

THE ELIMINATION OF HARD SEEDS IN NEWLY THRESHED
MEDICAGO SATIVA (ALFALFA)

By

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A THESIS

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INTRODUCTION

Among the seeds of many trees and plants is to be found a varying proportion of what are known as "hard seeds" that because of the nature of their coverings are slow to germinate. It appears that this covering in some instances is a provision of nature to enable the seed to "winter over" the action of the frost and elements; the covering is injured, however, to the extent that germination ensues at the proper time of the year.

In many of the legumes is to be found a varying percentage of hard seeds ranging from five to fifty per cent of the whole. These seeds have a gelatinous covering, often known as a natural water-proof varnish, that renders them impervious to the action of water until the covering has been broken in some manner.

OBJECT

The author has attempted to find a practical method of treating the newly threshed seed in order to secure, if possible, full germination of hard seeds. It is a well known fact that new alfalfa seed does not germinate as well as seed which is several months or a year old. When new seed is used for planting, more seed must be used than ordinarily, or the seed must be treated in some manner so that a higher per cent of germination may be secured.

In order to accomplish this end definite methods of mechanical and chemical scarification have been worked out and the results, secured in germination tests conducted every two weeks throughout the experiment, were carefully tabulated. Other investigators have studied this same problem and all agree that the scarifying of seeds in some manner so as to permit the absorption of water renders them capable of prompt germination, greatly increasing the percentage of germination of the treated over the untreated seed.

MATERIALS AND METHODS

A quantity of newly threshed seed was secured through the Yuma Experiment Station and recleaned in a fanning mill until it would grade about No. 3. A germination test was run at the beginning of the experiment and subsequent tests following the various treatments were made every two weeks for the duration of the tests. The U. S. standard moisture test taken showed a water content of 8.9 per cent. Commercial sulphuric acid of 1.84 sp. gr. was used.

TREATMENTS

I. One pound of seed was weighed out at the beginning of the experiment and re-weighed at intervals of two weeks throughout the experiment to determine shrinkage of seed kept

under ordinary storage conditions, and a curve made of same at the close of the experiment.

II. Germination tests were run on duplicate samples of seed of each treatment every two weeks throughout the experiment to determine the change in viability.

III. A large sample of seed from the original lot was sub-divided and treated as follows:

1. One lot was rubbed between sandpaper until well scarified.
2. One lot was shaken with sand in a bag.
3. One lot was divided into five parts and treated as follows:
 - a. Seed was immersed in acid and immediately washed.
 - b. Seed was left in acid for five minutes.
 - c. Seed was left in acid for ten minutes.
 - d. Seed was left in acid for twenty minutes.
 - e. Seed was left in acid for thirty minutes.

The seed that was treated with acid was placed in an ordinary tumbler and sufficient acid added to wet it thoroughly. After each lot of the seed had been treated for the required amount of time a metal screen was placed over the tumbler and the seed washed in running water for five minutes, care being taken to stir the seed thoroughly in order that all traces of the acid might be removed. The wet seed was then spread out and dried thoroughly and stored for use later on.

In running the germination tests the seeds were divided into two classes, yellow and brown, duplicate tests of one hundred seeds of each being run.

RESULTS

Todaro¹ found that the hard seeds of various leguminous species could withstand immersion in concentrated sulphuric acid for an hour or more without apparent injury, and that they were rendered capable of prompt germination, but he thought that if seeds were so treated and allowed to dry that they would not show the effect of immersion in acid when planted.

Cornell² found that the maximum germination was secured after acid treatment for ten minutes, but that seed could be left in acid for a period not exceeding two hours without injury. But if seed was left in acid for a longer period injury would result to the seed coats and the radicals of many seeds. The author has found that thirty minutes of acid treatment gave the best results and that no permanent injury to seed coats or radicals was apparent.

Sulphuric acid attacks the alfalfa seed with such vigor that (depending upon the length of time seed is in acid) severe injury will result if care is not taken to prevent same. In this experiment the seeds which were treated for thirty minutes showed to a pronounced degree the effects of the acid, particularly the immature seeds, many of which were badly shrivelled and acid eaten.

