

EFFECT OF THINNING DATE AND GENOTYPE ON SOME PHENOLOGICAL AND QUALITY CHARACTERISTICS OF SUGAR BEET SEED

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Abstract

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We analyzed the effect of thinning date and genotype on some phenological and quality characteristics of sugar beet seed produced by the over wintering method in two calendar years. Experiments were conducted in sugar beet seed plots located in the agro-ecological region of southern Bačka. The earlier genotype C had a higher correlation coefficient between the number of seeds per inflorescence branch and seed germination than the later genotype S. The two genotypes had similar correlation coefficients between the length of inflorescence branch and the number of seeds.

Compared with thinning in the spring, the fall thinning had significant effects on the length of the inflorescence branch, number of seeds per inflorescence branch and seed viability.

Key words: sugar beet seed crop, genotype, fall thinning, spring thinning, seed number per inflorescence branch, seed viability, length of inflorescence branch

Introduction

Many studies have shown that crops with a large number of plants/ha and a small number of empty places produce the highest yield of superior quality. Establishing the optimum number of plants is the most important factor for sugar beet yield and quality (Märlander, 1991). Sugar beet germination needs to be completed in a few days and this is an indicator of seed quality. Initial growth of sugar beet seedlings should be dynamic, and this will be reflected on later phenological stages of plant growth. Various factors govern the dynamics of sugar beet growth. It is considered that plants which do not compete for water and nutrients have shorter period of vegetation (Winner, 1974). In field conditions, sugar beet plants develop a different phenotype, which later in the vegetation affects the competition among plants for nutrients and water (Büchse, 1999).

Initial growth of many plant species can be represented by an exponential curve (Hunt, 1978). Date of

sugar beet planting tends to affect date of emergence, which is also heavily influenced by the weight, and area of cotyledons (Boiffin et al., 1992).

The objective of this study was to determine the effect of different thinning dates on the length of inflorescence branch, number of seeds per inflorescence branch and seed viability in two sugar beet genotypes differing in maturity group.

Materials and Methods

The effect of date of thinning of seed plots on the growth and development two sugar beet genotypes was examined in production plots of the Institute in 2010/2011. Encrusted seed was used for planting. Both genotypes were planted in the same arrangement and their emergence was uniform. Thinning was applied to ensure the equal number of plants/ha for both genotypes (Table 1).

Conventional cultural practices and the overwintering method were applied in the analyzed sugar beet seed

plots. Thinning, as a measure of crop care after sowing, was performed at the stages of second-third pair of leaves (15 October 2010) and fourth-fifth pair of leaves (15 March 2011). Mineral fertilizers were applied in accordance with the chemical analysis of soil and N-min method (Marinković et al., 2003) (Table 2).

The materials used in this study were two different sugar beet genotypes. The first one (C / KWS MS 138) is the female parent of the early hybrid variety Lara. The second one (S / NS-MS-031) is the female parent of the late hybrid variety Irina.

The weather conditions during planting in the late summer of 2010 were favorable for germination of sugar beet seed. The fall was cold and the snow was early.

Snow blanket remained until the second half of February 2011, when severe frosts occurred. The first half of spring was favorable for the growth of sugar beet seed crop, while a drought was registered in the second half of spring (Table 3).

Regression analysis (Hadživuković, 1977) and correlation analysis (Hadživuković, 1984) were performed to statistically process the obtained data.

Results

The quality of seed samples of the two genotypes used for planting was uniform (Table 4). The genotypes differed by one gram in the absolute weight of seed. The

Table 1
Dates of planting and fall and spring thinning

Genotype	Planting date	No. of plants/ha after emergence	No. of plants/ha after thinning	
			15.10.2010	15.03.2011
C	22.08.2010	135000	85000	85000
S	22.08.2010	131000	85000	85000

Table 2
Application of mineral fertilizers, kg/ha (Marinković et al., 2003)

Application method	N	P ₂ O ₅	K ₂ O	Fertilizer	kg/ha	N	P ₂ O ₅	K ₂ O
Previous soil status	110	79	55					
Plowed under				8-24-16	350	28	84	56
Plowed under				Urea 46	200	92		
Top dressed	92			AN-34	270	92		
Total						212	84	56

Table 3
Meteorological conditions, Novi Sad, 2010/2011

	08-07	09-07	10-07	11-07	12-07	01-08	02-08	03-08	04-08	05-08	06-08	07-08
Mean monthly temperature, C ^o	23	15	11	4	0	2	6	8	13	18	22	22
Total rainfall, mm	77	78	100	113	31	23	7	44	25	47	116	57
Total potential evapotranspiration, mm	98	77	51	23	11	13	27	45	69	118	128	130

Table 4
Physical characteristics of seed of the two genotypes

Genotype	Thousand-seed weight, g	Water absorption in 4 h, g H ₂ O	Laboratory emergence, %
C	12.57	0.32	95
S	11.23	0.31	91

genotypes were equal regarding water absorption. Seed germination varied slightly, by 4% in favor of genotype C. The above suggests that the genotypes had the same quality prerequisites for plant growth and development in seed plots.

