EESTI NSV TEADUSTE AKADEEMIA TOIMETISED. XVI KÖIDE
BIOLOOGIA. 1967, Nr. 4

ИЗВЕСТИЯ АКАДЕМИИ НАУК ЭСТОНСКОЙ ССР. ТОМ XVI
БИОЛОГИЯ. 1967, № 4

https://doi.org/10.3176/biol.1967.4.05

K. KASK

EARLY FRUIT MATURITY OF FRUIT TREE SEEDLINGS AS AN AFTERACTION OF TREATING THE SEEDS WITH ALTERNATE TEMPERATURES

The experiments on 5 fruit tree species (plum, Manchu cherry, apricot, peach, apple) carried out at the Institute of Experimental Biology (Academy of Sciences of the Estonian SSR) in 1958—1964 demonstrated that a prolonged treatment of the seeds with alternate temperatures caused changes in growth, biochemical composition as well as overwintering of the seedlings (Каск, 1964а, 1964б). A general growth depression was stated in the first life-year: germination slowed down, the seedlings were lower and had fewer branches, the branches were shorter and the stems slenderer as compared to the seedlings grown from seeds stratified at 4—8° C only. In the following years the growth depression phenomena disappeared and the experimental plants caught up with the control ones. The biochemical changes had a more constant nature, which became particularly evident in very unfavourable weather conditions. For instance, in the severe winter of 1962/63 the polyphenol content in the shoots of the 4-year-old experimental seedlings was statistically lower than that in the control ones, whereas the sugar content in March (during the last winter frosts) was greater. The treatment of the seeds with alternate temperatures called forth an increase in the variation of the phenotypic characters of the seedlings. The mentioned phenomenon concerned the winter-hardiness of the plants as well: to some extent more seedlings of the experimental version, compared with the control version, were destroyed during the first overwintering, but in the following years the percentage of the winter-hard seedlings was somewhat higher (Каск, 1964б). The results described refer to the necessity of carrying on the studies in the subsequent fruiting stage of the ontogeny of the seedlings.

In this paper the studies in the maturing-time of fruits, carried out from 1964 to 1966, are described.

Materials and Methods

Two fruit-tree species — Manchu cherry (*Cerasus tomentosa* (Thunb.) Wall.) and apricot (*Armeniaca vulgaris* Lam.) — were used in the experiments.

The seeds of Manchu cherry were obtained in 1960 from the Far East (Experimental Station of the Gorno-Taëzhnaya, Ussuriysk) — two forms of the species under the names of 'Selection' and 'Late-flowering selection', and one seed lot named by us the 'Kiev reproduction', received from Kiev (Ukrainian Scientific Research Institute of Fruit Gardening). In all probability, the primary material used in Kiev was of a Far East origin as well.

The seeds of the apricot variety 'Bairak' were obtained from Kiev in 1958, from the Ukrainian Scientific Research Institute of Fruit Gardening. In addition, observations were made on the seedlings of the apricot variety 'Uspekh' and of a hybrid plant, Nos 22—39 (seeds obtained from Michurinsk in 1955), in experiments initiated by Acad. J. Eichfeld, using the same method.

The seeds in the experiment were influenced in 10-day periods alternatively at 4 to 8° C and —1 to —3° (in refrigerator), from the beginning of the stratification until the appearance of the embryonic radicle. The control seeds were stratified at 4 to 8° only. The time of the stratification of the apricot seeds lasted for $2^1/_2$—$3^1/_2$ months, and that of Manchu cherry seeds — for 2 months. The seeds were put in coarse-grained washed sand (1955, 1958) or in sphagnum (1960). The experimental and control seedlings of every variety or form were cultivated in similar soil and in the same fertilizing and pruning conditions (Каск, 1964a). The number of the seedlings remaining until the beginning of the fruiting stage may be seen in tables 1 and 3.

The maturing time of apricot fruits was established on the grounds of day-to-day observations. As to Manchu cherry, the maturing time was established on July 25th, 1964, and the seedlings were arranged in three groups in accordance with the stage of their fruit maturity: 1) the fruits red, full in size, partially soft when touched (the beginning of full maturity) → early-maturing seedlings; 2) the fruits green or white, less than half of the size — late-ripening seedlings; 3) intermediate of the two afore-mentioned groups. In 1965 and 1966 observations on Manchu cherry were made at 3—5-day intervals.