The plump mature seed showed burns and scars of various shapes and depths, many of them extending through the cuticle. It is the opinion of the author that if such severe burns result from thirty minutes of acid treatment, and in view of the fact that this lot gave one hundred per cent germination practically from the first treatment, further treatment would not only be unnecessary, but would possibly result in serious injury to the seed.

Each lot was kept in the germinating oven five days.

Table I - Check lot no treatment

Date each test began	Av. per cent yellow seeds germinated	Av. per cent hard yellow seeds	Av. per cent brown seeds germinated
Nov. 2	89	11	23
" 17	96	4	23
Dec. 2	92.5	7.5	26
" 15	95.5	4.5	25
" 29	95	5	17.5
Jan. 12	92	8	17.5
" 26	95	5	15.5
Feb. 9	97.5	2.5	15.5
" 23	97.5	2.5	11.5
Mar. 9	97.5	2.5	13
" 23	96.5	3.5	6.5
Apr. 8	97	3	10

Table 2. Seeds scarified with sandpaper

Date each test began	Av. per cent yellow seeds germinated	Av. per cent hard yellow seeds	Av. per cent brown seeds germinated
Check Table 1	89	11	23
Nov. 7	88.5	6.5	21.5
Nov. 17	92	8	22
Dec. 2	93	7	18.5
" 15	97.5	2.5	20.5
" 29	96	4	25
Jan. 12	94.5	5.5	14
" 26	95	5	17
Feb. 9	95.5	4.5	8
" 23	98.5	1.5	14
Mar. 9	97	3	12.5
" 23	96.5	3.5	7
Apr. 8	96	4	14.5

This treatment resulted in an immediate loss in germination of yellow seeds over check of -.5 per cent.

Table 3. Seed scarified with sand in a bag

Date each : test began	Av. per cent : yellow seeds germinated	Av. per cent: hard yellow seeds	Av. per cent brown seeds germinated
Check Table 1	89	11	23
Nov. 10	93	7	23
" 17	91.5	8.5	24.5
Dec. 2	94.5	5.5	24.5
" 15	95	5	22
" 29	98	2	24
Jan. 12	93	7	15
" 26	96.5	3.5	7.5
Feb. 9	97.5	2.5	11
" 23	99	1	7
Mar. 9	96	4	9
" 23	97	3	2
Apr. 8	97.5	2.5	5

This treatment resulted in an immediate gain in germination of yellow seeds over check of 4 per cent.

Table 4. Seed immersed in acid and immediately removed.

Date each test began	Av. per cent yellow seeds germinated	Av. per cent hard yellow seeds	Av. per cent brown seeds germinated
Check Table 1	89	11	23
Nov. 3	89.5	10.5	23
" 17	93	7	16
Dec. 2	96	4	13
" 15	95	5	11.5
" 29	98	2	17
Jan. 12	97	3	10.5
" 26	96	4	11.5
Feb. 9	97.5	2.5	8.6
" 23	94	6	12
Mar. 9	97	3	11
" 23	96	4	3
Apr. 8	96	4	7

This treatment resulted in an immediate gain in germination of yellow seeds over check of .5 per cent.

Table 5. Seed left in acid five minutes

Date each test began	Av. per cent yellow seeds germinated	Av. per cent hard yellow seeds	Av. per cent brown seeds germinated
Check Table 1	89	11	23
Nov. 7	94.5	5.5	18.5
" 17	97	3	14.5
Dec. 2	96.5	3.5	16.5
" 15	95.5	4.5	17
" 29	99	1	17.5
Jan. 12	96	4	9
" 26	97	3	8
Feb. 9	98.5	1.5	5
" 23	99	1	9
Mar. 9	98.5	1.5	9
" 23	98.5	1.5	4.5
Apr. 8	99	1	4.5

This treatment resulted in an immediate gain in germination of yellow seeds over check of 5.5 per cent.