Leaf area per plant was measured at the following phenological stages: leaf rosette stage, the stage of appearance of inflorescences branches and full flowering using the method of Campbell and Viets (1967). A comparison of the genotypes by the t-test at the 0.05 level showed no significant difference in leaf area index (Table 5).

Figure 1 shows that, in the case of genotype C, the correlation between number of seeds and seed viability was directly proportional, with the correlation coefficient of $r = 0.40$. The t-test showed a significant difference at 0.01 level between independent and dependent variables, which was 4.88^{**} .

In the case of genotype C, the correlation between the length of inflorescence branch and number of seeds was $r = 0.24$ (Figure 2). The t-test showed a significant difference at 0.01 level of 2.77^{**} .

The standard error for genotype C ranged from 0.08 to 0.27.

In the case of genotype S, the correlation between the number of seeds and seed viability was $r = 0.31$, which was less than in genotype C (Figure 3). The t-test showed a significant difference at 0.01 level of 3.61^{**} .

The coefficient of correlation between the length of seed stalk and number of seeds in genotype S was $r = 0.33$, higher than that in genotype C (Figure 4). The t-test showed a significant difference at 0.01 level of 3.94^{**} .

In genotype C, the standard error ranged from 0.10 to 0.33.

The correlation between the fall and spring thinning concerning the length of inflorescence branch was $r = 0.67$ (Figure 5). The t-test showed a significant difference at 0.01 level of 9.99^{**} .

The correlation between the fall and spring thinning concerning the number of seeds per inflorescence branch was $r = 0.52$ (Figure 6). The t-test showed a significant difference at 0.01 level of 6.76^{**} .

The correlation between the fall and spring thinning was highest for seed viability, $r = 0.68$ (Figure 7).

Table 5
Leaf area index of the two genotypes (Campbell and Viets, 1967)

Genotype	Leaf area/plant/cm ²	t-test	r ²
C	1531		0.95
S	1554		0.95

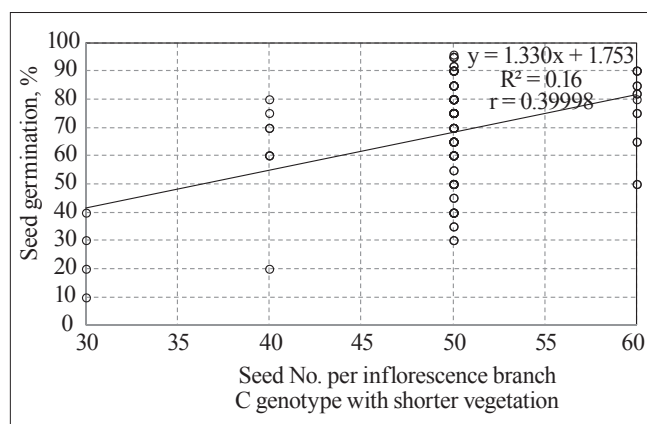


Fig. 1. No of seeds per inflorescence branch and seed viability - genotype with shorter vegetation

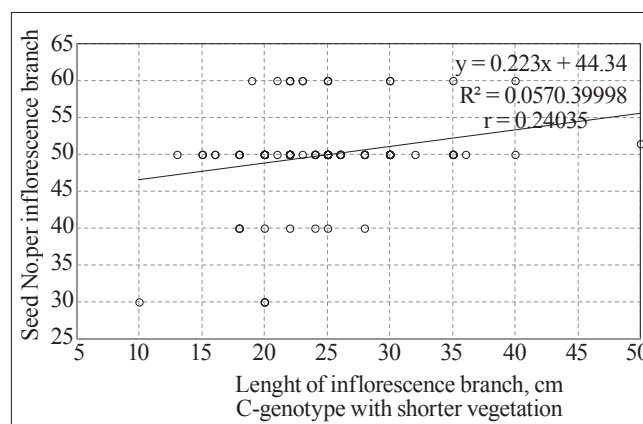


Fig. 2. Length of inflorescence branch and no of seeds per inflorescence branch - genotype with shorter vegetation

The t - test showed a significant difference at 0.01 level of 10.39**.

