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LENGTH, ROOTLET LENGTH AND FIELD GERMINATION

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SUMMARY

During 1993, some laboratory tests have conducted to determine the effects of seed size in spring brewing barley on the length of the germ and rootlet (seed fractions were as follows: 2,8 mm, 2,5 mm and 2.2 mm of diameter, respectively). By a statistical analysis of the date on the length of germ and rootlets in spring barley, statistically significant differences were found to be among the fractions tested, and the largest average value was attained by the seed fraction of 2,8 mm, and the lowest one by 2,2 mm.

During 1993 and 1994, a trials have established on the selection field, following the split-plot method, to determine the effects of the above seed fractions and unsieved seed as standard in field trials, and two sowing dates, on field germination (the number of emerged plants/m^2). The differences in the number of emerged plants/m^2 found between the two sowing dates were statistically very significant and the larger number of emerged plants/m^2 was found after the first sowing date.

As for the field trial, the differences found in the number of emerged plants/m^2 among the fractions were statistically very significant. The largest number of emerged plants/m^2 was attained with the seed fraction of 2,8 mm, and the lowest one with the seed fraction of 2,2 mm, in both years of investigation.

Key words: barley, seed size, sowing date, germ length, rootlet length, field germination

INTRODUCTION

Seed size has had no effect on laboratory germination, but seedlings from large seed have emerged more rapidly in the field. Plants grown from large seeds were taller, heavier and had more tillers than plants grown from small seeds, Chastain et al. (1995). Large seeds of winter wheat have had higher field emergence and higher laboratory germination. Seed size has had the influence on the intensity and the rate of the first phenophases in the development of spring barley. Laboratory germination and field emergence is positively correlated. Large seeds of winter wheat have had the largest values of germ length and rootlet length and small seed had the lowest values, Martinčić et al. (1990, 1991,1994).

Peterson et al. (1989), Matotan (1992), Ragasits et al. (1992) have concluded that large seeds have had more rapidly germination and have produced higher density stands in field than small seeds of winter wheat. Large seeds have had higher field emergence than small seeds, too. Large seeds of spring barley always have higher field emergence and longer germ and rootlet than small seeds,

Ujević (1988). Kolak (1994) have had similar results whereas large seeds of winter wheat and spring barley have had longer germ and rootlet length than small seeds. Large seeds have had higher field emergence, too. Small seeds of cereals always have shorter germ length and rootlet length. Also, small seeds always germinate with lower number of rootlet than large seeds, Jevtić (1980). Some authors claim germ and rootlet growth to be inhibited by the presenece of ethanol in seed as well as by air deficiency in soil, Parker et al (1995) and Vanova et al. (1995).

Seedlings produced from large seeds have emerged more rapidly and produced higher density stands than small seeds in Trial 1 (1990 - 1991) but not Trial 2 (1991 - 1992), and plants grown from large seed were somewhat larger in spring, but seed size had no other effect on growth or yield, Chastain et al. (1995).

Therefore, our objective has been to find whether and to what degree the length of germ and rootlet depends on seed size. Another objective has been to find whether the total number of plants emerged in field depends on the seed size and sowing date.

MATERIAL AND METHODS

The laboratory testing was conducted in 1993, testing the spring brewing barley, cultivar Astor. The cultivar Astor has a low stem, a two-rowed and large spike that gives high yields (genetic potential 8 t/ha), and very good brewing qualities (Martinčić et al, 1991). Three seed fractions were included in testing (mm of diameter) as follows: 2,8 mm, 2,5 mm and 2,2 mm. Each fraction was tested in eight replications (20 seeds per replication).

Seed fractions were separated on the device after EBC. The seed was stick to a black cotton tissue, the size of which was 150 cm x 50 cm and the seeds were 2.5 cm apart. The interspace between the kernel and the selvedge of the tissue was 3 cm. Each tissue was considered a replication. The tissue was wrapped into a roll and left vertically in a pot filled with water, at 20°C (ascending circulation of water trough the tissue). After seven days, the measurements of the length of germ and rootlets were made, using the special adjustable scale for mm, whereas the results were given in cm, giving accurate data up to one digit after decimal. The results obtained were analysed statistically using the variance analysis and Lsd - test (least significant differences).

