

## On the Qualities of Hulled Timothy Seed.

By

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### 1. Introduction.

The germination results arrived at in the laboratory differ greatly from those obtained in the field. Consequently, it is attempted to find new laboratory methods which would bring the results of these tests in closer relation to the field test results. Therefore, the questions concerning abnormal seedlings, the value of hard seeds, and seed diseases which influence these results have been raised at the last international seed testing conferences.

In addition to the qualities and factors mentioned, there are various mechanical seed injuries which affect the viability of seeds. The effects of these injuries appear either directly, as in the case of an injured embryo, or indirectly, as in the case of injured cotyledons, endosperm, or seed coat, or may be observed during the time of growth. In the laboratory tests these mechanical injuries either do not influence the seed viability at all or do so to a much smaller extent than in the field. Therefore, it is very important in seed testing work to be able to know the mechanical injuries and the extent to which they affect the seed viability both in the laboratory and the field tests.

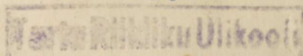
By evaluating the injured seeds it is essential to know the relationship between the results of the laboratory tests and those of the field tests in order, on the basis of the laboratory results, to be able to determine the sowing value of the seed.

### 2. The Percentage of Hulled Seeds in Timothy.

Hulled seeds are a very common feature arising from mechanical injury and they occur in comparatively great quantities in lots of *Avena sativa*, *Phleum pratense*, *Dactylis glomerata*, *Agrostis alba*, and *Cichorium Intybus* of North European origin. The greatest quantity of hulled seeds, however, appears in timothy seed, and the percentage which depends upon the threshing, is higher in the case of machine threshing than in the case of hand threshing, and moreover it depends upon the rotation speed of the threshing machine drum and its closeness to the receiving skip.

Climatic conditions at the period of growth have no particular influence on the occurrence of hulled seeds, though the percentage is higher in dry summers. The dryness of the seed and the maturity

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of the timothy at the time of threshing on the field are much more important. Over-ripe and very dry seed is more easily subject to hulling.

The quantity of hulled seeds depends also upon the genotype of the timothy, and more particularly upon the firmness with which the spikelets are attached to the rachis, and how the seed is wrapped in the floral glumes. The firmer the spikelets are attached to the rachis and the floral glumes to the seed, the higher must be the rotation speed of the drum and the greater the mechanical friction in order to have the seeds detached (H. Witte; E. Kitunen). Furthermore, the rate of hulling depends upon the form of the palea as well as upon the way in which the caryopsis is enwrapped (N. Sylvén). According to E. Kitunen, timothy seeds of a lengthy hull shape and with well developed rough hull nerves are much more easily hulled, since their seed coats enwrap the caryopsis less closely and flexibly.

Table 1.

*Average and Maximum Percentage of Hulled Timothy Seeds from Esthonia, Sweden and Finland.*

	Esthonia			Sweden			Finland		
	%		Number of Samples	%		Number of Samples	%		Number of Samples
	Average	Maxim.		Average	Maxim.		Average	Maxim.	
1935.....	18.4	54.0	32	17	90	1498	22.3	70.3	1469
1934.....	21.5	46.1	47	15	97	1569	18.5	68.9	1775
1933.....	27.1	75.9	26	13	85	1575	16.9	67.8	1585
1932.....	12.3	33.0	20	13	95	987	19.4	65.2	1825
1931.....	38.7	49.3	4	19	85	1169	19.5	94.7	4133
1930.....	26.2	33.4	5	18	95	1105	19.1	72.8	3131
1929.....	26.5	30.5	4	16	65	234	19.2	—	1787
1928.....	36.4	44.5	2	22.7	—	337	20.9	—	1426
1927.....	12.4	22.4	4	23.3	—	310	—	—	—
1926.....	19.2	46.8	7	—	—	—	—	—	—
Average ....	21.2	75.9	151	16.3	97	8784	19.4	94.7	17131

Ordinarily, the percentage of hulled seed in North European timothy seed fluctuates between 15 and 25 %. For example in Sweden the 9 year average (1927—35) was 16.3 %, in Finland (average for 8 years, 1928—35) 19.4 %, and in Esthonia (average for 10 years, 1926—35) 21.2 % (Table 1). In timothy seed from these countries the percentage of hulled seeds is the smallest in the case of Sweden, over 20 % in about  $\frac{1}{5}$  of the samples. For Finland it is over 20 % in about  $\frac{1}{3}$  of the samples, and for Esthonia in about  $\frac{1}{2}$  of the samples.

