

VIABILITY CHARACTERISTICS AND PHYSIOLOGICAL BEHAVIORS IN CABBAGE SEEDS IN DEPENDS ON STAGE OF MATURITY

ХАРАКТЕРИСТИКА НА ЖИЗНЕНОСТТА И ФИЗИОЛОГИЧНИТЕ ПРОЯВИ НА СЕМЕНА ОТ ЗЕЛЕ В ЗАВИСИМОСТ ОТ СТЕПЕНТА НА ЗРЯЛОСТ

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ABSTRACT

The main purposes of the present study were to establish the changes during different stage of maturity and development of cabbage seed as well as earliest behaviors of viability and harvesting data. The experiments were carried out with two typical Bulgarian cultivars Balkan and Ditmarsko ranno. Samples of seeds in different days after flowering – 30, 40, 50 and 60 days were analyzed.

The physiological parameters and viability and vigor were investigated. The weight of one seeds was highest between 40 and 50 days. The primary germination was observed in seed harvested in 30 days, but the stability one was registered on 60 day. The intensity of respiration and activity of enzyme peroxides changed during seed development and maturity.

Key words: cabbage, maturity, morphological characteristics, vigor, viability.

РЕЗЮМЕ

Основната цел на настоящето изследване е да се установят промените в семената от зеле през различни стадии на зрялост, както и най-ранните прояви на жизненост и срок на семедобиване. Опитите се проведоха с два основни български сорта – Балкан и Дитмарско ранно. Проби от семена, взети на 30, 40, 50 и 60 ден след цъфтеж се анализираха.

Проучиха се физиологични параметри и жизненост на семената. Масата на едно семе е най-голяма на 40 и 50 ден. Най-ранна кълняемост се наблюдава в семената от 30 ден след цъфтеж, но стабилни посевни качества се установиха в семена, взети на 60 ден. Интензивността на дишане и активността на ензима пероксидаза се изменяха по време на развитие и узряване на семената.

Ключови думи: зеле, зрялост, морфологична характеристика, растежна сила, жизненост.

DETAILED ABSTRACT IN BULGARIAN

Основната цел на изследването е да се установят промените в семена от зеле през различни стадии на зрелост и развитие, както и да се определи най-ранното настъпване на жизненост и срок на прибиране. Опитите бяха проведени в Аграрен университет, Пловдив, България, през периода 2005-2007 със сортове зеле – Балкан – за късно полско производство и Дитмарско ранно – за ранно полско производство, отгледани по метода “на розетката”. На 30, 40, 50 и 60 ден след цъфтеж са взети проби за определяне на: маса и диаметър на едно семе, кълняема енергия, кълняемост, свежа маса на прорастъците, дължина на ембрионалния корен и на хипокотила, скорост и дружност на прорастване, съдържание на: въздушно сухо вещество, абсолютно сухо вещество, интензивност на дишане, пероксидазна активност, съдържание на суров протеин, общи захари и мазнини.

Установи се, че и при двата сорта масата и диаметра на едно семе нараства до 50 ден след цъфтежа (Таблица 1), като най-силно е нарастването между 30-40 ден. Най-ранни прояви на кълняемост бяха отчетени за Балкан на 40 ден, а за Дитмарско ранно на 30 ден след цъфтежа. На 60 ден се установи и стабилна кълняемост – 88,6% за Балкан и 86,3% за Дитмарско ранно, което показва, че най-ранния срок за прибиране на семената от зеле е 60 дни след цъфтежа. Дължината на ембрионалния корен и на хипокотила (Таблица 2) нарастват най-много между 50 – 60 ден. Най-важният показател на растежната сила – свежата маса на прорастъците се увеличава значително в периода 40-50 дни след цъфтежа и е най-висока между 50-60. Между този показател и кълняемостта е установена положителна корелация – $r=0,78$ и $r=0,86$. Тези резултати още веднаж показват че възможния срок за прибиране е 60 дни след цъфтежа. Най-силно промени върху скоростта и дружността на