Discussion

The meteorological conditions were favorable for sugar beet seed production applying the over wintering method. The initial growth of plants unfolded under optimal conditions regarding the supply of water and mineral nutrients and temperature (Hoffmann, 1997).

The tested genotypes were equal regarding the water absorption power of seed. The recorded rate was a good starting point for further growth of plants (Durrant and Jaggard, 1988).

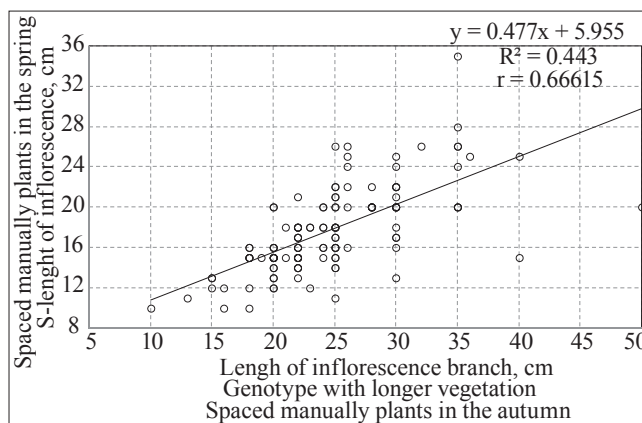


Fig. 5. Length of inflorescence branch, plants were spaced manually in the autumn and in the spring – genotype with longer vegetation

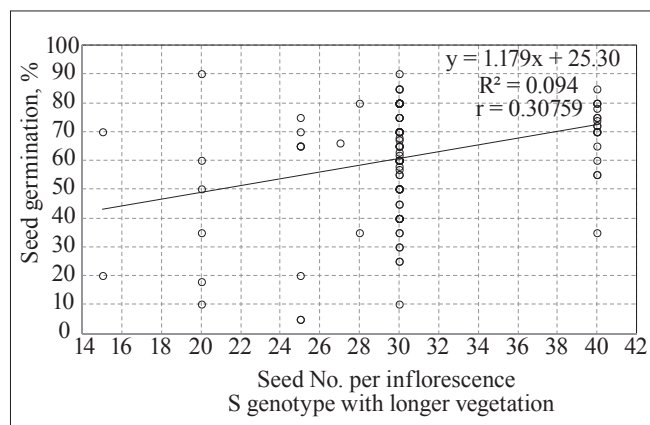


Fig. 3. No of seeds per inflorescence branch and seed viability - genotype with longer vegetation

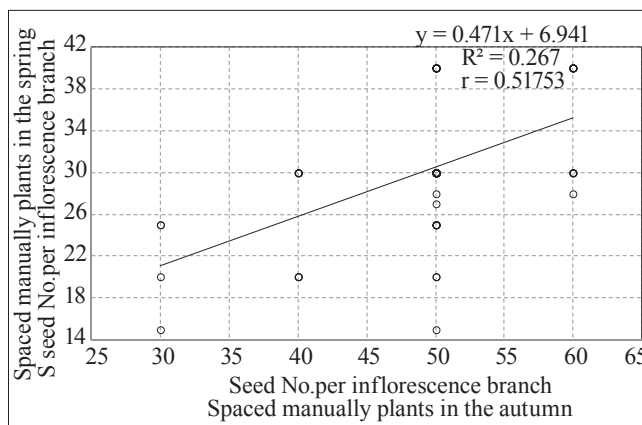


Fig. 6. No of seeds per inflorescence branch, plants were spaced manually in the autumn and in the spring – genotype with longer vegetation

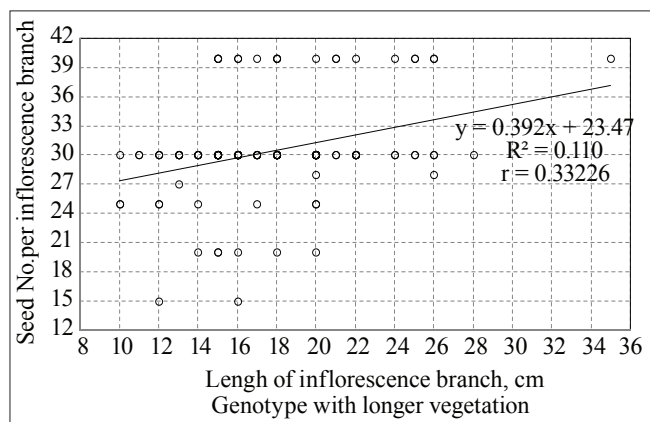


Fig. 4. Length of inflorescence branch and no of seeds per inflorescence branch - genotype with longer vegetation