The hulled seed content of Estonian timothy seed was as follows (10 year average):

Hulled seeds %	Number of samples %	
0.0— 4.9	14.6	
5.0— 9.9	7.9	
10.0—19.9	25.2	In some timothy seed samples the hulled seed content in cer- tain years may reach 70 % or more.
20.0—29.9	27.2	
30.0—39.9	17.2	
40.0—49.9	5.2	
over 50.0	2.7	

In timothy seed from Central European countries, the percentage of hulled seeds may be the same as that shown above while in American timothy seed the percentages may be even higher.

### 3. *The Present Evaluation of Hulled Timothy Seeds.*

The value of hulled timothy seeds, their germination and viability, depend upon the degree of the mechanical injuries. Ordinarily the injury is limited to the hulling while the caryopsis has remained uninjured. According to E. Kitunen, the percentage of injuries limited to the removal of the palea amounts to 91.0 %. The other injuries are those of injured endosperm, or embryo. About 1 % shows mechanical injuries of the endosperm, while the embryo seems to be quite intact, and only about 8 % of all the hulled seeds had an injured embryo. The percentages reported by E. Kitunen vary considerably with different genotype of timothy and seed maturity, with the way in which the threshing is done, and with the manner in which the drum of the threshing machine has injured the seeds. If the injury is limited to the hulling and the embryo has remained sound, the laboratory germination of the hulled seeds is almost equal to that of normal or unhulled seeds. But if the embryo has been injured, due to the threshing, the laboratory germination is considerably reduced. This fact is responsible for the great differences between the laboratory germination results of hulled seeds obtained by different experiment stations. For example, according to Settegast, hulled seeds germinated just as well as normal seeds, while according to Burchard and Kitunen, the laboratory germination of hulled seeds was 10 % lower than that of normal seeds. If the germination of normal seeds is fixed at 100, that of hulled seeds would, according to Heinrich, be 57.9 %—67.2 %, and according to N. Sylvén 75.7 %—93.5 %.

In general, when dealing with fresh, normal mature timothy seeds gathered and threshed under normal conditions the present laboratory tests show a 10—25 % lower germination of the hulled seeds. If the seeds are older and in some way injured before harvesting

the difference between the laboratory germination of hulled and unhulled seeds may amount to 25—50 %.

The comparatively small difference in the laboratory germination between normal and hulled timothy seeds is explained by the fact that in the laboratory, where the germination conditions are favourable, only the hulled seeds with an injured embryo prove to be unable to germinate. However, when sown in the field and in soil, where temperature and humidity conditions are less favourable for the germination, and where various bacteria and fungi have easy access to the injured seeds, the seed viability may be weakened to such an extent that it loses its capacity for germination, or if it does germinate, the seedlings are unable to braird. All similar tests show the germination of hulled timothy seeds in the soil to be much lower than that of normal seeds. If thus according to Dorph-Petersen, the number of seedlings in the soil originating from normal seeds is fixed at 100, the percentage of seedlings from hulled seeds under the same conditions is only 58—78 %. In the opinion of Kajanus, hulled seeds in the soil germinate 3 times as low as in the laboratory. According to E. Kitunen, hulled seeds sown in the soil  $\frac{1}{2}$  cm deep produce 68—82 % seedlings if the number of seedlings from normal seeds is fixed at 100. Korsmo found that the laboratory germination of normal and hulled seeds was almost equal, but sown in the soil  $\frac{1}{2}$  cm deep, the percentage of seedlings from hulled seeds was only 68.2 % (the number of seedlings from normal seeds being fixed at 100). If the laboratory germination is fixed at 100, hulled seeds sown in the field to a depth of 1 cm, according to N. Sylvén, gave only 39 % of seedlings. According to H. Kotkas (7 samples of  $5 \times 100$  seeds each) in field tests conducted in the spring and autumn of 1934, the hulled seeds of 1933 harvest showed a brairding value of 40—79 %, if the number of seedlings from normal seeds was fixed at 100, and hulled seeds of 1928 harvest a brairding value of 14.9—26.6 %.