The field trials were ccnducted during two growing seasons (1993 and 1994) on Osijek euteric cambisol of a normal degree of soil fertility, whose agrochemical characteristics are given in Table 1. Previous crop was soybean. Also, there were used four grain fractions as follows: 2,8 mm, 2,5 mm, 2,2 mm and unsieved seed previously served as standard in field trials. The seeding rate was 625 germinable seeds/m^2. The size of the each replication plot was 5 m2 (5m x 1m). Each fraction was sown in eight replications (four replications in the first and four in the second sowing date, rescpectively). Interrow spacing was 12.5 cm (total eight rows per replication). Before sowing, the seed was treated with fungicide. The trial was established following the split - plot method. The results of field investigations (the field emergence) were shown as two-years mean values. There were used two sowing dates with two-weeks interval (the optimal and later terms): the middle of March and beginning of April. While the emerged plants/m^2 were counted, marginal rows were excluded, so the counting was done on the remaining six inward rows, only. The results obtained were processed statistically using the variance analysis and tested with Lsd - test.

Table 1. Soil analysis data on Osijek euteric cambisol (Eastern Croatia)

Humus	(%)	1.00
pH (H_2O)		6.08
$N\text{-}NO_3$	mg/100 g	2.43
$N\text{-}NH_4$	mg/100 g	0.81
P	mg/100 g	1.66
K	mg/100 g	7.79
Ca	mg/100 g	26.51
Active clay	(%)	20.51

RESULTS

Laboratory testing

Before we started the investigation of the effects of seed size on the length of germ and rootlet, the 1000-kernel weight was measured and the results were shown in Table 2. The results suggests that the 1000-kernel weight was decreasing with smaller seeds of spring barley. The results of testing the effects of seed size on the length of germ are shown in Tables 3 and Figure 1. The largest mean values of the germ length were attained with the seed fraction of 2,8 mm (9.0 cm), further with the fraction of 2,5 mm (7.2 cm), whereas the lowest values were attained with the seed fraction of 2,2 mm (4.6 cm). The differences are very significant ($P<0,01$).

Table 2. 1000-kernel weight of seed size of spring barley

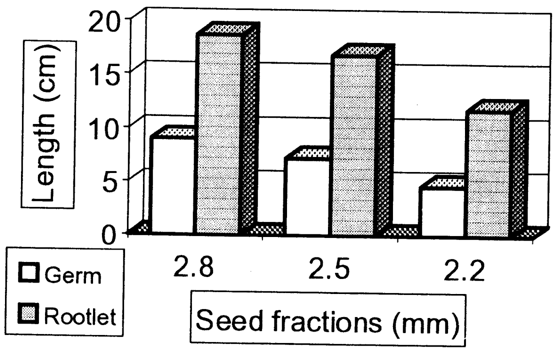
Seed size (mm)	1000 kernels weight (g)
2.8	49.20
2.5	39.51
2.2	29.06
Unsieved seed	44.16

Similar conection was found between seed size and rootlet length (Tables 3 and Figure 1). It was found again that the rootlets were shorter with a smaller seed size and smaller weight, respectively. The largest mean values were attained with the seed fraction of 2,8 mm (18.7 cm), further with the fraction of 2,5 mm (16.8 cm) and the lowest values with the seed fraction of 2,2 mm (11.8 cm). There was a positive and statistically very significant corelation ($r=0.717^*$) between the length of germ and length of its rootlets, meaning that a longer germ implies a longer root and vice versa.

Table 3. Seed size of spring barley in relation to the length of germ and rootlet

	Germ length (cm)			Rootlet length (cm)		
Seed size (mm)	2.8	2.5	2.2	2.8	2.5	2.2
	9.3	7.4	4.6	18.3	15.9	11.6
	9.0	7.0	4.3	18.0	16.8	12.0
	9.1	7.1	4.6	18.7	16.7	11.8
	9.0	7.2	4.4	19.1	16.9	11.7
	9.1	7.3	4.5	18.4	16.5	11.8
	8.7	7.1	4.7	18.7	17.7	10.9
	8.9	7.2	4.8	19.4	16.8	11.9
	8.9	7.3	4.9	19.0	17.1	12.7
Average	9.0	7.2	4.6	18.7	16.8	11.8
		$Lsd_{0,05}=0,1787^*$			$Lsd_{0,05}=0,1787^*$	
		$Lsd_{0,01}=0,2432^*$			$Lsd_{0,01}=0,2432^*$	

Figure 1. Seed size of spring barley in relation to the length of germ and rootlet



Field experiment

While investigating the number of emerged plants/m^2 (field germination), the differences were recorded between the two sowing dates (Tables 4, 5 and 6 and Figure 2). A larger number of emerged plants was attained after the first sowing date (569 plants/m^2) in comparison to the second one (520 plants/m^2). The differences found between two sowing dates were statistically very significant (P<0,01).

