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germ tubes that were highly significantly shorter than germ tubes from either the virus-free or WCMV infected plants. This decrease in germ tube length perhaps reflected the debilitating effect on the whole plant rather than a direct effect of the virus on the pollen grain as was suggested by Medina and Grogan (4) for pollen from bean plants infected with yellow bean mosaic.

Discussion

The growth of the pollen germ tubes was significantly shorter when pollen was taken from plants infected with CYMV than when it was taken from virus-free plants or those infected with WCMV. This could mean that under natural pollination, pollen from CYMV infected plants would not form germ tubes of sufficient length to reach the embryo sacs. If this happened, then pollen from CYMV infected plants would not participate in fertilization. Genetic evidence in tetraploid alfalfa demonstrated that a pollen parent with long pollen tubes could fertilize a greater proportion of the ovules in an alfalfa ovary than a pollen parent with short pollen tubes, according to Barnes and Cleveland (1). Pollen from CYMV infected plants and from healthy plants appears to germinate equally well although the flowers of infected plants are smaller and have fewer florets. The opportunity of the pollinating insect to trip the floret would appear to be equal in both cases. Thus, potential seed production from plants in a given field could be directly influenced by the number of plants infected with CYMV or a virus that reduced pollen length similar to CYMV.

In the seed producing areas of Idaho, one of the accepted practices is to allow the red clover plants to grow until just before the onset of blooming and then clip the plants. This is done to interfere with the life cycle of the clover seed chalcid which lays its eggs in the developing seed pod. Plants infected with CYMV, when clipped, do not re-grow readily and those that do are stunted and weakened. Plants thus affected produce fewer heads and fewer florets per head and the resulting pollen germ tubes are shorter. This is in agreement with Goth and Wilcoxson (3) who stated that clones and inbred lines of Wegener red clover infected with yellow bean mosaic virus produced fewer flowers and only one-tenth the seed of virus-free plants.

Summary

Plants of Dollard red clover were inoculated with clover yellow mosaic virus or white clover mosaic virus or left uninoculated. Percent pollen germination and length of pollen germ tube were recorded for each treatment. There was no significant difference in percent pollen germination. However, the germ tube length of pollen from plants infected with clover yellow mosaic virus was significantly shorter than that from white clover mosaic virus infected plants or the virus-free check. This reduction in pollen germ tube length of clover yellow mosaic virus infected plants may play a role in the lowered seed yields of red clover reported in many areas.

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VIABILITY OF COTTONSEED AFTER LONG PERIODS OF STORAGE[1]

J. B. Pate and E. N. Duncan[2]

THE results reported here are part of a continuing study on the viability of seed of cotton (*Gossypium hirsutum* L., *Gossypium barbadense* L., and *Gossypium thurberi* Tod.) after various periods of storage under different moisture and temperature conditions.

An experiment was begun in 1937 to study the effects of moisture and temperature on the viability of upland cottonseed stored in sealed containers. Seed of 2 varieties 'Carolina Dell' and 'Deltapine A', with initial germination averaging 87%, were adjusted to levels of moisture ranging from 7 to 14% and stored at constant temperatures of 33, 70, and 90° F. Seed of each variety at each moisture level were also stored under seasonal temperature fluctuations to serve as controls. Several containers for each moisture-temperature level were stored so that viability could be determined over an extended period. Germination was determined after various periods of storage and reported in 1942, 1946, 1953, and 1957 (1, 2, 3, 4). Detailed methods of storage, moisture adjustment, moisture determination, and germination are presented in these reports. Since there were no appreciable differences in germination, data for the two varieties were combined.

Seed remaining in this experiment were recently tested after storage for 25 years. Data for the 25-year period (Table 1) show that seed stored at 33° F. with 7, 9, and 11% moisture had not deteriorated. Seed stored at 33° F. and 13% moisture germinated only 16% after 25 years. All other seed were either nonviable after shorter periods of storage or quantities of seed stored were not sufficient for additional studies.

In another experiment, seed of *G. hirsutum, G. barbadense,* and *G. thurberi* were obtained from Sacaton, Ari-

[1] Cooperative investigations of the Crops Research Division, ARS, USDA, and the Tennessee Agricultural Experiment Station, Knoxville, Tennessee. Received Nov. 16, 1963.

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Table 1. Germination of cottonseed stored in sealed containers for various times at different moisture and temperature conditions.

