COMUNICACIONES

Response of cotton genotypes to presowing hydration-dehydration treatments under accelerated and natural ageing conditions.

Resumen. Los efectos de pretratamientos mediante hidratación y deshidratación con agua, vapores de iodo, fosfato dibásico de sodio y pantotenato de calcio, sobre el control del deterioro de las semillas, fue estudiado en cuatro cultivares de algodón, sometidas tanto a envejecimiento acelerado como también al proceso normal. Se observaron diferencias genotípicas en cuanto a la resistencia bajo condiciones de aceleramiento; "Bhagya" y "Sharada" mostraron poco efecto, mientras que en "Jayadhar" la germinación se redujo a más de la mitad. Pretratamiento de las semillas con agua, fosfato dibásico de sodio o pantotenato de calcio, reduce el deterioro considerablemente. La germinación de las semillas se correlacionó significativamente con el pretratamiento con agua en el caso de "Sharada", con la conductivilidad eléctrica en el de "Laxmi" y con la permeación de azúcares en "Jayadhar"; ninguno de los pretratamientos mostró incremento en la germinación de "Bahagya".

Considerable evidence are available to show that changes in permeability of plasma membrane occur during storage with consequant loss of seed viability. Increased cell-permeability of deteriorated seed allows large quantities of cellular components to diffuse out when placed in water. Seed deterioration was well correlated with increased electrical conductance and sugars of seed leachates (1, 3, 10, 18, 19). Presowing hydration-dehydration of seeds with water or dilute solution of chemicals significantly slow down deterioration of various crop seeds (6, 11, 14, 15). Artificial or accelerated ageing technique as developed by Delouche (12), has become an useful technique in understanding the mechanism of seed deterioration and also to predict the loss of seed vigour. Recently Bourland and Ibrahim (9), reported variation among cotton cultivars for resistance to seed deterioration using this technique. In the present paper, the genotypic variation in cotton seed deterioration under both accelerated and natural ageing conditions as well as its control by hydration-dehydration pretreatments are reported.

Material and methods

Four cotton cultivars, viz., 'Sharada', 'Laxmi', 'Bhagya', (*Gossypium hirsutum*, L.) and 'Jayadhar' (*G. herbaceum*, L.) were raised in field (medium black soil) in 1981-82 season and the seeds collected were sundried and stored in paper envelopes. Three months after collection, the seeds were subjected to hydration-dehydration (soaking for five hours followed by shade drying to original weight) pretreatments with water, sodium phosphate dibasic (10^{-4} M) and calcium pentethenate (10 ppm). In another treatment seeds were exposed to iodine vapours for 24 hours, in a vaccum desiccator (5.5 l) by placing 2 g iodine in a Petri plate. The seeds were then allowed to age artificially at the 100 percent relative humidity and 40°C for three days. Following this, seeds (100 per treatment) were sown on sand filled in a plastic pot, in triplicates. The total seedling emergence, 12 days after sowing was recorded, as a measure of germinability. Non-aged and aged seeds without pretreatments constituted two sets of control.

Seed leachate was collected by placing 1 g seed in 25 ml distilled water for one hour. The electrical conductivity and sugars in the seed leachate were determined in a conductivity bridge (4) and by colorimetry (16) respectively. Water soluble sugars in seed was extracted and estimated following the method of Agrawal (2).

The naturally aged seeds stored in paper envelopes after seven months under prevailing laboratory conditions (relative humidity 82 ± 2% ; temperature 26 ± 2°C; seed moisture around 9%) were subjected to hydration-dehydration pretreatments as under accelerated ageing system, excluding the iodine vapours treatment The germination test was done as above, with cultivars 'Bhagya', 'Laxmi' and 'Jayadhar' only.

Results

Hydration-dehydration pretreatments particularly water under accelerated ageing system and calcium pantothenate as well as sodium phosphate dibasic under natural ageing system significantly enhanced the germination over untreated aged or non-aged seeds (Table 1).

Under both the systems of ageing, 'Bhagya' maintained significantly higher germination percentage than others, while 'Laxmi' showed relatively lower germination. However, under natural ageing system, genotypic response to pretreatments differed significantly. Thus, calcium panthothenate for 'Bhagya' and 'Jayadhar' and water for 'Laxmi' proved to be better treatments than others.