#### 4. *Utilization Possibilities of Hulled Timothy Seeds According to the Tests of 1934—36.*

The results of tests made by different persons agree to a great extent, showing that hulled timothy seeds sown in the soil braird one half to one third lower than normal seeds, but it must be borne in mind that a number of these tests are laboratory pot-tests and that others have been made with too little material, and during too short a time. In order to obtain more reliable results as to the brairding of hulled timothy seeds, and to their yield of plants, the Seed Control Station conducted extensive tests in the fields of the State Agricultural Experiment Station at Kuusiku during the 3 years, 1934—36. These tests were carried out on typical silurian soil of North Esthonia where on limestone mantle-rock the thickness of very rich humus soil is about 30 cm. The amount of precipitation at the time of the brairding in

the years in question was different and therefore had a different effect on the brairding. In 1935, with a higher precipitation more seedlings brairded than in 1934. Consequently, in order to evaluate the hulled timothy seed correctly it is necessary to extend the tests over a number of years. If conducted during one year only, the results, under the influence of varying weather conditions, may be misleading. The 3 year test period includes one year with an abundant rainfall and one year with a low rainfall and the influence of the weather conditions on the brairding of the seedlings therefore ought to be levelled, and the results of the tests thus should give a sound basis for comparison of the value of hulled timothy seeds with that of normal seeds.

In the 1934 tests 8 different kinds of timothy seeds were used, 2 of which were of the 1933 harvest, 4 of the 1932 harvest, and 2 of the 1931 harvest. Of each kind 1—3  $\times$  400 hulled seeds and 1—3  $\times$  400 normal seeds were used. These seeds were sown by hand in rows of 150 cm length, 400 seeds per row. The space between the rows was 12 cm. Sowing took place on May 23rd, and the seeds were sown to a depth of 0.5—1.0 cm. The seedlings were counted on June 5th. The produce was gathered in, each row separately, on August 13th. The yield of each row was weighed separately after the soil had been washed off from the roots and the plants had been dried.

In the 1935 tests 15 different samples of timothy seed were used, viz. 6 samples of the 1934 harvest, 6 of the 1933 harvest, and 3 of the 1932 harvest. 3  $\times$  400 normal seeds and 3  $\times$  400 hulled seeds were used of each kind. These seeds were sown 0.5—1.0 cm deep in rows of 1 m length, 300 seeds in each row. The space between the rows was 20 cm. Sowing took place on June 5th. The seedlings commenced brairding on June 17th, and were counted on June 21st. The mature plants were gathered on October 7th and weighed, after the soil had been washed off from the roots.

In the 1936 tests samples of 13 different kinds of timothy seeds were used. 4 kinds were of the 1935 harvest, 3 kinds of the 1934 harvest, and 3 kinds of the 1932 harvest. 4  $\times$  300 normal seeds and 4  $\times$  300 hulled seeds were used of each kind. These seeds were sown by hand in rows of 1 m length, 300 seeds in each row. The space between the rows was 20 cm, and the seeds were sown 0.5—1.0 cm deep. Sowing took place on June 9th and 10th. The seedlings commenced brairding on June 25th, and were counted on June 29th. The plants were gathered and counted on October 2nd—5th. Weighing was done after the soil had been washed off from the roots and the plants had been dried.

As it appears from the results of these tests, the number of seedlings produced by hulled seeds (Table 2), and the total weight of plants produced by these seeds (Table 3) vary greatly from year to year, depending upon the amount of precipitation at the time of germination and brairding of the seedlings, as well as upon the humidity of the

*Table 2.*  
*Number of Seedlings Produced in the Field by Hulled*  
*and Unhulled Seeds.*