Table 6. Seed left in acid for ten minutes

Date each test began	: Av. per cent: yellow seeds germinated	Av. per cent: hard yellow seeds	Av. per cent brown seeds germinated
Check Table 1	89	11	23
Nov. 4	98	2	11
" 17	98.5	1.5	14.5
Dec. 2	98.5	1.5	12.5
" 15	99.5	.5	6.5
" 29	99	1	27
Jan. 12	99	1	6.5
" 26	99	1	3
Feb. 9	100	0	3.5
" 23	99.5	.5	5.5
Mar. 9	100	0	2.5
" 23	100	0	.5
Apr. 8	99.5	.5	6.5

This treatment resulted in an immediate gain in germination of yellow seeds over check of 9 per cent.

Table 7. Seed left in acid twenty minutes

Date each test began	Av. per cent yellow seeds germinated	Av. per cent hard yellow seeds	Av. per cent brown seeds germinated
Check Table 1	89	11	23
Nov. 4	98	2	10.5
" 17	99.5	.5	7
Dec. 2	99	1	10
" 15	99	1	17.5
" 29	97.5	2.5	13
Jan. 12	99.5	.5	5
" 26	100	0	2.5
Feb. 9	99.5	.5	3.5
" 23	99	1	2
Mar. 9	100	0	4.5
" 23	99	1	2
Apr. 8	100	0	1

This treatment resulted in an immediate gain in germination of yellow seeds over check of 9 per cent.

Table 8. Seed left in acid for thirty minutes

Date each test began	Av. per cent yellow seeds germinated	Av. per cent hard yellow seeds	Av. per cent brown seeds germinated
Check Table 1	89	11	23
Nov. 7	99.5	.5	10
" 17	99.5	.5	8
Dec. 2	99.5	.5	12.5
" 15	100	0	14
" 29	100	0	10.5
Jan. 12	100	0	8.5
" 26	99.5	.5	3.5
Feb. 9	100	0	4
" 23	100	0	7
Mar. 9	100	0	4.5
" 23	99.5	.5	2
Apr. 8	100	0	3

This treatment resulted in an immediate gain in germination of yellow seeds over check of 10.5 per cent.

Table 9. Summary

Treatment	Av. per cent : yellow seeds : germinated	Av. per cent : hard yellow seeds	Av. per cent : yellow seeds : germinated	Increase in : per cent of : yellow seeds : germinated	Av. per cent : brown seeds : germinated	Decrease in : per cent of : brown seeds : germinated				
Check	89	97	11	3	8	23	10	56		
Scarified with sandpaper	88.5	96	6.5	4	-0.56	7.9	21.5	14.5	6.5	37
Scarified in a bag with sand	93	97.5	7	2.5	4.5	9.6	23	5	0	78
Immersed in acid only	89.5	96	10.5	4	.56	7.9	23	7	0	70
In acid for five minutes	94.5	99	5.5	1	6.2	11.2	18.5	4.5	19.6	80
In acid for ten minutes	98	99.5	2	.5	10.1	11.7	11	6.5	52.1	70
In acid for twenty minutes	98	100	2	0	10.1	12.3	10.5	1	54.3	96
In acid for thirty minutes	99.5	100	.5	0	11.8	12.3	10	3	56.5	87

The first test of untreated seed was used as a check on subsequent work.



Plate 1. Check lot. Untreated seed magnified to 20 X. Showing characteristic flaking of the gelatinous coating. These flakes and shreds appear (under the microscope) very much like commercial cocoanut