Results

There was no evidence of differences at the beginning of the fruiting stage in our experiments (table 1).

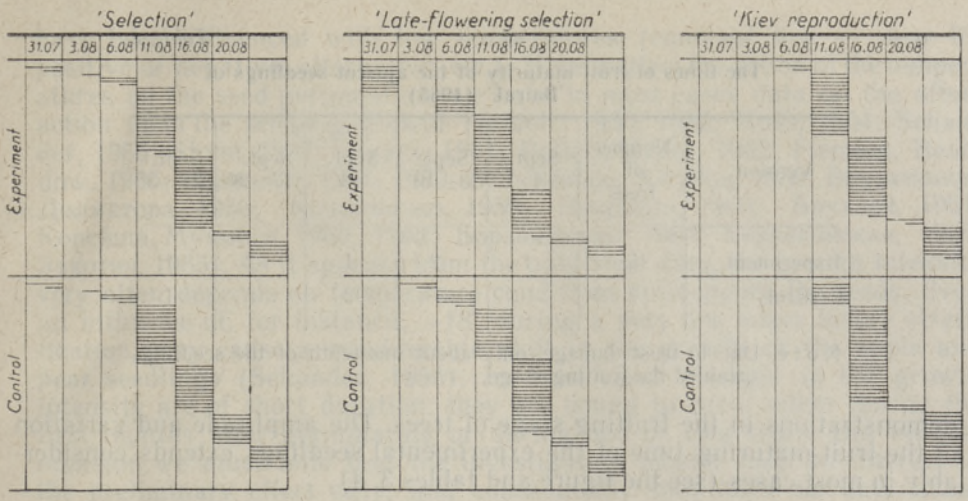
Table 1

The beginning of the fruiting stage in Manchu cherry

Material	Total number of shrubs, 1964 (in brackets — 1965)		Percentage of fruit-bearing shrubs			
			1964		1965	
	Experiment	Control	Experiment	Control	Experiment	Control
'Selection'	83(82)	85(82)	80	87	91	93
'Late-flowering selection'	35(34)	42(40)	57	60	91	85
'Kiev reproduction'	33	29	70	66	91	86

In table 1, the shrubs which flowered, but did not bear fruit have not been taken into consideration. For instance, in 1964, 80 to 90 per cent of shrubs flowered, but without noticeable differences between the experimental and control versions. Nevertheless, attention must be called to the following circumstance: the first fruit-bearing of the Manchu cherry seedlings was expected in 1963 already, but as a result of the frost damage in the preceding severe winter the shrubs did not bear fruit that year. Therefore the early-maturing seedlings might have remained unnoticed. Consequently, although the data at our disposal do not show any considerable differences in the arrival of the fruiting stage, we have no reason to deny such a possibility.

Considerable differences between the experimental and control seed-



Maturing times of the fruit of Manchu cherry in 1965, per 100 plants.

lings became evident in the maturing time of their fruits. In Manchu cherry, all the observations within the three years yielded the same results. In the experimental version the percentage of the late-ripening seedlings was always smaller than that of the controls in all the three forms. In two forms the percentage of the early maturing seedlings in the experimental version was considerably higher than that of the controls, whereas in one form the differences were negligible (see table 2 and the figure).

Table 2

The percentage of early-maturing and late-ripening seedlings of Manchu cherry (July 25, 1964)

Material	Early-maturing		Late-ripening	
	Experiment	Control	Experiment	Control
'Selection'	20	23	29	41
'Late-flowering selection'	53	8	25	50
'Kiev reproduction'	39	11	30	58

The results of the experiments with apricot seedlings were analogical with those of the Manchu cherry. We did not discover any noticeable differences in the time of the beginning of fruit-bearing, but our experiments did not permit to make a firm negative decision either. Considerable differences became evident in the maturing time of the fruit (table 3).