Number of Sample, and Year of Harvest	Seed Germination in Laboratory		% Content of Hulled Seeds in Seed Sample	Percentage of Seedlings produced in the											
	Time	%		1934 Test			1935 Test			1936 Test					
				Normal Seeds	Hulled Seeds	Test Repeated	Normal Seeds	Hulled Seeds	Test Repeated	Normal Seeds	Hulled Seeds	Test Repeated			
<i>1935</i>															
18435	Nov.	1935	92.5	16.8	—	—	—	—	—	—	—	55.0	40.3	4	
18463	Dec.	1935	89.3	32.3	—	—	—	—	—	—	—	63.0	48.3	4	
18458	Dec.	1935	92.8	28.0	—	—	—	—	—	—	—	65.3	55.0	4	
18507	Dec.	1935	58.1	34.8	—	—	—	—	—	—	—	35.2	21.1	4	
Average %					—	—	—	—	—	—	—	54.6	41.2		
					—	—	—	—	—	—	—	100.0	75.5		
<i>1934</i>															
17453	Febr.	1935	95.3	32.0	—	—	—	96.5	58.6	4	—	—	—	—	
17427	Jan.	1935	96.8	20.0	—	—	—	97.4	56.3	4	66.8	34.6	4	4	
17426	Jan.	1935	98.3	15.8	—	—	—	94.5	65.2	4	—	—	—	—	
17168	Jan.	1935	96.1	41.4	—	—	—	90.0	52.9	4	71.7	38.4	4	4	
17170	Jan.	1935	97.0	25.6	—	—	—	88.3	57.3	4	—	—	—	—	
17236	Jan.	1935	96.1	38.0	—	—	—	94.5	55.5	4	55.4	36.8	4	4	
Average %								93.5	57.6		64.6	36.6			
								100.0	61.6		100.0	56.6			
<i>1933</i>															
16866	May	1934	91.5	27.5	—	—	—	91.5	55.5	4	—	—	—	—	
16872	May	1934	86.3	33.0	—	—	—	87.8	57.8	4	56.8	39.9	4	4	
16867	May	1934	87.5	26.4	—	—	—	91.5	55.6	4	—	—	—	—	
16077	Jan.	1934	93.3	29.8	79.3	46.7	3	92.2	61.0	4	70.9	31.1	4	4	
16315	March	1934	97.1	30.5	85.3	40.3	3	—	—	—	—	—	—	—	
16191	Jan.	1934	98.6	26.5	—	—	—	93.2	55.8	4	53.2	52.6	4	4	
16193	Jan.	1934	94.8	16.5	—	—	—	93.3	53.4	4	—	—	—	—	
Average %					82.3	43.5		91.6	56.5		60.3	41.2			
					100.0	52.8		100.0	61.7		100.0	68.3			
<i>1932</i>															
15170	Jan.	1933	96.8	33.0	86.9	39.3	2	98.6	48.3	4	59.5	48.3	4	4	
15000	Jan.	1933	81.6	26.9	56.8	33.7	3	—	—	—	—	—	—	—	
14943	Dec.	1932	96.6	18.3	84.5	37.8	1	96.8	53.3	4	65.4	43.1	4	4	
14989	Dec.	1932	96.8	14.3	87.0	43.3	1	91.4	52.2	4	74.0	46.5	4	4	
Average %					78.8	38.4		95.6	51.3		66.3	46.0			
					100.0	48.8		100.0	53.6		100.0	69.4			
<i>1931</i>															
13744	Dec.	1931	94.6	49.3	74.9	17.4	3	—	—	—	—	—	—	—	
13743	Dec.	1931	95.3	41.5	67.3	15.3	3	—	—	—	—	—	—	—	
Average %					71.1	16.4		—	—		—	—			
					100.0	23.1		—	—		—	—			
Average for the year of testing.. %					77.8	34.2		93.2	55.9		61.0	41.3			
					100.0	43.9		100.0	60.0		100.0	67.7			
Number of samples					8			15			13				
3 year average:					Normal seeds			78.1	%	%	100.0				
					Hulled seeds			45.8			58.6				

Table 3.  
Weight of Plants Gathered.

