
Generative development of various red beet cultivars after flowering induction

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After flowering induction in a growth chamber with low temperature ($+4 \pm 1$ °C) and 11 h photoperiod more red beets of Bordeaux and Cylinder type than of Detroit type formed stalks, flowered and ripened. The generative development of various cultivars of the same type differed, e.g., red beet 'Boltardy' did not ripen, and on the average 7.6 g seeds were gathered from red beet 'Pablo F₁'. The amount of ripening plants and seed plant productivity depended upon cultivar properties and postinduction growing conditions. Seed plants of Bordeaux type were more productive and ripened significantly more germinal seeds.

Key words: cultivar, flowering induction, generative development, red beet, seed plant

INTRODUCTION

Red beet (*Beta vulgaris* L. subs. *vulgaris* convar. *vulgaris* var. *rubra* Buren.) [1] is a biennial plant under climatic conditions of our country, producing a rich foliage and root crop in the first breeding year. It is urgent for breeding to obtain a generation of red beet in one year. In Poland two methods for speeding up red beet development are used: 1) mother plants are vernalized for eight weeks at temperature of +4 °C or 2) flowering in young plants is induced at a temperature of +4 °C and 12 h photoperiod [2, 3]. At the Lithuanian Institute of Horticulture a generation of Cylinder type red beet of breeding numbers was obtained in one breeding year when: 1) mother plants of late sowing after usual storage were planted in a heated greenhouse ($+18^\circ \pm 5^\circ$ C and 14–16 h photoperiod) at the end of January or at the beginning of February; 2) flowering in young plants was induced in 65 days in a growth chamber with low temperature ($+4^\circ \pm 1^\circ$ C) and 10 h photoperiod [4–6]. At the optimum temperature ($+5^\circ - +9^\circ$ C) thermoinduction of red beet proceeded 3–5 weeks [7].

Red beet cultivars of various types such as Egypt, Bordeaux, Detroit, Cylinder and others, in accordance with their morphological and biological characteristics were used in cross-breeding. In order to obtain their generation in one breeding year, it is important to know whether red beet of local and introduced cultivars develops generatively, flowers and ripens seeds upon inducing flowering in young plants under artificial conditions.

The aim of the present work was to estimate the possibility to obtain red beet generation of various cultivars of Bordeaux, Detroit and Cylinder type, when flowering in young plants was induced in a growth chamber with low temperature and short photoperiod.

MATERIALS AND METHODS

Trials were carried out in the experimental field and at the Laboratory of Plant Physiology at the Institute of Horticulture in 1998–1999. Red beet seeds of various cultivars of Bordeaux, Detroit and Cylinder type were sown into pots (volume 1 dm³) filled with compost (pH 6.0–7.0) on 2–15 January. Ten seedlings of each cultivar were grown in the greenhouse at a temperature of $+18^\circ \pm 5^\circ$ C and 14–16 h photoperiod (additional irradiation by SON-T Agro lamps), one plant – one sample.

Plants with 5–8 leaves were transferred to a growth chamber, where flowering was induced for 65 days at a temperature of $+4^\circ \pm 1^\circ$ C and 10 h photoperiod. Before and after flowering induction morphophysiological analyses were carried out and the organogenesis stages were determined according to the method prepared by F. Kuperman with co-authors [8].

Plants were transplanted to the field on 22–25 May. Before flowering, plants of each cultivar were isolated by polythene covers. Plant generative development (formation of inflorescences, flowering, seed ripening, productivity of seed plants and seeds

germination) was observed in the course of vege-
tation.

RESULTS AND DISCUSSION

It was established that before flowering induction the red beet apical domes were in organogenesis stage II, *i.e.* in juvenile phase. After 65 days of low temperature and short photoperiod treatment stage II ended in some plants and substage III₁ started in others (Table 1). The apical dome parameters of Cylinder type red beet changed more considerably: they were grown up mainly in the direction of inflorescence initials. The biggest diameter of apical dome was observed in red beet ‘Cylindra’ and ‘Rocket’ of Cylinder type and the smallest in red beet ‘Pronto’ of Detroit type.

Further processes of generative development in red beet proceeded in the field under moderate temperature and longer day conditions. Every year the amount of plants that formed inflorescences and flowered was bigger than the amount of seed ripening plants. According to the average of two-year results, 94.4% of Cylinder type and 92.0% of Bordeaux ty-

pe red beet formed stalks, 82.4% and 72.2% flowered, 44.7% ripened (Fig. 1). Less red beet of

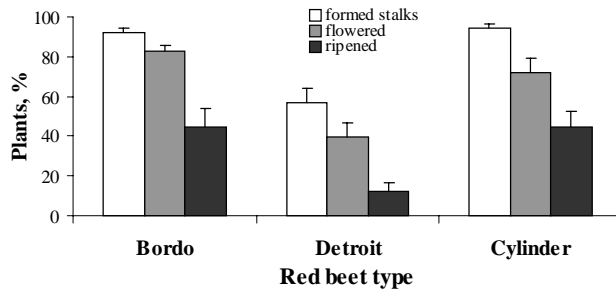


Fig. 1. Parameters of generative development of various red beet type after flowering induction (1998–1999)