Electrical conductance and leachate sugars as well as seed sugars differed significantly among the pretreatments and genotypes (Table 2) Pretreatments considerably lowered the electrical conductivity of the seed leachates, with significant reduction observed under calcium pantothenate and water pretreatments. Among the genotypes, EC was considerably less in 'Bhagya'. However, the extent of reduction over aged seeds differed with pretreatments among the genotypes The highest reduction was observed under sodium phosphate dibasic in 'Sharada' (50%) followed by calcium panthothenate in 'Laxmi' (36 8%). The sugar content of seed leachates, on the other hand, increased significantly in the pretreated seeds, barring water, wherein significant reduction was noticed. The genotypes references were apparent, with 'Laxmi' having highest concentration followed by 'Sharada' and least in 'Bhagya'. The water soluble seed sugars also exhibited a definite increase in pretreated seeds, particularly in calcium pantothenate treatment. However, in comparison to aged seeds, significant reduction was observed under water and sodium phosphate (dibasic) pretreatments, which was on par with non aged untreated seeds. This was evident, in all the genotypes, barring 'Jayadhar'. The percent sugar leached out of the seed, was significantly least in calcium pantothenate treatment, followed by water over that in aged untreated seeds. 'Bhagya' lost least seed sugars in leachates, while significantly higher quantities were lost in 'Laxmi'. As with other seed leachate characteristics, genotypes and pretreatment interaction differences were apparent with 'Jayadhar' and 'Laxmi' showing significant reduction in water pretreatment, while it was achieved in calcium pretreatment in 'Sharada' over both aged and non-aged seeds.

Discussion

The results generally confirmed earlier observations that hydration-dehydration pretreatments could effectively restore the seed vigour damaged by ageing (5, 6, 7, 8, 13, 14, 15). It is believed that much of the ageing damage is caused by what is termed 'free radial pathology'. The quenching effect of hydration on the propagation of free radicals may account for much of the beneficial effects of short-term hydration-dehydration pretreatments (5). This was evident from the altered pattern of leached substances from pretreated seeds

However, among the pretreatments iodine vapour did not improve the germination, as it believed

Table 1: Effect of hydration-dehydration pretreatments on percent germination of cotton seeds.

Treatment cultivar	Accelerated Ageing					Natural Ageing			
	Sharada	Laxmi	Bhagya	Jayadhar	Mean	Laxmi	Bhagya	Jayadhar	Mean
Non-aged control	86.7	57.3	93.3	84.0	80.3	–	–	–	–
Aged-untreated	78.7	46.7	81.3	41.3	62.0	18.7	29.3	20.0	22.7
Water	84.0	60.0	92.0	80.0	79.0	31.1	46.7	24.0	35.1
Iodine vapours	66.7	41.3	45.3	28.0	45.3	–	–	–	–
Sodium phosphate dibasic (10^{-4} M)	82.7	78.7	86.7	69.3	76.0	30.7	55.3	37.3	41.1
Calcium pantothenate (10 ppm)	82.7	66.7	85.3	68.0	75.7	26.7	66.0	41.3	44.7
Mean	80.2	56.2	80.7	61.8	–	26.8	49.3	30.7	–
C.D. 5% Cultivars (C)					6.4				4.1
Pretreatment (T)					7.8				6.0
Interaction CxT					NS				8.0

Table 2: Genotypic variation to hydration-dehydration pretreatments in seed and seed leachate characteristics of cotton.

TREATMENT	Seed leachate conductivity (μmhos/cm)					Seed leachate sugar (mg/g seed)					Water soluble seed sugar (mg/g seed)					Sugar leached (per cent)				
CULTIVAR	V_1	V_2	V_3	V_4	Mean	V_1	V_2	V_3	V_4	Mean	V_1	V_2	V_3	V_4	Mean	V_1	V_2	V_3	V_4	Mean
1. Non-aged control	350	233	133	200	229	0.598	0.829	0.295	0.104	0.456	14.33	14.00	17.25	15.50	15.27	4.17	5.92	1.71	0.67	3.12
2. Aged-untreated	233	250	125	200	202	0.742	0.504	0.206	0.460	0.478	19.17	15.00	22.67	13.50	17.28	4.04	3.36	0.91	3.41	2.93
3. Water	167	167	125	233	173	0.620	0.591	0.206	0.131	0.362	14.42	15.67	15.50	17.33	15.73	4.30	2.92	1.33	0.76	2.33
4. Iodine vapour	217	317	133	217	221	0.610	0.915	0.294	0.545	0.591	24.17	16.33	16.83	15.58	18.23	2.52	5.60	1.75	3.52	3.35
5. Sodium phosphate dibasic (10^{-4} M)	117	217	133	250	179	0.533	0.729	0.362	0.352	0.494	15.00	17.25	16.50	14.67	15.88	3.55	4.23	2.19	2.40	3.09
6. Calcium pantothenate (10 ppm)	217	158	117	183	169	0.316	0.587	0.271	0.325	0.500	18.17	18.08	21.58	19.25	19.28	1.74	3.25	1.26	1.69	1.98
7. Mean	217	224	128	214	–	0.570	0.676	0.272	0.319	–	17.54	16.05	18.40	15.97	–	3.89	4.21	1.52	2.07	–
C.D. 5% Cultivar (C)					26					0.028					0.57					0.24
Pretreatment (T)					32					0.035					0.70					0.29
Interaction (CxT)					64					0.075					1.40					0.58