Table 4. Seed size and sowing date of spring barley in relation to the field germination (average of two years)

	Number of emerged plants/m^2				
	Seed size (mm)				
Sowing date	2.8	2.5	2.2	Unsieved seed	Average
First	621	588	519	547	569
Second	554	551	461	512	520
Average	588	570	490	530	545
		Lsd $_{0,05}$		Lsd $_{0,01}$	
Sowing date (A)		2.9309*		4.3361**	
Seed size (B)		6.0657*		7.9844**	
A x B		8.5782*		11.2917**	

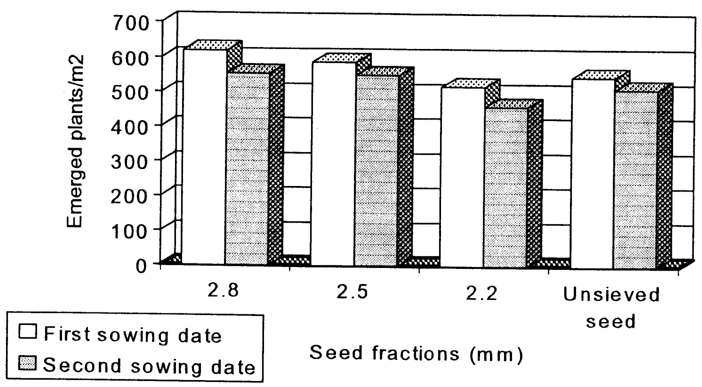
Table 5. Seed size and sowing date of spring barley in relation to the field germination (replications during 1993)

	Emerged plants/m^2							
	First sowing date				Second sowing date			
Seed size (mm)	2.8	2.5	2.2	Unsieved seed	2.8	2.5	2.2	Unsieved seed
1.	620	592	519	545	550	547	457	509
2.	619	591	522	548	553	553	456	511
3.	625	588	522	550	560	550	460	513
4.	624	589	525	553	557	550	459	511
Average	622	590	522	549	555	550	458	511

Table 6. Seed size and sowing date of spring barley in relation to the field germination replications during 1994)

	Emerged plants/m^2							
	First sowing date				Second sowing date			
Seed size (mm)	2.8	2.5	2.2	Unsieved seed	2.8	2.5	2.2	Unsieved seed
1.	620	582	511	543	550	550	463	511
2.	618	585	516	547	556	554	464	512
3.	620	587	516	544	552	548	464	515
4.	622	590	521	546	554	556	465	514
Average	620	586	516	545	553	552	464	513

Figure 2. Seed size and sowing date of spring barley in relation to the field germination



While investigating the effects of seed size on the number of emerged plants/m^2 in spring barley, statistically very significant differences (P<0,01) were found, as shown in Tables 4, 5 and 6 and Figure 2. From the mean values obtained, it is evident that the seed fraction of 2,8 mm gave the largest number of plants emerged/m^2, after the first sowing date (621 plants/m^2), and the seed fraction of 2,8 mm had the largest number of emerged plants after the second sowing date (554 plants/m^2). In consideration of the overall results regarding both sowing dates, the largest number of emerged plants/m^2 was attained with the seed fraction of 2.8 mm (588 plants/m^2), while the lowest one was attained with the seed fraction of 2,2 mm (490 plants/m^2).

DISCUSSION

Investigating the effects of seed size on the length of germ and rootlets, and germination in the field was conducted for certain reasons on spring barley in particular. Sowing of spring barley usually has to be under unfavourable climatic and soil conditions and on sowing dates not considered optimum ones, which effects considerably the level of grain yield.

Taking into consideration already published results of similar investigations, including those obtained in our investigations, we found that the length of germ , rootlets, and field germination depend on seed size of spring barley, as well. Such a marked dependance of the germ length and rootlets on seed size of spring barley is probably the consequence of a larger 1000-kernel weight and a larger portion of nutrients in endosperm, which brings about a larger number of primary rootlets (5-8), too, which appear to be longer than those of smaller seeds. Some earlier investigations have shown that seed size and its weight have a significant and positive effect on the length and the number of primary germ rootlets (Matotan, 1992). Similar results were obtained by Martinčić et al. (1990), who found that germination energy and germinability become lower with smaller seed size.