As to the fruit-bearing of the seedlings of the apricot variety 'Uspekh' and of the hybrid plant Nos 22—39, our observations were made during 4 years — 1962 to 1965. Every year some of the experimental seedlings had a noticeably earlier fruit-maturing time than the controls. But the fruit of the latest seedlings ripened more or less simultaneously, both in the experimental and control versions.

From the results obtained it can be concluded that a prolonged influence of alternate temperatures on seeds leads to changes in seedlings, the shift of the average maturity to an earlier time-interval being one of the

Table 3

The times of fruit maturity of the apricot seedlings of 'Bairak' (1965)

Version	Number of trees	Sept. 4	Sept. 8—10	Sept. 14	Sept. 17—20	Sept. 28—30
Experiment	5	1	2	1	—	1
Control	7	—	—	2	4	1

Note. Due to frost damage, only about one-tenth of the seedlings attained the fruiting stage.

demonstrations in the fruiting stage of trees. The amplitude and variation of the fruit-maturing time of the experimental seedlings extends considerably in most cases (see the figure and tables 3, 4).

Table 4

The shift and variation in the fruit-maturing time of seedlings, 1965

Species	Form or variety	Shift of average maturity to earliness in days	Coefficient of variation of fruit-maturing time, %	
			Experiment	Control
Manchu cherry	'Selection'	+0.8	34	35
	'Late-flowering selection'	+3.6	53	34
	'Kiev reproduction'	+2.2	45	33
Apricot	'Bairak'	+6	96	31

Discussion

The experiments on the influence of alternate temperatures on the seeds of arboreal plants demonstrate the potentiality of a certain afteraction in the ontogeny of the seedlings.

Here the paper by Lammerts (1942 — cited by Crocker, Barton, 1953) is of particular interest since it states the hastening of flowering of the peach trees when the very young seedlings were exposed to a certain period of cold. 91 per cent of these flowered in two years as compared with 55 per cent of trees from after-ripened seeds. Also, the number of flowers per tree was greater. The earlier flower-bud formation in peach, as an afteraction of treating the seeds with alternate temperatures, was observed by Koreisha and Muminov (Корейша, Муминов, 1962). The influence of different stratification temperatures on the earlier flower-bud formation of fruit-tree seedlings has been indicated by some other investigators as well (Кочерженко, 1959; Веньяминов, Юсубов, 1959). But we have not found any studies concerning the shift of fruit maturity.

Here we want to point out that various changes may be detected if before or during the stratification, or at the end of that period, the seeds

have been influenced with low temperatures (constant low — near 0°, positive or negative, alternative, etc.). If we neglect the action of the temperatures on the seed-germination, we have in most cases data on the afteraction upon the seedling-growth (Rudolf, 1950, 1952; Huss, 1954; Schander, 1956; Stone, 1957; Zagaja, 1961; Pollock Bruce, 1962; Flemion, Beardow, 1965; Родионов, 1956, 1959; Веньяминов, Юсубов, 1959; Веньяминов, Долматова, 1959; Кочерженко, 1959; Некрасов, 1960; Брухлей, 1961; Корейша, Муминов, 1960, 1962; Борзаківська, 1964; Борзаковская, 1965; Закотин, 1965). As it appears from the published data, the growth intensity very often depends on temperature conditions influencing the seeds. Even an influence of, for instance, —18° during a very few hours before stratification, may cause a considerable shift in the growth of the apple and pear seedlings (Schander, 1956). In most cases changes in the growth intensity are of short duration: they are bound to occur either during the first months after germinating or during one or two years. But on this occasion we must note that the investigators mostly took an interest in the preliminary effect only, and consequently they have no data about the later years of ontogeny. The growth stimulation achieved in the first years may be used in the practice of sylviculture (Некрасов, 1960).