V_1 = Sharada; V_2 = Laxmi; V_3 = Bhagya; V_4 = Jayadhar.

Table 3: Correlation (r) between seed characters and germination

		EC	Seed sugar	Leachate sugar	% Sugar leached
1) Mean of all varieties		−0 3078 ns	0.2012 ns	−0.3857 ns	0.4104 *
2) Individual varieties					
	Sharada	−0 1329 ns	−0.8109 **	−0.2292 ns	−0.3474 ns
	Laxmi	−0 8032 **	0 2523 ns	−0.3247 ns	−0.3474 ns
	Bhagya	0.0031 ns	0.0661 ns	−0.0711 ns	−0.1186 ns
	Jayadhar	0.5084 *	0.3832 ns	−0.9288 **	−0.9185 **

ns = Non-significant; * = significant at 0.05 P; ** significant at 0.01 P

to be (7) Iodine has a role in the stabilization of lipoprotein membranes of the cell, rendering them less susceptible to lipid peroxidation and free radical reaction. Thus, use of iodine, in arresting deterioration needs further confirmation.

It is said that seeds with seed vigour resist accelerated ageing test (6, 17). Generally, this view appears to be true since 'Bhagya' which maintained relatively higher germination under accelerated ageing, retained its relative vigour under natural ageing conditions also.

Although it is generally agreed that a short term hydration-dehydration treatments with water or dilute solution of chemicals could repair the damage caused by ageing, the way in which it is accomplished appears to be elusive. The pattern of leakage substances as well as seed sugars among the genotypes and pretreatments differed considerably. Thus generally, it appeared that none of the seed/leachate characteristics studied bore any relationship with seed vigour (Table 3). However, among the individual genotypes, seed sugars in 'Sharada', EC of seed leachates in 'Laxmi', and leachate sugar and/or percent sugar leached out of seed in 'Jayadhar' were found to strongly influence, regatively the germination. None of the characters studied was found to have any influence on germination in 'Bhagya' which incidentally maintained high degree of germinability.

Our observations lend support to the view that altered membrane permeability to be major cause of loss in seed viability. These changes are generally found in cotyledons. However, the extent of deterioration caused in the Cotyledons *vis-a-vis* embryos leading to loss in seed vigour, are yet to be elucidated.

Acknowledgements

The authors thank Dr. Y. C. Panchal, Professor and Head, Department of Crop Physiology, College of Agriculture, Dharwad and Dr. B H. Katarki. Senior Scientist (Cotton), for providing necessary facilities and encouragement to carry out the work reported in this paper.

Summary

The effect of hydration-dehydration pretreatments with water, iodine vapours, sodium phosphate-dibasic and calcium pentothenate on the control of seed deterioration was studies in four cotton cultivars under both accelerated and normal ageing systems. Genotypic differences were observed in resistance to ageing under accelerated system; 'Bhagya' and 'Sharada' showed little effect, while in 'Jayadhar' the germinability reduced to more than half. Pretreatment of seed with either water, sodium phosphate dibasic or calcium pantothenate checked the deterioration considerably. Seed germination was significantly correlated with water soluble sugars of seed in 'Sharada', electrical conductance in 'Laxmi' and leachate sugar in Jayadhar, none of the parameters had any relationship with germination in 'Bhagya'.