прорастване (Таблица 3) се забелязват между 30 и 60 ден. Сухата маса на семената се увеличава постоянно през всички изследвани периоди (Таблица 4), като също има положителна корелация с кълняемостта – $r=0,77$ и $r=0,79$. Подобна е тенденцията и за абсолютно сухото вещество. Интензивността на дишане е най-висока към 50 ден след цъфтеж за Балкан и до 40 ден за Дитмарско ранно. Подобни резултати се отчетоха и за активността на ензима пероксидаза. Суровия протеин (Таблица 5) намалява при Балкан и нараства при Дитмарско ранно. Най-високо съдържание на захари беше определено за семената от 60 ден, а за мазните на тези от 50 ден. Корелационните коефициенти между съдържанието на мазнини и кълняемостта са също положителни и високи.

В заключение можа да се изтъкне, че масата и диаметра на семената от зеле нарастват до 50 ден след цъфтежа. Стабилна кълняемост и растежна сила се отчита на 60 ден, което е и най-ранния възможен срок за прибиране. Узряването е свързано с увеличаване на сухото вещество и с намаляване на дишането и на активността на ензима пероксидаза. При узряване съдържанието на суров протеин се изменя слабо, най-високо е съдържанието на общи захари на 60 ден, а на мазнини на 50 ден.

INTRODUCTION

The correct determination of the harvesting date in vegetable seeds is important to a great extent for their life potential, sowing qualities, term of storage and affecting in many cases their future yield. The significance of this practice increases particularly in vegetable species characterized by non-uniform ripening of fruits as a cabbage [7]. The hypothesis of Harrington that seeds attain maximum sowing qualities at the end of their complete maturation, or at the so-called stage of mass maturity and at reaching maximum physiological maturity, is very

Table 1. Morphological and sowing characteristics of cabbage seeds
Таблица 1. Морфологична и посевна характеристика на семената

Variants/ Варианти	Weight of one seeds/ Маса на едно семе – mg		Diameter of one Seeds/ Диаметър на семе – cm		Germination energy/ Кълняема енергия - %		Germinability/ Кълняемост - %	
	Balkan/ Балкан	Ditmarsko ranno/ Дитмарско ранно	Balkan/ Балкан	Ditmarsko ranno/ Дитмарско ранно	Balkan/ Балкан	Ditmarsko ranno/ Дитмарско ранно	Balkan/ Балкан	Ditmarsko ranno/ Дитмарско ранно
30 day/ден	5.43	6.55	0.30	0.28	0.0	2.0	16.45	13.0
40 day/ден	6.21	7.69	0.30	0.31	1.1	2.0	19.08	21.0
50 day/ден	6.86	8.02	0.32	0.28	4.65	3.0	37.53	31.65
60 day/ден	5.79	7.63	0.28	0.27	76.0	74.3	88.66	86.3
5.0%	0.44	0.77	0.04	0.01	1.82	1.09	30.23	14.17
GD1.0%	0.85	1.12	0.06	0.02	2.67	1.58	43.78	20.53
0.1%	1.24	1.69	0.09	0.04	3.87	2.37	65.68	30.8

common [6]. However some authors, as Ellis et al. [4] and Demir et al. [3] revealed the presence of contradictions in this assertion. Tekrony and Egli [15], comparing the dependence of seed viability and sowing qualities on the maximum dry matter content in them, established that in dry seed species such as lettuce, onions, cabbage etc. maximum seed viability was established at the initiation of high dry matter accumulation, or somewhat earlier Still and Bradford [13] developed a model for more precise determination of the time of physiological maturity initiation and the suitable harvesting date of high quality cabbage seeds as quantified germination rate, uniformity of germination, viability and sensitivity of germination to water potential and abscisic acid. They established that when maturing seeds became more uniform and their sensitivity to water potential and abscisic acid decreased.