In some single investigations it is indicated that the temperature conditions during stratification or germinating of seeds may cause great shifts in the biochemistry of seedlings (Корейша, Муминов, 1960, 1962; Борзаківська, 1964; Борзаковская, 1965). The physiological accommodation of plants to unfavourable environmental factors may be changed as a result of such deep reorganizing (Каск, 1964б). The results revealing the possibility of enhancing winter-hardiness in seedlings by affecting seeds with certain temperatures (Родионов, 1959; Веньяминов, Юсубов, 1959; Брухлей, 1960; Корейша, Муминов, 1960, 1962; Борзаківська, 1964; Борзаковская, 1965) may also be explained in this way. I should like to emphasize on this occasion that various changes in a certain direction must be interpreted only as shifts in statistical means. Not all seedlings from affected seeds change in the same direction or adapt themselves to a similar extent. The winter-hardiness of many plants may be reduced and therefore even the percentage of the destroyed plants may increase.

A treatment of seeds is advantageous if it causes an increase in the diversity of plant forms with features that are of interest to us. The possibility of selecting the forms with outstanding qualities opens up wide vistas to an acclimatizer or plant breeder.

Summary

The afteraction of a prolonged treatment of *Cerasus tomentosa* and *Armeniaca vulgaris* seeds with alternate temperatures (during the whole stratification) was studied. An earlier fruit-maturity was established in the seedlings. The shift in the direction of the early maturity is found to be a statistical regularity; in some seedlings the maturing time was as late as that in the latest control seedlings. The increase in the amplitude of the variation of the qualities of the seedlings gives a plant breeder the possibility of selecting the most outstanding seedlings. The changes in the growth, biochemical composition and adaptability of seedlings have been discussed.

*

The author is indebted to Mrs. Irene Tiivel for guidance in English, and to gardener Heino Sibul for his assistance in the actual gardenwork.

REFERENCES

Crocker W., Barton L. V., 1953. Physiology of Seeds. USA, Waltham, Mass.

Flemion F., Beardow J., 1965. Production of peach seedlings from nonchilled seeds. II. Effect of subsequent cold periods on growth. Contribs Boyce. Thompson Inst. 23 (4) : 101—107.

Huss E., 1954. Undersökningar över vattenhaltens betydelse för barrtrådsfröets kvalitet vid forvaring. Statens Skogsforskn. Inst. Medd. 44 (7) : 1—60.

Pollock Bruce, 1962. Temperature control of physiological dwarfing in peach seedlings. Plant Physiol. 37 (2) : 190—197.

Rudolf P. O., 1950. Cold soaking — a short-cut substitute for stratification. J. Forestry 48 (1).

Rudolf P. O., 1952. Cold soaking of Jack pine seeds. J. Forestry 50 (8).

Schander H., 1956. Keimungsphysiologische Studien an Kernobst. V. Z. Pflanzenzücht. 35 (3) : 345—361.

Stone E. C., 1957. Embryo dormancy and embryo vigor of sugar pine as affected by length of storage and storage temperatures. Forest Sci. (3) : 357—371.

Zagaja S. W., 1961. The effect of stratification of embryos on the subsequent cherry (*Pr. avium*) seedlings growth. Bull. Acad. Polon. Sci., Ser. sci. biol. (6) : 267—269.

Борзаківська І. В., 1964. Вплив змінних температур і деяких хімічних речовин на зимостійкість сіянців горіха волоського та каштана їстівного. Укр. ботанічний ж. 21 (4) : 16—24.

Борзаковская И. В., 1965. Некоторые пути повышения зимостойкости сеянцев древесных растений. В сб.: Рост и устойчивость растений 1 : 158—163. Киев.

Брухлей М. А., 1960. Влияние предпосевной обработки проросших семян низкими температурами, сроков посева и режима освещения во время вегетации на формирование зимостойкости сеянцев персика. В сб.: Физиология устойчивости растений : 352—356. М.

Брухлей М. А., 1961. Влияние продолжительности предпосевной обработки проростков семян (яровизация) с применением низких температур и режима освещения на формообразовательные процессы у некоторых плодовых культур. В сб.: Морфогенез растений 2 : 272—274. М.

Веньяминов А. Н., Долматова Л. А., 1959. О стратификации семян. Сад и огород (11) : 46—49.

Веньяминов А. Н., Юсубов А. М., 1959. Влияние условий подготовки семян абрикоса на развитие сеянцев. Агробиология (1) : 148—150.

Закотин В. С., 1965. Рост и развитие сеянцев яблони в условиях Московской области. Сб. работ молодых ученых. Н.-и. зональн. ин-т садоводства нечерноземн. полосы : 85—90. М.

