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Influence of seed germination dynamics on quality of tomato seedlings

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Summary

The influence of seed germination dynamics on selected features of the seedling of 4 tomato cultivars (Beta, Betalux, Promyk, New Yorker) meant for field cultivation were investigated. It was shown that flowering was the earliest in combinations with plants received from the seeds of the fastest germination, while the greatest delay of flowering was observed in plants received from the seeds of the longest germination (after 10 days). Plants grown from the seeds which had germinated the fastest were significantly higher, had greater average number of leaves, and had greater mass than plants from the seeds germinating longer. Further observations carried out at the moment of flowering of plants of all combinations did not show any significant differences in terms of investigated features except average height of plants.

Key words: tomato, cultivars, seed germination, seedling

INTRODUCTION

Quality of the seeds is one of the most important problems in plant production. Receiving good crops depends on using high quality seeds: only healthy, fully vital, and well developed seeds can give strong and proliferous plants. High quality of seeds ensures good growth of seedlings which are particularly sensitive to improper environmental conditions. Further growth, development, and yielding of plants depends on the good growth of seedlings (Grzesiuk 1967, Grzesiuk, Górecki 1981). Perry (1978) expressed an opinion that the rate and levelling of seed germination and seedling growth show their high vigour. Numerous studies proved that the seeds with low germination capacity do not guarantee good emergency and yielding even if the sowing rate was increased (Woyke et al., 1990; Tendaj, Gruszecki, 1995). In our

research it was shown that the dynamics of seed germination significantly influences the quality of tomato seedlings (paper in print). The aim of this paper was to state, if the differentiation resulting from the rate of seed germination, also influences the quality of seedlings.

MATERIAL AND METHODS

The research was carried out in years 1992-1994 in the Department of Vegetable and Medicinal Plants of the Agricultural University in Lublin and in the greenhouse of the Agricultural Experimental Station of the above University. The influence of seed germination dynamics on selected features of seedlings of 4 tomato cultivars (Beta, Betalux, Promyk, New Yorker) meant for field cultivation, was investigated. Seed germination dynamics was investigated in laboratory (standard) and greenhouse conditions; the observations were carried out at the same time. In the greenhouse the seeds were sown during the first week of April on Petri's plates, 200 seeds each, in 4 replications for each variety, in all experimental years. Then they were put on benches at the temperature of 20-28^{0}C (day) and 14-20^{0}C (night). As they were germinating (3, 5, 7, and 10 days after sowing) after the radicule had appeared, the seeds were moved from plates to boxes, put in gashes 1 cm deep with the spacing of 5 × 5 cm, covered with sand, and watered. 12 days after sowing few seeds germinated and that was why they were not put under further observation. The received seedlings were pricked after reaching the phase of growth in which the smallest of them could be pricked.

The estimation of the seedlings was made:

a) when in the plants (within cultivar) the first flower had flowered in a blossom, no matter if the plants derived from the seeds germinating after 3, 5, 7, or 10 days,
b) after plants from every germination term had reached the same phase of growth and development (indicated by flowering of the first flower in the blossom) in order to state if there were still some morphological differences between plants of different germination terms, in that phase.

Biometric measures of the plants included: height of plants (cm), number of leaves, collar-root diameter (mm), number of clusters developed, and mass of plants (g). The results were evaluated statistically using the method of variance analysis according to triple cross classification for non-orthogonal data. Statistical inference was carried out on the basis of Tukey's multiple confidence intervals at the confidence level of a=0.05. Because of the fact that the seeds of some species had not germinated after 3 days, it was impossible to carry out the statistical analysis for all counting terms. Therefore the analysis was performed only for 2nd, 3rd, and 4th counting term (i.e., 5, 7, and 10 days after sowing, respectively). The significance of differences in each year was shown using letter indications: means marked with the same letter did not differ significantly from each other.

RESULTS AND DISCUSION

The signal to carry out the observation of a seedling was the flowering of the first flower in the blossom in one of the combinations within a variety. On the basis of biometric measures (Table 1) it was shown that the plants grown from the seeds

germinating with the highest rate (after 5 days) were significantly higher than the plants from the seeds germinating longer, had more leaves and greater mass. Significant differences in terms of the described features appeared between all combinations. In this phase of growth and development of the plants, no significant differences in collar-root diameters of seedlings of investigated varieties were stated. The influence of seed germination dynamics on the number of developed racemes was observed only in the case of the seedling received from seeds germinating after 10 days – it had fewer racemes than the plants derived from seeds germinating after 5 and 7 days.

Table 1

Biometric measurements of plants of 4 tomato cultivars taken in the flowering phase of the first flower in blossom from one combination within the cultivar (cm).