Still [12] assessed primarily the susceptibility of seeds to abiotic stress factors, particularly to reduced water potential and shelf life and used its as a biological base to development a model for determining the harvesting date of cabbages seeds.

The main purposes of the present study were to establish the changes during different stage of maturity and development of cabbage seed as well as earliest behaviors of viability and harvesting date.

MATERIALS AND METHODS

The experiments carried out in Experimental field of Department of Horticulture, in Department of Physiology and Plant Biochemical and in Central Scientific Laboratory at the Agricultural University, Plovdiv, Bulgaria in 2005-

Table 2. Vigour behavior of cabbage seeds
Таблица 2. Растежна сила на семената от зеле

Variants/ Варианти	Length of embryo root/ Дължина на ембрионалния корен – cm		Length of hypocotyls/Дължина на хипокотила - cm		Fresh weight of sprouts of one seed/Свежа маса на прорастъците на едно семе – mg	
	Balkan/ ан/Ба- лкан	Ditmarsko ранно/Дит- марско ранно	Balkan/Ба лкан	Ditmarsko ранно/Дит- марско ранно	Balkan/ Балкан	Ditmarsko ранно/Дит- марско ранно
30 day/ден	2.70	1.40	3.19	1.50	17.8	13.8
40 day/ден	3.55	2.60	2.99	1.84	29.5	23.8
50 day/ден	4.67	2.95	3.08	3.15	30.2	29.3
60 day/ден	6.24	4.44	4.40	5.76	41.6	47.5
5.0%	1.02	0.6	1.66	0.85	6.3	9.02
GD1.0%	1.48	0.87	2.41	1.24	9.2	13.06
0.1%	2.23	1.30	3.62	1.86	12.35	19.56

Table 3. Rate and simultaneity of germination of cabbage seeds
Таблица 3. Скорост и дружност на прорастване на семена от зеле

Variants/ Варианти	Rate of germination/Скорост на прорастване – day/дни		Simultaneity of germination/ Дружност на прорастване - %	
	Balkan/ Балкан	Ditmarsko ранно/ Дитмарско ранно	Balkan/ Балкан	Ditmarsko ранно/ Дитмарско ранно
30 day/ден	6.11	7.1	2.18	1.85
40 day/ден	5.82	6.86	3.65	2.60
50 day/ден	5.33	5.91	2.69	2.1
60 day/ден	2.14	2.48	8.98	9.25
5.0%	0.9	1.72	2.77	2.7
GD1.0%	1.31	2.5	4.02	3.92
0.1%	1.97	3.75	6.03	5.88

2007 with two typical Bulgarian cabbage cultivars Balkan – for late field production and Ditmarsko ranno – for early field production. The plants were grown as overwintering transplanting in stage of eight leaves. In 30, 40, 50 and 60 days after flowering seed samples were taken from central stems of 30 different plants. The weight and diameter of one seed, germination energy (first count) and germinability (final count) [5] were determined. The vigour behaviors – fresh weight of sprouts of one seed, length of embryo root and hypocotyls, rate [9] and simultaneity [14] of germination were analyzed at the moment of germinability account. Air-dry matter (1,0 g of seed in four replication were dried in ambient temperature for 20 days and its weight was measured), absolutely dry matter, intensity of respiration (gasmeterically), peroxidase activity, content of row protein, total sugar and lipid content [11] were investigated. The statistical analyses were made by ANOVA. The presented data are average values from three years of investigating, because the trends were similar.

RESULTS AND DISCUSSION

The weight of one seed (Table 1) from both cultivars increased to 50 days after flowering and reached from 5,43 mg to 6,86 mg for Balkan and from 6,55 mg to 8,02 mg for Ditmarsko ranno. The highest growth was observed between 30 and 40 day – 0,78 mg and 1,14 mg for both mentioned cultivars, respectively. In the period between 50 and 60 day decrease of the seed weight was registered with 1,07 mg (Balkan) and 0,39 mg (Ditmarsko ranno). It could be due to the natural loss of the water during maturation processes. The other seed morphological index – diameter of seed, there was the similar trend of development. The changes were in short limits and the decrease began for Balkan also in 50-60 day, but in Ditmarsko ranno it observed yet between 40-50 day.