On the basis of the results of investigating the effects of seed size on the length of germ and rootlets, our opinion is that attention is to be drawn in particular on the quality of seed material, and especially to kernel size. This applies primarily in cases of unfavourable conditions of soil and climate after sowing (drought or excess of moisture in soil at germination or emergence, or a bad seed bad preparation before sowing). In such a case, when larger kernels are sown, a better plant development will be manifested, as well as a better vigour and formation of its root system. Since the seed fractions od 2,8 mm and 2,5 mm had similar length of germ and rootlets, it is assumed that both seed fractions can meet all the principal criteria set for spring barley as seed material, however, during processing, attention is to be drawn to larger seed.

Also, Bošnjaković (1979) concluded that among the parameters tested, sowing date has the largest effects on the level of yield. The same author mentioned that seed sown on the first sowing date attained yields higher by 9.28% in comparison to the second sowing date or even by 18.69% as compared to the third one.

As for our investigation, a reduced number of emerged plants/m^2 sown on the second sowing date might be a consequence of unfavourable soil and climate conditions (excess of moisture, drought). Under such conditions a germ uptakes more nutrients and spends more energy for its growth, or emergence. Matotan (1992) found that larger seeds have a stronger and more vigourous germ which springs up on the ground in a shorter period of time as compared the the smaller ones. A young germ uptakes the energy from endosperm and the fact is that a larger endosperm has a larger amount of nutrients available to the germ (Martinčić et al. 1991). Therefore, to achieve an optimum plant stand, a more reliable solution would be to sow larger seed of a better quality, which is a guarantee that sowing will be a succes under unfavourable conditions of soil and climate.

The results obtained on the effects of seed size on the length of germ and rootlets and field emergence represent a scientific and professional contribution to improving seed production, and in this way to a larger and more stable production of spring barley.

CONCLUSIONS

The investigation showed that the largest values of the germ length were attained with fraction of 2,8 mm (9.0 cm) whereas the lowest values were attained with the fraction of 2,2 mm (4.6 cm). The differences found in the length of germ among seed fractions were statistically very significant ($P<0.01$).

Similar results were obtained while investigating the effects of the seed size on the length of rootlets. It was found again that the rootlets were shorter with a smaller seed size and smaller weight, respectively. The largest values were attained with the seed fraction of 2,8 mm (18.7 cm) and the lowest values with the seed fraction of 2,2 mm (11.8 cm).

A larger number of emerged plants was attained after the first sowing date (569 plants/m^2) in comparison to the second one (520 plants/m^2), in both years. The differences were statistically very significant ($P<0,01$). The investigation of the effects of seed size on the number of emerged plants/m^2 showed that the seed fraction of 2,8 mm gave the largest number of emerged plants (588 plants/m^2), while the lowest one was attained with the seed fraction of 2,2 mm (490 plants/m^2), during two years of investigation.

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UTJECAJ VELIČINE SJEMENA JAROG JEČMA NA DUŽINU KLICE I KORJENČIĆA, TE POLJSKU KLIJAVOST

SAŽETAK

Istraživanja o utjecaju krupnoće zrna jarog ječma na dužinu klice i primarnih klicinih korjenčića sprovedena su tijekom 1993. godine u laboratoriju Poljoprivrednog fakulteta u Osijeku. Iz naturalnog sjemena ječma dobivene su frakcije sjemena na stroju za izdvajanje frakcija po EBC-u (sjeme promjera 2,8 mm, 2,5 mm i 2,2 mm). Dobiveni rezultati pokazuju da je najdužu klicu i najduži primarni klicin korjenčić postiglo krupno sjeme ječma (sjeme promjera 2,8 mm) dok je najkraću klicu i primarni klicin korjenčić imalo sitno sjeme ječma (sjeme promjera 2,2 mm).

Drugi dio istraživanja obavljen je poljskim pokusima koji su postavljeni tijekom 1993. i 1994. godine po split-plot shemi na selekcijskim poljima Poljoprivrednog instituta u Osijeku. Pored navedene tri frakcije zrna u istraživanje je uzeto i neprosijano sjeme kao standard. Sjetva je obavljena u ranijem i kasnijem roku a dobiveni rezultati pokazali su da je klijavost u polju (broj izniklih biljaka po jedinici površine) bila veća kod prvog u odnosu na drugi rok sjetve. Također je ustanovljeno da je krupno sjeme ječma postiglo veću poljsku klijavost u odnosu na sitno sjeme. Razlike ispoljene u poljskoj klijavosti, kako između rokova sjetve tako i između frakcija zrna, pokazale su se statistički visoko opravdane ($P<0,01$).

Ključne riječi: ječam, veličina sjemena, datum sjetve, dužina klice, dužina korjenčića, poljska klijavost

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