Каск К., 1964а. Влияние обработки семян переменными температурами на рост сеянцев древесных растений. Изв. АН ЭССР, сер. биол. 13 (2) : 95—105.

Каск К., 1964б. Последействие обработки семян переменными температурами на биохимические процессы в сеянцах древесных растений. Изв. АН ЭССР, сер. биол. 13 (4) : 251—266.

Корейша З. И., Муминов Т. Г., 1960. Изменения роста и развития персика от воздействия пониженных температур на прорастающие семена. Физиол. растений 7 (1) : 89—91.

Корейша З. И., Муминов Т. Г., 1962. Влияние пониженных температур на рост и развитие персика. Тр. Н.-и. ин-та садоводства, виноградарства и виноделия УзССР 26 : 49—56.

Кочерженко И. Е., 1959. Ускорение развития и плодоношения сеянцев древесных растений. В сб.: Итоги и перспективы исследования развития растений : 120—136. М.—Л.

Некрасов В. И., 1960. Предпосевная обработка семян лесных древесных пород пониженными температурами. Изд. АН СССР. М.

Родионов А. П., 1956. О подзимних посевах персика. Изв. АН СССР, сер. биол. (4) : 67—73.

Родионов А. П., 1959. Формирование зимостойкости у сеянцев персика в зависимости от их стадийного состояния. Наследственность и изменчивость растений, животных и микроорганизмов, 2 : 294—297. М.

Academy of Sciences of the Estonian SSR,
Institute of Experimental Biology

Received
Jan. 30, 1967

K. KASK

MÕNEDE VILJAPUULIIKIDE SEEMNETE KÄSITLEMINE VAHELDUVATE TEMPERATUURIDEGA JA SELLE JÄRELMÕJU SEEMIKUTE VARAVALMIVUSELE

Resümee

Uuriti viltja kirsipuu (*Cerasus tomentosa* (Thunb.) Wall.) ja hariliku aprikoosipuu (*Armeniaca vulgaris* Lam.) seemnete pikaajalist (kogu stratifitseerimisperioodil) vahelduvate temperatuuridega käsitlemist selle järelmõju seisukohalt seemikute viljade valmimisajale. Tehti kindlaks, et seemnete mõjutamine kutsub seemikutel esile viljade varajasema valmimise. Näidatakse, et viljade valmimisaja nihkumine varajuse suunas on statistiline seaduspärasus: osal seemikutel jäi viljade valmimisaeg niisama hiliseks kui kontrollvariandi kõige hilisematel seemikutel. Seemikute omaduste varieeruvuse amplituudi suurenemine võimaldab rakendada seemnete mõjutamist väljapaistvamate omadustega seemikute valikuks selektsioonipraktikas.

Eesti NSV Teaduste Akadeemia
Eksperimentaalbioloogia Instituut

Saabus toimetusse
30. I 1967

К. КАСК

ВЛИЯНИЕ ПЕРЕМЕННЫХ ТЕМПЕРАТУР НА СЕМЕНА НЕКОТОРЫХ ПЛОДОВЫХ РАСТЕНИЙ И ЕГО ПОСЛЕДЕЙСТВИЕ НА РАННЕСПЕЛОСТЬ СЕЯНЦЕВ

Резюме

Изучали влияние длительного воздействия переменными температурами (в течение всей стратификации) на семена войлочной вишни (*Cerasus tomentosa* (Thunb.) Wall.) и обыкновенного абрикоса (*Armeniaca vulgaris* Lam.) с точки зрения последействия на сроки созревания плодов у сеянцев. Применение температурного воздействия значительно ускорило созревание плодов. Показано, что сдвиг сроков созревания — статистическая закономерность: часть сеянцев осталась по сроку созревания плодов на уровне самых поздних сеянцев контрольного варианта. Увеличение амплитуды варьирования свойств сеянцев позволяет применять метод на практике при селекции для отбора сеянцев с выдающимися свойствами.

Институт экспериментальной биологии
Академии наук Эстонской ССР

Поступила в редакцию
30/I 1967