The best important characteristics for seed development and maturation are their sowing quality. The first manifestation of germination even though very weakly was registered for Balkan on 40 day after flowering and for Ditmarsko ranno on 30 day. The germination energy changed slowly to 50 day after flowering and in 60 day was observed sharply increase and reached to 76,0 % and 74,3 % for Balkan and Ditmarsko ranno, respectively. The germinability increased uniformly and stable levels were accounted on 60 day. The germinability – 88,6% for Balkan and 86,3% for Ditmarsko ranno approached strongly to the requirements for first class according Bulgarian State Standard. It indicates that the earliest acceptable harvesting date of seed cabbage is no earlier

than 60 days after flowering. Statistical significance of the differences between variants was established.

Except of the germination very considerable are the parameters of vigour. They are indicative not only that seed is able to emergence of embryo root but also that seed can development normally sprouts in different condition [2,5]. As pointed out Perry D. A. [8] vigour is the sum of the properties which determine the potential level of activity and performance of the seed or seed lot during germination and seedling emergence. Seeds which perform well are termed “high vigour seeds”. Schmidt L. [10] reported that vigour is a more important characteristic of seed, which described better the seed status. One of the most uses feature for determination of vigour is fresh matter of sprouts [2]. The length of embryo root (Table 2) increase regularly during each periods of investigation. The highest step of increase was registered between 50 and 60 day with 1,57 cm and 1,49 cm for Balkan and Ditmarsko ranno, respectively. The length of hypocotyls varied in Balkan from 3,19 cm on 30 day to 4,40 cm on 60 day and in Ditmarsko ranno from 1,50 cm to 5,76 cm for the mentioned periods. There also the increase was highest between 50-60 day. The fresh matter of one sprout is one of the basic vigour parameters and it increased gradually. Sharply increase established between 40-50 day with 18,45 mg and 10,65 mg and highest between 50-60 day – 51,13 mg and 54,65 mg for Balkan and Ditmarsko ranno, respectively. High positive correlation between this sprout behavior and germinability was established – $r=0,78$ and $r=0,86$ for both mentioned cultivars. The data for these three vigour characteristics once again confirmed that the appropriate harvesting date for cabbage seeds is 60 day after flowering. The differences between data are statistically significant.

Additionally information about whole seed status gives the rate and simultaneity of germination (Table 3). To 50 day after flowering these indices were with very weakly values. The rate of germination between 30-50 day improved and changed in short limits, the difference was only 0,78 day and 1,19 day, but between 30 and 60 day the differences reached to 3,97 day and 4,62 day for Balkan and Ditmarsko ranno, respectively. Improvement was observed also for simultaneity – from 2,18% on 30 day in Balkan on 50 day this parameter was 8,98% and for other cultivar this change were from 1,85% to 9,25%. Discrepancy from regularly established trend of development was observed in simultaneity, when on 40 day the values were insignificant higher than this one in 50 day.

One of the basic indicators for seed maturity is an increase of dry matter content. The maturation processes and changes in chemical seeds components correspond

with increase of dry matter (Copland and McDonald [2], Broniewski, St. et al. [1]). Dry matter (Table 4) increased constantly in each investigating period. In cultivar Balkan from 33,30% on 30 day it reached to 79,20% on 60 day. In Ditmarsko ranno the differences between initial day of study to 60 day after flowering was 48,95 %. This parameter there were high and positive correlation with germinability – $r=0,77$ and $r=0,79$ for Balkan and Ditmarsko ranno, respectively, which confirm its importance for sowing quality of seeds. The similar trend observed also for absolutely dry matter, but there the differences were smaller. During the maturation and development of the seeds the intensity of respiration changed significant. The values of this behavior in Balkan increased to 50 days after flowering and after that in 60 day decreased, while in the other cultivar the decrease began in 50 day yet. Similar course observed for activity of enzyme peroxides – decrease in Balkan on 60 day and in Ditmarsko ranno on 50 day.