June 14, 1984

K. V. JANARDHAN,* B S. JANAGOUDAR*, K. VENKATA SUBBAIAH*

* Department of Crop Physiology, College of Agriculture, Dharwad-580005, Karnataka, India

Literature cited

1. ABDUL BAKI, A A. and ANDERSON, J D. Physiological and biochemical deterioration of seeds. In Kozlowski, T T. ed. Seed Biology. New York, Academic Press. 1972, pp. 283-315.

2. AGRAWAL, P.K., Genotypic variation in germination and membrane permeability in wheat (*Triticum aertinum*) seeds during storage under ambient conditions. Seed Research 7: 120-127 1979

3. AGRAWAL, P.K. and SIDDIQUI, M.N. Influence of storage temperature and seed moisture on germination, free fatty acid content and leaching of sugars from soybean seeds during storage. Seed Research 1: 75-82. 1973

4. ANDERSON, A.M., HART, T.R. and FRENCH, R.C. Comparison of germination techniques and conductivity tests of cotton seeds. Proceedings of International Seed Testing Association 29: 81-86. 1964.

5. BASU, R.N. Physico-chemical control of seed deterioration. Seed Research 4: 15-23 1976.

6. BASU, R.N. and DASGUPTA, M. Control of seed deterioration in wheat (*Triticum aestivum* L.). Indian Agriculturist 18: 285-288 1974

7. BASU, R.N. and RUDRAPAL, A.B. Physicochemical control of seed deterioration by free radical controlling agents. Indian Journal of Experimental Biology 16: 1070-1073. 1979.

8. BASU, R.N., CATTOPADHYAY, K. and PAL, P. Maintenance of seed viability in rice (*Oryza sativa* L.) and jute (*Corchorus capsularia*. L and *Corchorus olitorius* L.) Indian Agriculturist 18: 75-79. 1974

9. BOURLAND, F.M. and IBRAHIM, A.A.L. Effect of accelerated againg treatments on six cotton genotypes. Crop Science 22: 637-640. 1982.

10. CHING, T.M. and SCHOOLCRAFT, I. Physiological and chemical differences in aged seeds. Crop Science 8: 407-409, 1962.

11. DASGUPTA, M. and BASU, R.N. Prolonging the viability of sheat seed. 14th All India Wheat Workers Workshop: Bidhan Chandra Krishi Viswavidyalay, Kalyani, W. Bengal, India. 1973

12. DELOUCHE, J.C. Seed Deterioration. Seed World 92: 14-15, 1963.

13. DELOUCHE, J.C., MATTHEWS, R.K., DOUGHERTY, G.N. and BOYD, A.H. Storage of seeds in tropical regions. Seed Science and Technology 1: 663-662. 1973

14. DHARMALINGAM, C. and BASU, R.N. Control of seed deterioration in cotton (*Gossypium hirsutum* L.) Current Science 47: 484-487, 1978.

15. HAYDECKER, W., Vigour. In Roberts, E.H. ed. Viability of seeds. London, Chapman and Hall 1972. pp. 209-252.

16. MCCREADY, R.M., GUGGOL. Z.J., SILVIERA, V. and OWENS, H.S. Deterioration of starch and amylase in vegetables. Analytical Chemistry 22: 1156-1158. 1950.

17. MUSGRAVE, M.E., PREIESTLEY, D.A. and LEOPOLD, A.C. Methanol stress as a test of seed vigor. Crop Science 20: 626-630. 1980.

18. PRESLEY, J.T. Relation of protoplast permeability to cotton seed viability and predisposition to seedling disease. Plant Disease Reporter 42: 852. 1958.

19. TAKAYANAGI, K. and MURAKAMI, K. Rapid germinability test with exudate from seed. Nature 218:493 1968.

Tablas de volumen para *Gmelina arborea* Roxb. en Manila de Siquirres, Costa Rica.

Summary. Double entry over-and under-bark tables are given for total volume and volume to 10 cm over-bark top diameter for 17 years old *Gmelina arborea* Roxb plantations at Manila in Siquirres, Costa Rica. Individual tree volumes were calculated using the Smalian method for the sections and a top cone. Total and commercial volume tables were developed using a linear regression model based on natural logarithms. Fifteen regression models were tested. The Furnival index, the coefficient of determination, the residual distribution, and the significance of the coefficients of the equations indicate the best fit to be the natural logarithm model.

Las plantaciones de *Gmelina arborea* Roxb. en Manila de Siquirres fueron establecidas entre 1966 y