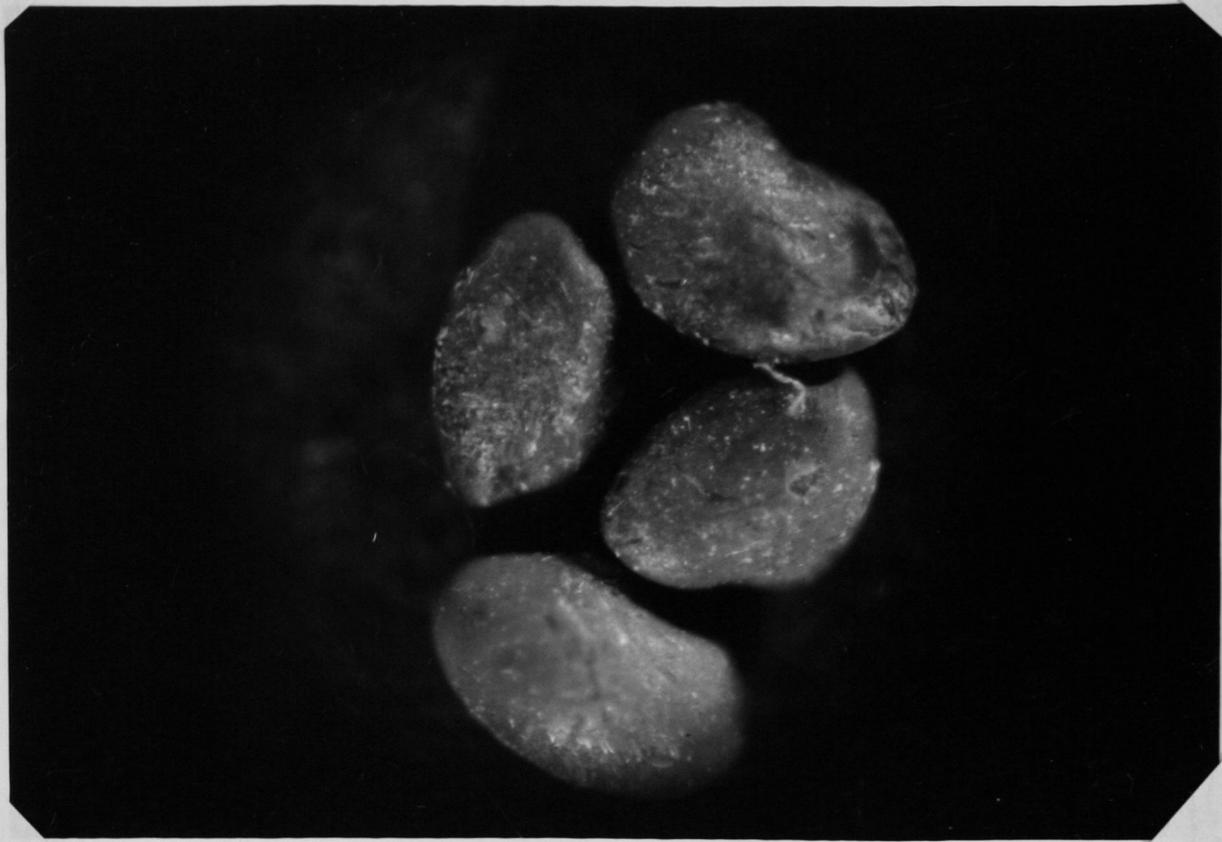


Plate 2. Lot 1. Seed scarified thoroughly between sandpaper, showing scratches and holes torn in the gelatinous covering and extending through cuticle to seed coat proper. (X 20).



Plate 3. Seed treated with acid for 30 minutes. Showing characteristic acid burns. Pits at lower edge of the two right hand seeds, show burns and shrivelling to be observed on the average acid treated seed, Lower left hand corner, effect of acid on immature seed, showing extent of acid burns on the shrivelled brown and green seeds, the acid destroying practically all viability. (X 20)

The seed that was immersed in the acid only long enough to wet it thoroughly gave an immediate germination test of 89.5 per cent or only .5 per cent better than the check lot, and 1 per cent better than the lot scarified with sandpaper. The seed treated with acid for five minutes gave an immediate germination test of 94.5 per cent, an increase of 5.5 per cent over the check lot and 6 per cent increase over seed scarified with sandpaper. The seed treated with acid for ten minutes gave an immediate germination test of 98 per cent or 9 per cent better than the check lot, and 9.5 per cent better than the lot treated with sandpaper. The seed treated with acid for twenty minutes gave an immediate germination of 98 per cent, which was the same result secured in the previous lot. The seed treated with acid for thirty minutes gave an immediate germination of 99.5 per cent, or 10.5 per cent better than the check lot and 11 per cent better than the lot scarified with sandpaper.