The contents of chemical components change during seed maturation (Table 5). Some cultivar responses were established for row protein content. In Balkan it decreased, while in Ditmarsko ranno increased during maturation in short limits. Total sugar content was with

highest values on 60 day in both cultivars. Lipid content increased to 50 day after flowering and after this moment decreased insignificant, but the values were higher than in 30 and 40 days. This is one of the main energy sources for seed germination. The correlation coefficients between lipid content and germinability were positive, middle for Balkan – $r=0,45$ and high for Ditmarsko ranno – $r=0,63$. Copland and McDonalds [2] pointed out that usually high lipid content associated with decreased protein content.

CONCLUSIONS

During the maturation and development of cabbage seeds occurred changes. The weight and diameter increased to 50 day after flowering.

Stable germination energy and germinability were established on 60 day and differences with previous period were very sharp. This indicated that the earliest and appropriate harvesting data for cabbage seeds is 60 after flowering. Highest vigour such as length of embryo root and hypocotyls, fresh matter of sprouts, rate and simultaneity of germination observed also for seed harvested on 60 day after flowering.

Table 4. Physiological indexes of cabbage seeds
Таблица 4. Физиологични показатели на семена от зеле

Variants/ Варианти	Air - dry matter/ Въздушно суха маса %		Absolutely dry matter/Абсолютно суха маса - %		Intensity of respiration/ Интензивност на дишане		Peroxidas activity/ Пероксидазна активност	
	Balkan /	Ditmarsko ranno/ /	Balkan /	Ditmarsko ranno/ /	Balkan/ /	Ditmarsko ranno/ /	Balkan/ /	Ditmarsko ranno/ /
	Балкан	Дитмарско ранно	Балкан	Дитмарско ранно	Балкан	Дитмарско ранно	Балкан	Дитмарско ранно
30 day/ден	33.30	27.61	88.3	77.2	120	165	245	245
40 day/ден	44.32	33.81	89.58	79.5	130	180	235	250
50 day/ден	45.00	45.07	90.0	86.0	238	155	240	245
60 day/ден	79.20	76.56	92.2	89.61	155	142	238	225
5.0%	11.99	17.1	6.01	4.45	10.22	7.6	7.55	7.49
GD1.0%	17.02	24.76	8.71	6.57	14.8	11.02	10.93	10.85
0.1%	25.11	37.15	13.07	9.86	22.21	16.53	16.4	16.28

Table 5. Chemical components of cabbage seeds
Таблица 5. Химичен състав на семена от зеле

Variants/ Варианти	Content of row protein/ Съдържание на суров протеин - %		Total sugar content/ захари Общи -%		Lipid content/ Съдържание на мазнини -%	
	Balkan/ Балкан	Ditmarsko ranno/ Дитмарско ранно	Balkan/ Балкан	Ditmarsko ranno/ Дитмарско ранно	Balkan/ Балкан	Ditmarsko ranno/ Дитмарско ранно
	30 day/ден	20.72	20.4	9.00	9.00	35.92
40 day/ден	19.84	21.70	9.12	9.38	37.3	33.1
50 day/ден	19.50	21.36	9.75	10.76	41.98	35.26
60 day/ден	17.04	23.63	11.30	11.72	39.36	34.88
5.0%	1.16	1.56	0.97	0.66	0.78	2.23
GD1.0%	1.69	2.27	1.41	0.88	1.13	32.3
0.1%	2.54	3.40	2.12	1.32	1.70	4.85

The processes of maturity are corresponded with increase of dry matter. In the harvesting data the intensity of respiration and activity of enzyme peroxides decreased. Row protein content changed in short limits. The sugar content was highest in 60 day, while the lipid content increased during maturation and in the moment of harvesting decreased.

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