	Cultivar	Plants grown from seeds germinating after the following days			
		5	7	10	Means from 5, 7, 10
Plant height (cm)	Beta	29,8	24,8	22,9	26,1 a
	Betalux	27,6	27,2	24,4	26,6 a
	Promyk	33,1	29,9	23,8	31,3 b
	New Yorker	42,7	40,8	36,4	40,3 c
	Means	33,4 c	30,7 b	27,9 a	
Number of leaves	Beta	10,5	10,4	9,7	10,2 c
	Betalux	8,9	8,8	8,7	8,8 a
	Promyk	10,1	10,0	9,3	10,1 c
	New Yorker	10,1	9,3	8,9	9,5 b
	Means	9,9 c	9,6 b	9,1 a	
Number of clusters	Beta	2,3	2,0	1,8	2,0 b
	Betalux	1,6	1,6	1,3	1,5 a
	Promyk	2,1	1,9	1,0	1,9 b
	New Yorker	2,2	2,1	1,6	2,0 b
	Means	2,0 b	1,9 b	1,5 a	
Collar root diameter (mm)	Beta	6,9	6,9	6,7	6,8 b
	Betalux	6,9	6,7	6,5	6,7 b
	Promyk	6,1	6,1	5,7	6,1 a
	New Yorker	6,7	7,0	6,6	6,8 b
	Means	6,6 a	6,7 a	6,6 a	
Plant mass (g)	Beta	19,7	17,8	16,2	18,2 b
	Betalux	18,8	14,2	13,8	15,9 a
	Promyk	16,8	14,2	13,8	16,3 ab
	New Yorker	33,3	27,3	17,4	16,7 c
	Means	22,2 c	18,9 b	16,2 a	

In this growth phase the highest seedling was demonstrated by New Yorker cv. that differed significantly from the other cultivars in respect of the feature discussed. There weren't any significant differences in the seedling height recorded between Beta and Betalux cvs., wheres significant differences regarding this feature appeared between Beta and Betalux cvs., as well as Promyk and New Yorker ones. The highest number of leaves was statedain Beta cv. seedling (10.2 units) and Promyk (10.1 u). The greatest number of clusters developed in this growth phase was noted in the following seedlings: Beta (2.0 u), New Yorker (2.0 u) and Promyk (1.9 u) cvs., while significantly less - a seedling of Betalux cv. (1.5 u). The significantly lowest diameter of collar root was shown by Promyk cv. seedling (6.1 mm). Between the plants of the other cultivars there were no significant differences as regards this feature. The highest mean plant mass was demonstrated by New Yorker cv. seedling. No significant differences in respect of mean plant mass were recorded between Betalux and Promyk cvs. as well as Beta and Promyk cvs.

Table 2.

Retardation in flowering of plants in relation to combination in which flower appeared earliest (days).

Cultivar	1992				1993				1994			
	Number of days from sowing to seed germination											
	3	5	7	10	3	5	7	10	3	5	7	10
Beta	–	0	5	5	0	0	0	0	–	0	0	–
Betalux	0	5	5	5	–	0	0	2	–	0	5	–
Promyk	0	5	5	–	0	0	0	5	–	0	3	–
New Yorker	0	3	3	7	–	0	0	3	–	0	5	5

Flowering usually started in combinations with plants received from the seeds which had germinated the fastest (Table 2), while the greatest delay in flowering was observed in plants received from the seeds germinating the longest (after 10 days). The greatest differentiation in the rate of flowering appeared in 1992 (delay in flowering depending on the combination was 0 – 7 days), while the smallest differentiation was in 1993 (0 – 5-day delay shown by plants derived from seeds germinating the longest – after 10 days).

Following biometric measures of the seedling were carried out at the moment of flowering of the plants of all combinations (Table 3). The results indicate that the seedling received from the seeds of longer germination flowered later, but in the phase of flowering it was no different in terms of the average number of developed racemes, collar-root diameter, and plant mass from the seedling received from the seeds of faster germination. Only the plants derived from the seeds germinating after 5 days were significantly higher than the plants derived from the seeds germinating after 7 and 10 days.

Table 3.

Biometric measures of plants of 4 tomato cultivars taken after reaching same phase of growth and development by plants of all combinations (flowering of the first flower in blossom) (cm).

	Cultivar	Plants grown from seeds germinating after the following days			
		5	7	10	Means from 5, 7, 10
Plant height (cm)	Beta	29,8	25,1	24,2	26,6 a
	Betalux	28,5	29,9	28,1	28,9 b
	Promyk	33,8	31,6	31,6	32,8 c
	New Yorker	43,6	39,9	38,4	40,8 d
	Means	33,9 b	31,7 a	30,2 a	
Number of leaves	Beta	10,5	10,5	9,8	10,3 b
	Betalux	8,8	9,6	9,3	9,3 a
	Promyk	10,2	10,3	11,8	10,3 b
	New Yorker	10,2	9,3	9,0	9,5 a
	Means	9,9 a	9,9 a	9,5 a	
Number of clusters	Beta	2,3	2,2	2,1	2,2 b
	Betalux	1,7	2,0	1,7	1,8 a
	Promyk	2,2	2,1	1,8	2,1 b
	New Yorker	2,2	2,0	1,8	2,1 b
	Means	2,1 a	2,1 a	1,9 a	
Collar root diameter (mm)	Beta	6,9	6,9	6,9	6,9 b
	Betalux	6,9	6,9	7,1	6,9 b
	Promyk	6,2	6,4	7,0	6,3 a
	New Yorker	6,7	7,0	7,1	6,9 b
	Means	6,7 a	6,8 a	7,0 a	
Plant mass (g)	Beta	19,7	19,8	19,6	19,7 a
	Betalux	21,0	20,4	20,6	20,6 a
	Promyk	19,0	23,7	31,3	21,1 a
	New Yorker	34,3	26,8	23,6	28,6 b
	Means	23,6 a	22,6 a	21,8 a	