AGE INCREASES GERMINATION PERCENTAGE

This experiment was run for a period of five months, beginning November 7, 1922 and closing April 16, 1923. Of the seven lots of scarified seed and the one lot used as a check, the lots treated with acid for twenty minutes and thirty minutes respectively gave the largest per cent increase in germination over the check

or a total of 12.3 per cent each. The seed scarified with sand-paper gave an increase of 7.9 per cent and the seed scarified with sand in a bag, an increase of 9.6 per cent. Of the lots that were treated with acid, the lot immersed long enough to wet it gave an increase of 7.9 per cent; the lot that was treated for five minutes 11.2 per cent, and the lot that was treated for ten minutes 11.7 per cent. Seed treated with acid for ten minutes gave an average germination of 98 per cent at the beginning of the experiment and 99.5 per cent at the close of same, and the lot treated with acid for thirty minutes, an average germination of 99.5 per cent at the beginning and 100 per cent at the close.

COST OF TREATING SEED

Commercial sulphuric acid can be obtained in carload lots F.O.B. smelters at Douglas and other points at a cost of \$2 per gallon, and in demijohns of five gallons each for \$2.50 per gallon, a cost which might possibly render the use of it prohibitive in seed treatment. That is, if the seed to be treated did not contain over ten per cent of hard seeds. But seeds containing over ten per cent of hard seeds and only a small percentage of brown and immature seed can be profitably treated by the acid method with acid costing \$2.50 per gallon, since one gallon of acid is sufficient to treat two or three bushels of seed.



Plate 4. Cross-section of plump mature untreated seed, showing impermeable coat or cuticle as a thin white line at bottom of top seed.

(20X)

COLOR OF SEEDS AND ITS EFFECTS ON GERMINATION

Most commercial lots of alfalfa seed contain a mixture of yellow, brown and green colored seeds. The seeds which will germinate well are the plump yellow mature ones. The immature seeds are the shrivelled brown and green colored ones. The amount of immature seed in a given quantity of alfalfa is governed largely by the character of the season during which the seed was developing and ripening, and also the stage of maturity at which it was harvested. If alfalfa for seed is grown under good conditions and cutting is done at the right time, the percentage of immature seed will be small.

An average germination of 23 per cent was secured from the brown seeds that had received no treatment, results obtained showing an almost total absence of viability among the brown seeds that were treated with acid.

CONCLUSIONS

The author can say that it will practically always pay to scarify newly threshed alfalfa seed if it is to be planted at once, that is, unless the percentage of brown seeds is too great; that germination can be greatly increased, depending upon the percentage of hard seeds present, and a much thicker stand can be secured. Either mechanical or chemical methods can be used, though the mechanical method will be more satisfactory to use, particularly if the person wishing to scarify the seed has had but little experience