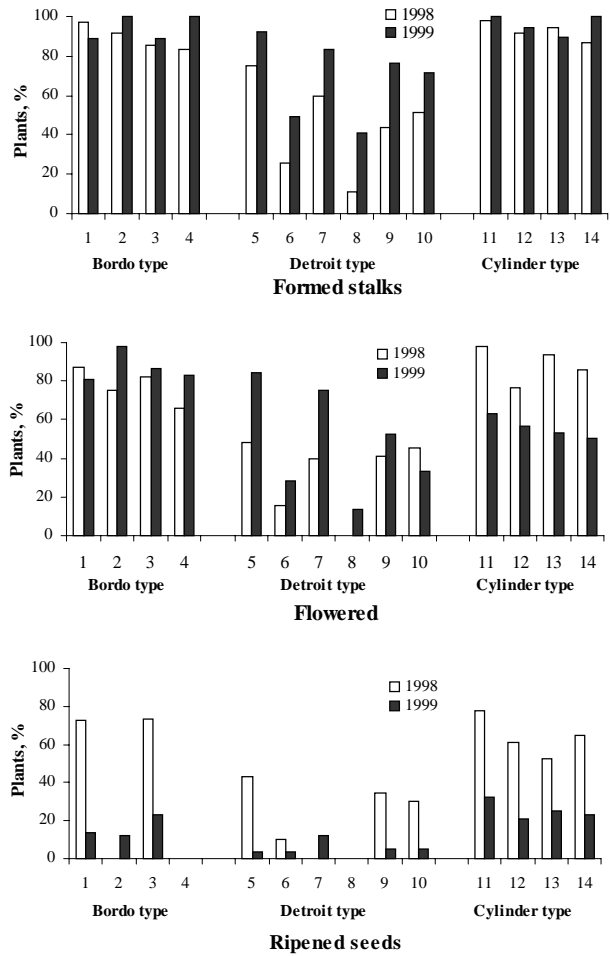


Fig. 2. The influence of environmental conditions on generative development of various red beet cultivars after flowering induction: 1 – ‘Kamuoliai 2’, 2 – ‘Ainiai’, 3 – ‘Joniai’, 4 – ‘683-1’, 5 – ‘Detroit 2’, 6 – ‘Bikores’, 7 – ‘Pronto’, 8 – ‘Boltardy’, 9 – ‘Wodan F₁’, 10 – ‘Pablo F₁’, 11 – ‘Cylindra’, 12 – ‘Rocket’, 13 – ‘Kosak’, 14 – ‘Ilgiai’

Table 1. Morphophysiological analyses of various red beet cultivars after flowering induction (1998–1999)

Red beet type	Cultivar or breeding number	Organogenesis stage	Length of apical dome, mm	Diameter of apical dome, mm
Bordeaux	‘Kamuoliai 2’	II end, III ₁	0.09 ± 0.027	0.14 ± 0.021
	‘Ainiai’	II, II end., III ₁ beginning	0.09 ± 0.011	0.13 ± 0.014
	‘Joniai’	II end, III ₁	0.11 ± 0.032	0.14 ± 0.026
Detroit	№ 683-1	II end, III ₁	0.11 ± 0.029	0.15 ± 0.020
	‘Detroit 2’	II end, III ₁	0.10 ± 0.021	0.14 ± 0.021
	‘Bikores’	II end, III ₁	0.11 ± 0.019	0.14 ± 0.023
	‘Pronto’	II end, III ₁	0.10 ± 0.020	0.12 ± 0.015
	‘Boltardy’	II end, III ₁	0.10 ± 0.026	0.15 ± 0.015
	‘Wodan F ₁ ’	III ₁ beginning, III ₁	0.11 ± 0.009	0.14 ± 0.029
	‘Pablo F ₁ ’	II end, III ₁	0.11 ± 0.023	0.15 ± 0.010
Cylinder	‘Cylindra’	III end	0.16 ± 0.014	0.17 ± 0.007
	‘Rocket’	III ₁ , III end	0.18 ± 0.018	0.17 ± 0.017
	‘Kosak’	III ₁	0.12 ± 0.014	0.14 ± 0.021
	‘Ilgiai’	III ₁	0.14 ± 0.024	0.14 ± 0.028

Detroit type developed generatively after flowering induction: 56.8% formed stalks, 39.8% flowered and only 12.8% of them ripened seeds.

Red beet of various types developed differently under the same growing conditions. In both years the Bordeaux and Cylinder type red beet developed more evenly than the Detroit type red beet (Fig. 2). Besides that, a distinct reaction to the flowering inducing factors was observed in various cultivars of the same red beet type. In 1998, 11% of Detroit type red beet 'Boltardy' raised stalks without forming inflorescences, in 1999 13.6% of them flowered but did not ripen seeds. At the same time 25.6–49.1% of Detroit type red beet 'Bikores' and 75.0–92.6% of red beet 'Detroit 2' formed stalks, 15.9–28.3% and 48.2–84.6% of them ripened seeds.