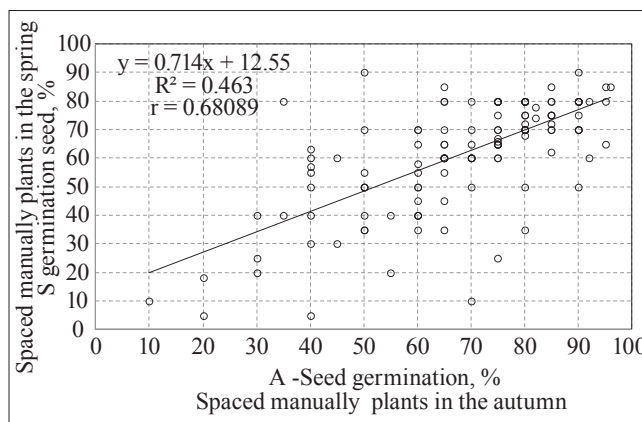


Fig. 7. Seed viability of plants were spaced manually in the autumn and in the spring – genotype with longer vegetation

The leaf area formation was considerably affected by weather conditions. Leaf area decreased as the number of plants increased from 40 000 to 160 000 ha (Роспілїл et al., 2000). In our experiment, the genotypes had the same leaf area because an equal number of plants was left after thinning, 85 000 plants/ha.

The relationship between the number of seeds and viability in genotype C could be described with a linear function. In other words, genotype (cultivar) and weather conditions had the greatest impact on sugar beet at the phenological stage of seed maturation. In the case of early cultivars, the primary root cortex starts flaking or cracking early due to secondary root thickening, which has a direct impact on plant growth (Boiffin et al., 1992). In genotype S, the correlation between the number of seeds and viability was lower, evidently due to the greater genetic variability, which occurs in genotypes with long growing season (Milford and Riley, 1980). The two genotypes had similar values of correlation between the length of seed stalks and the number of seeds. This could be due to the same soil and climate conditions, which however did not affect the other phenotypic characteristics of sugar beet (Vandendriessche, 2000).

The correlations between dates of thinning had a broader range ($r = 0.52$ to 0.68) than the correlations between genotypes ($r = 0.24$ to 0.39). The fall thinning exhibited higher impact on the length of the seed stalk, the number of seeds per inflorescence branch and seed viability than the spring thinning. Therefore, an early plant development has a decisive impact on the final phenophase stages of sugar beet seed crop. Generally, competition has a negative impact on plant growth because it diminishes the availability of growth factors, such as light, water and nutrients, resulting in lower biomass yield (Baeumer, 1992). In addition, assimilation can be reduced in certain plants because of their smaller growth (Wiley and Heath, 1969). It can be assumed that the accumulation of dry matter was delayed in plants with a late growth (Stibbe and Märlander, 2002). In our study, those were plants thinned in spring. All this confirms the statement of Boiffin et al. (1992) who claimed that the sugar beet is a plant species with an early growth. In our study, the fall thinning stimulated a rapid plant growth and earlier closing of rows, which resulted in significantly longer inflorescence branches,

larger number of seeds per inflorescence branch and better seed viability.

Stibbe and Märlander (2002) showed that competition between sugar beet plants was a major factor which affected all interactions. In our case, the competition had no effect in later phenological stages and it did not affect the quality of sugar beet seed.

Conclusion

The results of this study showed that, in addition to the weather conditions, plant nutrition and cultural practices suitable for a specific agro-ecological region, the growth of sugar beet plants in seed plots depends also on the competition for space during the early stages of growth. The fall thinning significantly influenced plant growth and seed formation in later phenological stages, and it is recommended for use in seed production. Obviously, the optimum number of plants/ha is formed in the fall.

In our study, the earlier genotype had significantly higher seed viability, number of seeds per inflorescence branch and the length of the inflorescence branch than the later genotype. This seems to explain the high demand for early genotypes by sugar beet growers and refineries.

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