физиологического возраста при различных способах хранения.

Резюме. Исследовано урожайность пяти сортов моркови при весеннем и летнем посеве в условиях низменной зоны Закарпатья (Виноградовский район). Изучено потери массы при длительном хранении. Идентифицировано возбудителей болезней и удельный вес гнилей на корнеплодах разного возраста при различных способах хранения. Обнаружена склонность возбудителей к поражению различных частей корнеплодов.

Г.Б. Попович

Уражуваність коренеплодів моркви хворобами залежно від їх фізіологічного віку за різних способів зберігання.

Резюме. Досліджено урожайність п’яти сортів моркви за весняного та літнього строків висівання в умовах низинної зони Закарпаття (Виноградівський район). Вивчено втрати маси при тривалому зберіганні. Ідентифіковано збудників хвороб та питому вагу гнилей на коренеплодах різного віку за різних способів зберігання. Виявлено приуроченість збудників до ураження різних частин коренеплодів.

1. – Yield of carrot within different sowing periods (average 2012–2014)

Varity	Spring			Summer		
	Total yield, t/h	Marketable yield, t/h	Marketability, %	Total yield, t/h	Marketable yield, t/h	Marketability, %
Nantes Kharkiv (control)	43,1	33,2	77,0	37,1	28,3	76,2
Red Giant	30,6	24,2	79,0	47,3	39,2	83,0
Rehulska	39,7	30,3	76,3	23,8	19,9	83,5
Queen of Autumn	38,7	26,4	68,2	32,4	22,4	69,2
Lange Rote Stumpfe	31,8	25,6	80,4	39,3	34,8	88,4

2. – Loss of mass of root of different age within long-term storage in boxes (October–April)

Сорт	Sowing period	Loss, %			Total loss, %	Marketable products after storage, %
		Natural mass loss	Sprouted roots	Absolute shortage		
Nantes Kharkiv (control)	Spring	5,4	1,3	3,1	18,8	81,2
	Summer	5,1	1,0	2,8	16,1	83,5
Red Giant	Spring	5,6	1,1	2,7	21,9	78,1
	Summer	5,1	0,7	1,8	17,3	82,7
Red Giant	Spring	5,8	1,2	2,5	24,4	75,6
	Summer	4,6	0,8	2,0	22,5	77,5
Queen of Autumn	Spring	7,0	1,4	1,9	31,3	68,7
	Summer	6,4	1,2	1,5	29,8	70,2
Lange Rote Stumpfe	Spring	6,3	0,9	3,2	26,7	73,3
	Summer	5,4	0,8	3,0	23,4	76,6
HIP 0,05	–	0,16	0,07	0,09	1,61	–

Note: vegetation period: spring sowing – 174 days, summer sowing – 123 fays.

3. – infestation of carrot depending on biological age and at different storage ways
(average 2012–2014)

Varity	Vegetation period	Way of storage	Rot share, %					
			White	Grey	Black	Fomoz	Bacterial	Mixed diseases
Nantes Kharkiv (control)	174	Boxes	16,8	7,9	3,3	8,7	3,2	3,3
		Plastic bags	9,3	3,8	1,8	5,4	2,2	2,8
		Claying	2,1	1,5	0,7	2,3	0,6	1,4
	123	Boxes	12,3	5,6	2,7	7,0	–	2,4
		Plastic bags	4,6	2,3	0,9	4,3	0,2	1,3
		Claying	1,6	0,3	0,3	–	–	1,1
Red Giant	174	Boxes	24,5	11,9	2,0	7,3	1,7	3,6
		Plastic bags	10,1	5,9	0,3	4,7	0,8	2,8
		Claying	2,8	1,8	–	2,0	–	1,1
	123	Boxes	19,2	9,7	2,1	6,0	1,2	3,0
		Plastic bags	9,0	3,3	1,0	4,0	0,4	2,5
		Claying	1,3	0,9	0,5	0,2	–	–
Rehulska	174	Boxes	6,7	6,4	6,0	23,2	4,3	2,7
		Plastic bags	2,8	0,9	0,4	11,1	2,1	2,0
		Claying	1,0	0,1	–	2,3	1,3	1,0
	123	Boxes	4,2	4,6	5,2	18,7	3,8	2,0
		Plastic bags	2,0	2,9	0,4	8,4	1,2	1,5
		Claying	0,2	–	–	2,0	0,6	0,9

Continuance Table 3.

Varity	Vegetation period	Way of storage	Rot share, %					
			White	Grey	Black	Fomoz	Bacterial	Mixed diseases
Queen of Autumn	174	Boxes	31,7	15,4	2,0	17,3	2,3	4,9
		Plastic bags	20,2	7,8	2,0	12,1	1,3	3,0
		Claying	3,4	2,0	0,7	3,2	0,5	0,6
	123	Boxes	26,5	13,2	0,6	14,5	2,0	3,6
		Plastic bags	13,4	5,9	0,4	10,9	1,0	2,2
		Claying	3,0	2,0	0,3	2,4	0,2	0,3
Lange Rote Stumpfe	174	Boxes	34,2	14,7	5,1	3,1	2,2	3,0
		Plastic bags	26,0	6,9	2,1	2,0	1,1	1,1
		Claying	5,0	3,1	0,9	0,7	1,0	0,2
	123	Boxes	32,6	9,2	4,6	2,7	0,9	2,1
		Plastic bags	18,1	6,1	2,9	1,8	0,6	1,0
		Claying	2,2	1,0	0,2	0,2	–	0,4
HIP 0,05			1,2	0,8	0,5	0,9	0,8	1,1