Methods of Loosening Tight Seed Caps in Monogerm Seed to Improve Germination

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Received for publication February 24, 1964

The germination of monogerm seed produced in British Columbia under good conditions is frequently lower than germination of multigerm seed found in the same sample. This fact is illustrated by the data from a greenhouse soil emergence test on monogerm and multigerm seed from the same seed sample of CS36, Contract 3. The germ count of the multigerm was determined by examination and the emergence results of spaced seeds are shown in Table 1. The monogerm emergence on a single-germ basis was 32.5% as compared to 44.8% for the multigerm. The comparison on a seed ball basis was 32.5% for the monogerm as compared to 69.5% for the multigerm. The cause for differences in emergence obviously lies in the actual physical or physiological differences as between the multigerm and monogerm. The present report has to do mainly with the physical problem of tight seed caps and methods of loosening them.

Table 1.—Emergence in greenhouse of untreated monogerm and multigerm seed.

Seed	No. seed balls	No. Germs	Emergence as			Total seedlings	Percent emergence	
			Singles	Doubles	Multi.		Germ.	Seed balls
CS 36-MM	200	455	77	59	3	204	44.8	69.5
CS 36-mm	200	200	65	0	0	65	32.5	32.5

Since non-germinating monogerm seeds usually appear sound and plump after 7 to 10 days in the germinator, the possibility of an abnormally thick seed cap was suspected. Chipping the seeds was found to greatly increase germination, but the emerging seedlings were frequently deformed by the constricting action of the remaining portion of the seed cap. Measurements of the thickness of the seed cap revealed that monogerm caps were 23.5% thicker than the caps of multigerm seed from the same sample. Snyder (2)[2] reported in 1959 that certain monogerms had tighter seed caps than some multigerms. Lackey (1) demonstrated in 1948 that dilute acids such as HCL and H_2SO_4 could act on the cementing materials in the seed coat, reputed to be pectin substances and hemicelluloses, and loosen the seed cap thus improv-

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[2] Numbers in parentheses refer to literature cited.

ing germination. Sodium hydroxide and sodium hypochlorite were also effective in loosening the seed caps, but depressed germination.

Enzyme Treatments

It was reasoned that if the pectins and hemicelluloses were the cementing substances, then the enzymes hemicellulase and pectinase should loosen the seed caps and improve germination. Treatments reported in Table 2 show that hemicellulase was the more effective and gave responses over a very wide range of concentration. While enzymes could be economically used to increase laboratory germinations, it was felt that the acid treatments might prove to be more effective and likely much cheaper to use on a commercial scale.

Table 2.—Effect of enzyme treatments on germination of monogerm seed.

Seed	Treatment material	Hours treated	% Germination
CS 36-3	H_2O	2	54
CS 36-3	Hemicellulase 1%	2	73
CS 36-3	Hemicellulase 0.1%	2	71
CS 36-3	Hemicellulase 0.01%	2	66
CS 36-3	Pectinase 1%	2	68
CS 36-3	Pectinase 0.1%	2	59
CS 36-3	Pectinase 0.01%	2	51

Alternate Soaking and Drying

While soaking seed has long been employed to remove materials toxic to germination, the possibility of soaking and drying, thus loosening the seed caps, appeared worthy of investigation. The results of one test are shown in Table 3. In this test the germination was improved 17% and 15% by three and four one-hour soakings followed by drying under a heat lamp. The treatments are, however, too time consuming to have commercial possibilities.

Table 3.—Effect of alternate soaking and drying on germination of monogerm seed.

Seed	Treatment material	Soakings		Dryings		% Germination
		No. times	Duration	No. times	Duration	
CS 40	O	0	—	0	—	66
CS 40	H_2O	4	1	4	1	81
CS 40	H_2O	3	1	3	1	83

Laboratory Scale Acid Treatments

In a preliminary test on CS36, Contract 3, it was found that a two-hour treatment with 3% HCL, followed by two-hour washing before placing in the germinator, raised the germination from 57% for untreated seed to 77% for the HCL treated seed.

Five different lots of seed were treated with 3% HCL for two hours, and washed for two hours without subsequent drying with the results as shown in Table 4. This acid treatment improved germination 24% to 27% on treatments where germination was between 41% and 50%, but gave inconclusive results on lots where untreated germination was already in the 74% to 78% range.

Table 4.—Effect of 3% HCl treatments.

Seed	Material treatment	Hours treated	Hours wash	% Germination
CS 36-3	H_2O	2	—	47
CS 36-3	HCl 3%	2	2	71
CS 41-4	H_2O	2	—	50
CS 41-4	HCl 3%	2	2	77
CS 36-5	H_2O	2	—	41
CS 36-5	HCl 3%	2	2	65
CS 33-11	H_2O	2	—	78
CS 33-11	HCl 3%	2	2	71
CS 40-23	H_2O	2	—	74
CS 40-23	HCl 3%	2	2	77

A test was designed to determine whether washing was essential after treatment with 3% acid. Seed that was washed after treatment gave 29% improvement in germination, whereas, seed that was not washed after acid treatment gave 28% and 32% improvement. Therefore, washing may not be essential, but washed seed should be less damaging on paper bags during shipment and storage, and less corrosive on seed drills and would, therefore, be preferred for commercial use.