A seedling of all the cultivars observed over the flowering phase differed significantly in respect of plant height that may be accounted for different growth vigour of these cultivars. Beta cv. seedling reached mean height of 26.6 cm at the flowering

moment of the first flower at a blossom, while Betalux cv. – 28.9 cm, Promyk cv. – 32.8 cm, and New Yorker cv. – 40.8 cm. Seedling of Beta cv. (10.3) and Promyk (10.3) showed significantly higher mean number of leaves as compared to Betalux cv. seedling (9.3) and New Yorker one (9.5). Significant differences in respect of mean number of developed clusters were proved between seedling of Betalux cv. (1.8) and that of the other cultivars:Beta (2.2), Promyk (2.1) and New Yorker (2.1). Promyk cultivar seedling manifested a significantly smaller collar root diameter (6.3 mm) as against the seedling of the other cultivars: Beta (6.9mm), Betalux (6.9mm), New Yorker (6.9mm). The significantly highest mean plant mass was shown by New Yorker cv. seedling (28.6 g). However, seedling of the other cultivars did not differ significantly in this respect (Beta – 19.7 g, Betalux – 20.6 g, Promyk – 21.1 g).

In literature there is a lack of research concerning the influence of differentiated rate of tomato seed germination on further growth and development of plants. Because in our earlier research a significant influence of the rate of germination on the quality of seedlings was stated, therefore trials were undertaken for further inference by analogy to the influence of other methods of improving seed germination and vigour growth of seedlings on further growth and development of plants. Research results do not match in this matter. Perry (1981) points out that high rate of seedling growth indicates their great vigour, but not necessarily has an influence on further growth and development of plants, because during that period, environmental conditions are of a great importance. Similar statement was presented by Golińska (1929) and Grzesiuk and Kulka (1981). Golińska's research (1929) showed that greater seedlings are more resistant in the first phase of growth to negative vegetation conditions, but the longer the growth of plants the smaller the differences between plants derived from those seedlings. Longer lasting relationship between the quality of seeds and the development of plants (until yielding) was shown by Austin and Longden (1967) and Sokołowska et al. (1995) in the case of carrot seeds.

The received results match the results of some other authors (Golińska 1929; Grzesiuk and Kulka 1981; Alvarado et al. 1987; Wolfe and Sims 1992) that the influence of the differentiated size of seedlings, despite of the reasons of that differentiation (for example: conditioning of seeds, stimulation, or like in our studies - differentiation resulting from seed germination rate), shows only in the initial phase of plant growth. In later phases, growth and development of plants are highly influenced by environmental conditions which can totally level the positive influence of the seed germination rate observed at the beginning.

CONCLUSIONS

1. Seed germination rate significantly influenced the investigated features of the seedling of tomato evaluated in the phase of flowering of the first flower in the blossom of one of the combinations within a variety. Plants derived from the seeds: germinating after 5, 7, and 10 days were different from each other in terms of average height, average number of leaves, and mass.
2. Tomato seedling developed from the seeds of different germination rate, observed in the same phase (flowering) was not really different from each other in terms of average number of developed clusters, collar-root diameter, and plant

mass. Plants derived from the seeds germinating after 5 days were significantly higher than plants derived from the seeds germinating after 7 and 10 days.

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Wpływ dynamiki kiełkowania nasion na jakość rozsady pomidora

Streszczenie

Badano wpływ dynamiki kiełkowania nasion na wybrane cechy rozsady 4 odmian pomidora (Beta, Betalux, Promyk, New Yorker) przeznaczonych do uprawy w polu. Wykazano, że kwitnienie z reguły rozpoczynało się w kombinacjach z roślinami uzyskanymi z nasion kiełkujących najszybciej, a największe opóźnienie w zakwitaniu wykazywały rośliny uzyskane z nasion kiełkujących najdłużej (po 10 dniach). Rośliny wyrosłe z nasion kiełkujących najszybciej były istotnie wyższe, charakteryzowały się większą średnią liczbą liści i masą w porównaniu z roślinami wyrosłymi z nasion kiełkujących dłużej. Dalsze obserwacje przeprowadzone w momencie kwitnienia roślin z wszystkich kombinacji nie wykazały już istotnych różnic pod względem badanych cech z wyjątkiem średniej wysokości roślin.