Number of Sample, and Year of Harvest	Weight of Plants Gathered in gms.								
	1934 Test			1935 Test			1936 Test		
	Normal Seeds	Hulled Seeds	Test Repeated	Normal Seeds	Hulled Seeds	Test Repeated	Normal Seeds	Hulled Seeds	Test Repeated
<i>1935</i>									
18435 ...	—	—	—	—	—	—	124.0	114.0	4
18463 ...	—	—	—	—	—	—	122.3	112.8	4
18458 ...	—	—	—	—	—	—	189.8	150.5	4
18507 ...	—	—	—	—	—	—	80.8	74.0	4
Average ....	—	—	—	—	—	—	129.2	112.8	
% .....	—	—	—	—	—	—	100.0	87.3	
<i>1934</i>									
17453 ...	—	—	—	123.4	129.3	4	—	—	—
17427 ...	—	—	—	142.0	101.1	4	128.5	105.3	4
17426 ...	—	—	—	111.8	83.2	4	—	—	—
17168 ...	—	—	—	90.5	86.4	4	172.0	115.8	4
17170 ...	—	—	—	175.0	153.8	4	—	—	—
17236 ...	—	—	—	109.6	77.3	4	161.8	112.5	4
Average ....	—	—	—	125.4	105.2		154.1	111.2	
% .....	—	—	—	100.0	83.9		100.0	72.2	
<i>1933</i>									
16866 ...	—	—	—	109.5	58.0	4	—	—	—
16872 ...	—	—	—	—	—	—	165.5	97.3	4
16867 ...	—	—	—	87.0	48.8	4	—	—	—
16077 ...	182.8	102.5	3	87.5	67.1	4	137.0	70.5	4
16315 ...	143.3	83.8	3	—	—	—	—	—	—
16191 ...	—	—	—	91.0	81.1	4	139.0	100.0	4
16193 ...	—	—	—	96.8	73.5	4	—	—	—
Average ....	163.1	93.2		94.4	65.7		147.2	89.3	
% .....	100.0	57.2		100.0	69.6		100.0	60.7	
<i>1932</i>									
15170 ...	145.5	84.8	2	150.5	90.9	4	159.0	100.8	4
15000 ...	103.7	75.2	3	—	—	—	—	—	—
14943 ...	150.0	86.3	1	118.8	112.1	4	144.5	103.3	4
14989 ...	170.3	66.0	1	136.8	68.4	4	179.5	162.8	4
Average ....	142.4	78.1		135.4	90.5		161.0	122.3	
% .....	100.0	54.9		100.0	66.9		100.0	75.9	
<i>1931</i>									
13744 ...	103.3	51.8	3	—	—	—	—	—	—
13743 ...	103.7	45.2	3	—	—	—	—	—	—
Average ....	103.5	48.5		—	—	—	—	—	—
% .....	100.0	46.8		—	—	—	—	—	—
Average for the year of testing ....									
% .....	137.8	74.5		116.4	87.9		146.4	109.2	
% .....	100.0	54.0		100.0	75.4		100.0	74.6	
Number of samples...	8			14			13		
3 year average: {	Normal seeds .....						132.5 gms.	%	100.0
	Hulled seeds .....						92.7 gms.	%	70.0

soil. By fixing the number of seedlings produced by normal seeds and the total weight of plants developed by these seeds at 100, we get the following percentages for hulled seeds: in 1934 on an average 43.9 % (58.8 %—22.7 %) braided and the total weight of the plants produced on an average was 54.0 % (56.1 %—43.6 %). The corresponding figures for 1935 were: 60.0 % (68.9 %—49.0 %) and 75.4 % (104.8 %—50.0 %) respectively, and for 1936 67.7 % (98.9 %—51.8 %) and 74.6 % (92.2 %—51.5 %) respectively.

The averages for field germination and weight of plants from all tests conducted with hulled seeds during the three years are 58.6 and 70.0 % respectively, when the standards for seedling production and weight of produce from normal seeds is fixed at 100.

In general, the germination of hulled seeds in soil depends upon the age and the general sanitary condition of the seed. If the seeds have been injured during gathering or storage, the viability of hulled seeds decreases more rapidly than that of normal seeds, and their germination in the soil is lower than that of normal seeds. Similarly, the germination of hulled seeds decreases more rapidly with the ageing of the seed.

Hulling only influences the germination and the capacity for braiding. It has no effect on the subsequent development of the plants. As may be seen from the 1936 tests (Table 4), the average weight of a plant produced by a hulled seed was 101.4 %, if the weight of a single plant developed from a normal seed was fixed at 100. In this respect, the results of the examinations conducted for the purpose of evaluating the hulled timothy seeds, agree with the results of my corresponding examinations of hulled oat grains, where, in the same way, the hulling had no effect on the weight of a single plant produced by a hulled oat grain.