Phosphoric acid treatments were also tried giving in some cases, improvement comparable to 3% HCL, but the optimum concentration was somewhat higher than for HCL and the results were more variable.

Neutralization of either H_3PO_4 or HCL after treatment by accurate titration caused no damage but in other tests, where the seed was neutralized by excess NH_3 gas, germination was severely reduced. This might have been anticipated since it has been reported that naturally occurring ammonia compounds inhibit germination.

A further test to determine the optimum ratio of seed to acid solution is shown in Table 5. The ratio of 3 seed to 1 acid by weight indicated insufficient acid, whereas, an acid soak of one-part seed to two-parts acid resulted in less benefit than the intermediate ratios. These results lead to the opinion that percolation with excess acid might be a practical commercial treatment. This should insure that all surfaces are exposed to acid action without damage by too deep a penetration from an excess soaking in acid.

Table 5.—Seed-acid ratio of 3% acid to seed (CS 36, contract 3).

Seed-acid ratio	Hours treated	Hours drying	% Germination	Abnormals
3:1	2	3½	76	3
2:1	2	3½	85	2
1:1	2	3½	91	0
1:2	2	3½	76	1

Percolation with Muriatic Acid

Further acid treatments were run to provide leads on commercial treatment methods. These were designed to suit operating conditions in the Ladner seed cleaning plant where the seed is handled and stored in 45-bushel plywood boxes. The plant is also equipped with a New Holland Model 733 Drying Bin which has a 10,000-pound capacity. The present tentative plan is to put screen bottoms in about nine storage boxes, fill these to within 8 to 10 inches of the top with processed seed. The boxes will then be flooded with 3% muriatic acid from an overhead tank. The seed will be allowed to drain for two hours and then the excess acid will be flushed away with water. The seed will then be elevated into the drier which must be filled to capacity to permit the drier to operate.

In order to obtain indications of the effectiveness of the above method, a series of treatments were run using a 4″ tile, three feet long, as a percolator chamber. This tile was stood upright on a Buckner funnel and six pounds of seed was percolated with 12 pounds of 3% muriatic acid. The treatment period was two hours and the excess acid was washed out with three changes of water. The seed was then dried with a small-scale forced-air drier at temperatures of about 105°F to approximate conditions in the commercial drier. The results of these tests are shown in Table 6. The results were quite consistent and gave an average improvement in germination of 21% and 20% for the two- and three-hour treatment period, respectively.

Table 6.—Effect of percolation with muriatic acid.

Seed	Treatment material	Seed-acid ratio	Draining hours	No. of washings	Hours drying	% Germination
CS 36-3	H_2O	—	—	0	0	68
CS 36-3	26% Mur	1:2	2	3	2-3	88
CS 36-3	26% Mur	1:2	3	3	2-3	80
CS 41-4	H_2O	—	—	0	0	57
CS 41-4	3% Mur	1:2	2	3	2-3	80
CS 41-4	3% Mur	1:2	3	3	2-3	80
CS 36-5	H_2O	—	—	0	0	56
CS 36-5	3% Mur	1:2	2	3	2-3	76
CS 36-5	3% Mur	1:2	3	3	2-3	80

Discussion

The evidence presented in this paper indicates that one of the important limiting factors in the germination of certain lots of monogerm seed grown in the Vancouver area is the tightness of the seed cap. Snyder (2) reported that when cloned seed-bearing plants were grown at mean temperatures of 66° and 76° F, a greater proportion of loose seed caps occurred at the higher temperature. Since July and August mean temperatures in Vancouver average 63° F and the mean at Phoenix is probably above 76° for this period, it is predictable that tight caps should be a complaint in British Columbia and loose caps should be a problem in Phoenix. Climatic conditions at Salem more closely resemble Vancouver than Phoenix and two poor germination lots from Oregon which were given the acid treatment were improved 23% in germination which indicates that the tight seed cap problem also exists in Oregon.

Tight seed caps have never been recognized as a problem in multigerm seed, but this may be because their seed caps are naturally thinner as was found in the one case examined.

While acid treatments of monogerm seed may prove practical and economical on a commercial scale, it should be possible to breed strains with thinner and looser seed caps. Inbred lines now on hand will be grown in British Columbia to see whether sufficient useful variation exists.

Conclusions

1. Monogerm seeds grown in the Vancouver area have been shown to possess thicker and tighter seed caps than multigerm seed from the same sample. These thick tight seed caps appear to be the main reason that monogerm has a lower percentage germination than multigerm grown under the same conditions.

2. Germination of monogerm seeds having tight seed caps was greatly improved by chipping off part of the cap, by alternate soaking in water and drying, by enzyme treatments and treatments with 3% HCL.

3. Semi-commercial treatments by percolation with 3% muriatic were successful in bringing germination up to acceptable levels. Acid treatments on a commercial scale presents no difficulties, but the drying of soaked seed in large quantities will be slow and somewhat risky.

Acknowledgments

The author wishes to acknowledge the contribution of G. M. Guccione on the effect of alternate soaking and drying, of F. R. Low and A. Schmand for the contributions to the seed treatment and germination experiments, and of Sam C. Campbell for supplying low-germinating samples of Oregon-grown seed.

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