It could be supposed that flowering induction processes in red beet of various morphological types or earliness occurred at different time and intensity, therefore their optimum regime of flowering induction (duration of induction and photoperiod, temperature) could differ.

Meteorological conditions at the time of inflorescence formation and flowering greatly influenced the productivity of seed plants. In 1998, 72.6–73.4% of some Bordeaux type, 52.8–78.0% of some Cylinder type and up to 43.4% of some Detroit type cultivars ripened seeds in the field (Table 2). In 1998 seed yield per plant was higher than in 1999. The summer of 1999 was not favourable for seed plants

growing, often the weather was warm and dry, especially in July, and the temperature rose to 45–50 °C under isolation covers. The biggest part of red beet pollen was sterile, so seed setting was poor. A more sensitive reaction to the environmental conditions was observed in Detroit type red beet – in 1999 only up to 12.5% of plants ripened seeds. Seed plants of Cylinder type late cultivars flowered later under better environmental conditions, so 20.7–32.1% of plants ripened in 1999.

Seed plants of Bordeaux type red beet 'Kamuoliiai 2' and 'Ainiai' were most productive: on the average 5.6–9.0 g of seeds were gathered from one plant. Seed yield of Detroit type 'Pablo F₁' was 7.6 g per plant, 'Bikores' and 'Wodan F₁' 1.2–2.0 g, seed plants of 'Boltardy' did not ripen in both years. Seed germination of various cultivars varied. In 1998 germinated 50% to 65% and in 1999 53% to 75% of seeds. Seeds of Bordeaux type red beet were significantly more germinative in all trials.

It is supposed that the duration of the juvenile stage and the response to flowering-inducing factors in various genotypes of red beet is different. For this reason plants pass the flowering initiation processes in a different way and their reaction to environmental conditions differs. On application of the method of speeding up red beet development in breeding it is expedient to investigate the optimum flowering induction regime for various types of red beet, to ensure a stabile generative development and ripening of plants in the field.

Table 2. Seed plant productivity and seed germination in various red beet cultivars (1998–1999)

Red beet type	Cultivar or breeding number	Seed yield per plant, g			Seed germination, %		
		1998	1999	average	1998	1999	average
Bordeaux	'Kamuoliiai 2'	13.1	5.0	9.0	63.0	62.0	62.5
	'Ainiai'	9.3	2.0	5.6	64.0	59.0	61.5
	'Joniai'	7.6	3.0	5.3	65.0	75.0	70.0
	№ 683-1	10.0*	–	10.0*	62.0	–	62.0*
	Average:	10.0	3.3	6.2	63.5	65.3	64.0
Detroit	'Detroit 2'	6.1	16	3.8	52.0	57.0	54.5
	'Bikores'	2.0	1.6	1.8	50.0	59.0	54.5
	'Pronto'	0	2.2	1.1	–	60.0	60.0
	'Boltardy'	0	0	0	–	–	–
	'Wodan F ₁ '	2.6	1.5	2.0	50.0	59.0	54.5
	'Pablo F ₁ '	7.2	8.0	7.6	54.0	53.0	53.5
Average:	2.6	2.5	2.6	51.5	57.6	55.4	
Cylinder	'Cylindra'	4.1	2.3	3.2	58.0	59.0	58.5
	'Rocket'	4.7	3.2	4.0	55.0	58.0	56.5
	'Kosak'	3.5	2.5	3.0	63.0	59.0	61.0
	'Ilgiai'	8.4	6.8	7.6	61.0	55.0	58.0
	Average:	5.2	4.9	4.4	59.2	57.8	58.5
	LSD ₀₅	3.96	3.37	3.29	3.61	6.47	4.07

* One year data

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ĮVAIRIŲ VEISLIŲ RAUDONŲJŲ BUROKĖLIŲ GENERATYVINĖ RAIDA PO ŽYDĖJIMO INDUKCIJOS

S a n t r a u k a

Po 65 parų žemos teigiamos temperatūros kameroje (4 ± 1 °C, 11 val. fotoperiodas), daugiau Bordo ir Cilindriinių tipo burokėlių formavo žiedstiebius, žydėjo ir subrandino sėklas, negu Detroit tipo. To paties tipo įvairių veislių burokėlių generatyvinė raida buvo skirtinga: pvz., ‘Boltardy’ burokėliai visai nederėjo, o iš ‘Pablo F₁’ augalų vidutiniškai surinkta po 7,6 g sėklų. Augalų veislinės savybės bei auginimo sąlygos lėmė derančių augalų kiekį ir sėklų produktyvumą. Patikimai gausiau derėjo ir subrandino daigesnes sėklas Bordo tipo burokėliai.

Raktažodžiai: burokėliai, veislės, žydėjimo indukcija, generatyvinė raida, sėklojai