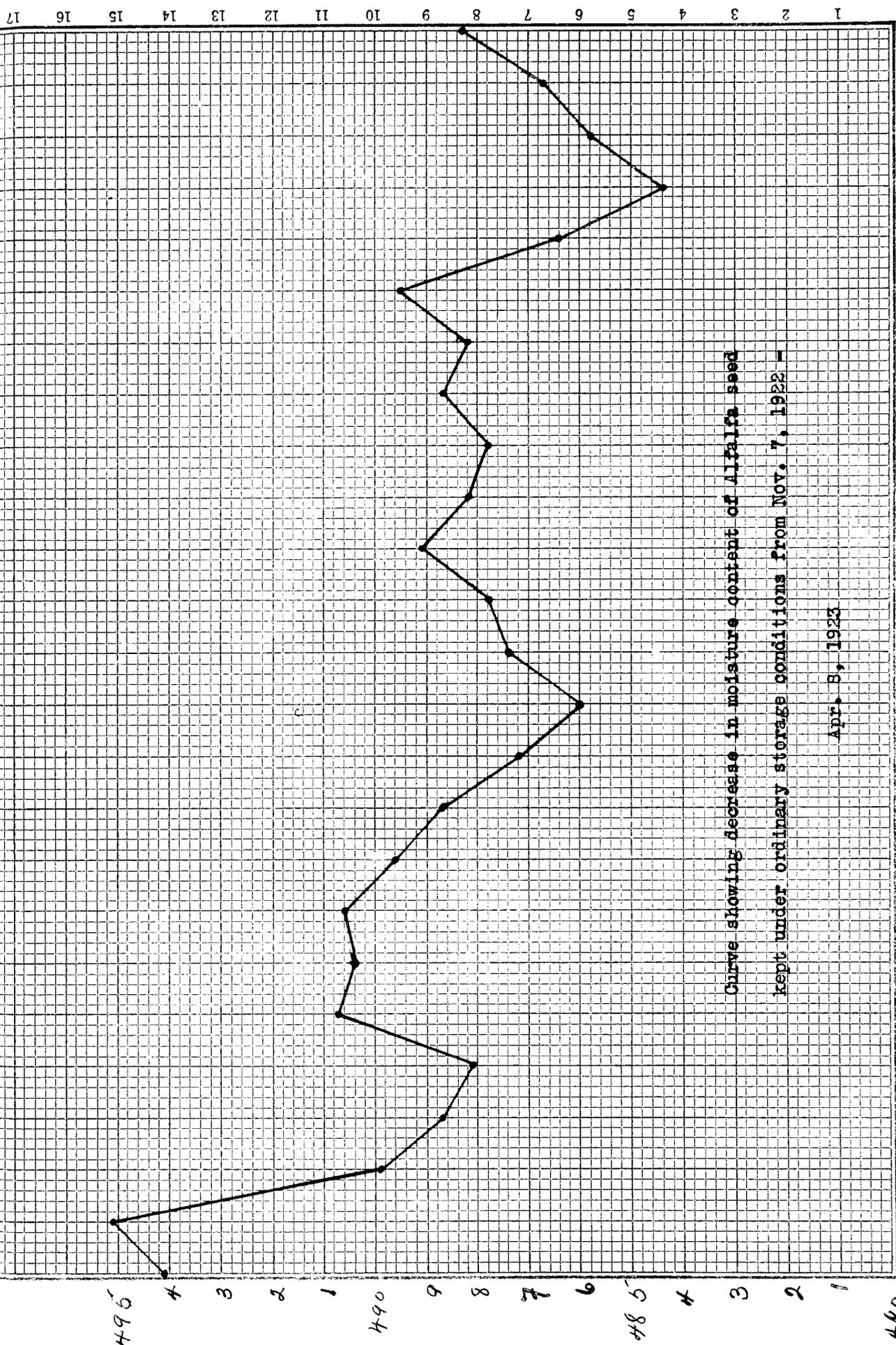
in the use of acid.

If the percentage of brown seeds is not too high the use of sulphuric acid in scarifying alfalfa seed will give the best results and it will pay to use it, especially if the seed to be treated has a high content of "hard seeds". Yellow mature seed that was treated with acid for thirty minutes by the author and a germination test run at once gave a result of 99.5 per cent or practically a one hundred per cent germination, while the same seed tested before the acid treatment germinated but 89 per cent.

Sulphuric acid caused an almost total loss of viability in the brown seeds - seeds which had given around 23 per cent germination, gave after thirty minutes of acid treatment only a 10 per cent germination and these resulting seedlings were very weak. Hence it would not be advisable to use the acid treatment for seed with a high content of brown seeds as the acid would probably do more harm than good.

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Curve showing decrease in moisture content of Alfalfa seed kept under ordinary storage conditions from Nov. 7, 1922 -

Apr. 8, 1923

Apr. 16
Apr. 8
Mar. 29
Mar. 22
Mar. 15
Mar. 8
Mar. 1
Feb. 22
Feb. 15
Feb. 8
Feb. 1
Jan. 25
Jan. 18
Jan. 11
Jan. 4, 1923
Dec. 28
Dec. 21
Dec. 14
Dec. 7
Dec. 2
Nov. 23
Nov. 16
Nov. 9
Nov. 3

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