It may be concluded from this that the palea has no influence on the plant yield. The purpose of the seed coat is to protect the embryo against the external injurious factors as long as the embryo is in a dormant state. When the coat is removed, the value of hulled seeds depends upon the mechanical injury of the caryopsis, and also upon the extent to which the embryo is exposed to different external injurious effects, before or after sowing. Since there are more injurious organisms in the soil than in the laboratory, the germination of hulled seeds is therefore considerably lower in soil. Future tests and researches must show whether it is possible to increase the germination of hulled seeds in soil by eliminating the injurious effect of the various bacteria and fungi by disinfection or other treatment of the seed. In the tests conducted by the Seed Control Station in Tallinn in 1935 and 1936 with seeds treated with »Ceresan« 7 hulled timothy seed samples gave on an average 11.8 % more seedlings and 11.7 % higher plant weight than untreated seeds. In the case of samples tested by N. Sylvén, the

Table 4.  
Weight of a Single Plant of the 1936 Test in gms.

Number of Sample, and Year of Harvest	Weight of Plants Gathered in gms.		Number of Plants Gathered.		Weight of a Single Plant in gms.	
	Normal Seeds	Hulled Seeds	Normal Seeds	Hulled Seeds	Normal Seeds	Hulled Seeds
<i>1935</i>						
18435.....	124.0	114.0	185.8	150.8	0.66	0.75
18463.....	122.3	112.8	210.3	155.0	0.58	0.72
18458.....	189.8	150.5	233.0	201.0	0.81	0.78
18507.....	80.8	74.0	130.8	93.5	0.62	0.79
Average.....					0.67	0.76
%.....					100.0	113.4
<i>1934</i>						
17427.....	128.5	105.3	203.7	136.5	0.63	0.77
17168.....	172.0	115.8	247.3	147.5	0.69	0.79
17236.....	161.8	112.5	193.0	136.8	0.84	0.82
Average.....					0.72	0.79
%.....					100.0	109.7
<i>1933</i>						
16872.....	165.5	97.3	203.5	146.0	0.81	0.66
16077.....	137.0	70.5	245.5	123.5	0.56	0.57
16191.....	139.0	100.0	183.3	183.3	0.76	0.54
Average.....					0.71	0.59
%.....					100.0	83.1
<i>1932</i>						
15170.....	159.0	100.8	205.3	161.0	0.77	0.62
14943.....	144.5	103.3	185.7	161.5	0.76	0.64
14989.....	179.5	162.8	236.3	179.0	0.76	0.91
Average.....					0.76	0.72
%.....					100.0	94.7
Average for the year of testing.....					0.71	0.72
%.....					100.0	101.4

treatment has given different results. It seems that the treatment has increased the germination of hulled seeds in soil only when the caryopsis or the endosperm have been injured by bacteria or fungi, while the embryo has remained uninjured and viable. In other cases the act of treatment may be negative.

### 5. Summary.

(1) Since the hulled seed content in timothy seed is rather high and their germination in soil considerably lower than in the laboratory, it is necessary on the Analysis Certificate to report their accurate percentage.

(2) In timothy seed of North European origin the percentage of hulled

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seeds is about 20. By evaluating the hulled seeds, 20 % may for the purpose of simplification, be counted as equal to normal seeds, this percentage being absolutely inevitable even under normal gathering and threshing conditions.

(3) If the percentage of hulled seeds is over 20, it means a poor genotype of the timothy, poor gathering and threshing. In this case the value of hulled seeds may be estimated as equal to about 50—60 % of that of normal seeds, the germination of hulled seeds in the field being about 40—50 % lower than that of normal seeds.

*Literature cited.*

(1) *E. Kitunen*: Kuoriutuneiden timotein siementen esiintyminen ja kylvösiemenarvo, 1929. — (2) *Nils Sylvén*: Om »skalade frön« hos timotejen. Sveriges Utsädesförenings Tidskrift, 1, 1934. — (3) *M. Heinrich*: Beiträge über die Keimung bespelzter und nackter Timothyfrüchte. Die landw. Versuchs-Stationen. Band XCIII, 1909. — (4) *B. Kajanus*: Über Keimung entspelzter Früchte von Timothee. Frühling Landw. Zeitung Jahrg. 1911. — (5) *K. Dorph-Petersen*: Beretning fra Statsfrøkontrollen for det 51. Arbejdsaar. Tidsskrift for Planteavl, 28. Bd., pp. 710-713. — (6) *H. Kotkas*: Soklata timutiseemnete idanevus mullas. »Agronomiam« nr. 8, 10, 1935. — (7) *A. Ratt*. Soklata kaeraterade väärtustamine külvises. (Mit deutscher Zusammenfassung: Bewertung der entspelzten Haferkörner im Saatgut.) »Agronomiam« nr. 6, 1934.

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