Moisture %	Temp. °F.	Germination percentage after various periods (years) of storage								
		1	2	3	5.5	7	13.5	15	19	25
7	33	87	87	87	90	94	90	91	92	91
9	"	92	87	93	89	92	93	91	92	82
11	"	89	88	91	79	89	88	93	89	86
13	"	90	87	86	87	92	91	72	51	16
14	"	88	90	85	61	34	10	0	--	--
7	70	93	91	90	84	89	85	73	51	--
9	"	87	91	82	81	59	0	--	--	--
11	"	86	89	68	1	--	--	--	--	--
13	"	72	23	3	--	--	--	--	--	--
14	"	17	0	--	--	--	--	--	--	--
7	Air	87	90	83	--	88	--	0	--	--
9	"	91	88	84	--	--	--	0	--	--
11	"	85	69	18	--	--	--	--	--	--
13	"	49	0	--	--	--	--	--	--	--
14	"	0	--	--	--	--	--	--	--	--
7	90	86	86	59	0	--	--	--	--	--
9	"	50	33	0	--	--	--	--	--	--
11	"	21	0	--	--	--	--	--	--	--
13	"	0	--	--	--	--	--	--	--	--
14	"	0	--	--	--	--	--	--	--	--

Table 2. Germination of cottonseed stored as follows: Sacaton, Ariz., in open storage from year of production to 1945; Knoxville, Tenn., in sealed containers at 70° F. from 1945 to 1957 and at 33° F. from 1957 to 1962.

Year of production	Species	No. seed lots	Germination percentage		
			1945	1957	1962
1926	G. hirsutum	1	70	30	19
1927	"	2	76	11	13
1928	"	6	72	30	14
1929	"	6	73	59	50
1930	"	7	70	67	54
1931	"	3	89	87	82
1932	"	3	62	60	53
1933	"	4	85	80	77
1934	"	1	76	94	93
1924	G. barbadense	1	92	50	50
1925	"	1	18	2	0
1926	"	2	73	27	7
1927	"	1	68	1	0
1929	"	3	48	6	1
1930	"	5	76	34	23
1931	"	4	76	37	26
1932	"	6	87	55	52
1933	"	4	90	73	66
1934	"	3	81	65	70
1937	"	2	96	75	84
1938	"	1	92	89	90
1931	G. thurberi	1	64	57	81

zona in 1945. These seed had been stored under open air conditions at Sacaton from year of production to 1945. Germination was determined in 1945 (2). Remnant seed were placed in sealed containers, stored at 70° F., and germinated in 1957 (4). Seed remaining after the second germination were stored at 33° F. and germinated in 1962. The germination of many of these samples was excellent in 1962 (Table 2) even though the age of the seed ranged from 24 to 38 years. Most samples deteriorated little from 1957 to 1962. Germination of *G. thurberi* was considerably higher in 1962 than in 1957 or 1945. Storage at 33° F. could have broken dormancy, but it is difficult to visualize dormancy in seed 31 years old.

These data show that cottonseed of good quality can be stored in sealed containers for extended periods, possibly more than 25 years, without loss of viability if the temperature is held at 33° F. and seed moisture in the 7 to 11% range.

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MECHANICAL PROCESSING OF KENAF FIBER[1]

Robert I. Jackson[2]

THE natural fiber of kenaf, *Hibiscus cannabinus* L., is found in the cortex layer and can be separated from the wood by machines in the form of ribbons. Both whole plants and ribbons are retted to produce a fiber which is spun into yarns varying in weight from coarse to fine. Dry ribbons, produced by a combine harvester-ribboner, may be spun economically only into coarse yarns which in turn are woven into material for bags with a somewhat open mesh. Bags of this type are suitable for coarse grain and commodities of similar size or larger. However, fine yarn spun from retted fiber is needed for closely woven sacks and hessians used for bale covers and carpet backing.

If ribbons the length of the plant are to be retted, much care has to be taken to keep the ribbons straight and in a parallel array. This is ordinarily accomplished through a hand operation which greatly increases the cost of the retted fiber. The long fibers must be kept parallel because it is not possible to card, spin, and weave them economically otherwise.

Both green and dry ribbons will ret satisfactorily. By stapling ribbons, that is, cutting them into predetermined lengths, it is possible to ret, wash, dry, and bale them mechanically. This will permit a great savings in labor costs. The stapling of the ribbons can be done either by a gang saw or guillotine. The ribbons should be stapled into lengths of 10 to 15 inches.

The ribbons from different portions of the plant require varying retting periods in order to produce the best possible quality of fiber. Thus by retting the basal portion longer, a complete ret is accomplished without over-retting the top portion and thus reducing its strength and quality. After the ribbons have been stapled and the two portions separated on the basis of time required to ret, they are kept separate through the remaining operations. Stapling, therefore, gives this additional advantage, permitting each portion to be retted the correct time which results in high quality fiber.

Once the stapled ribbons have been retted, they can be cleaned on a flexible, open-mesh chain belt washer as shown in Figure 1. The fiber from the retting tanks is

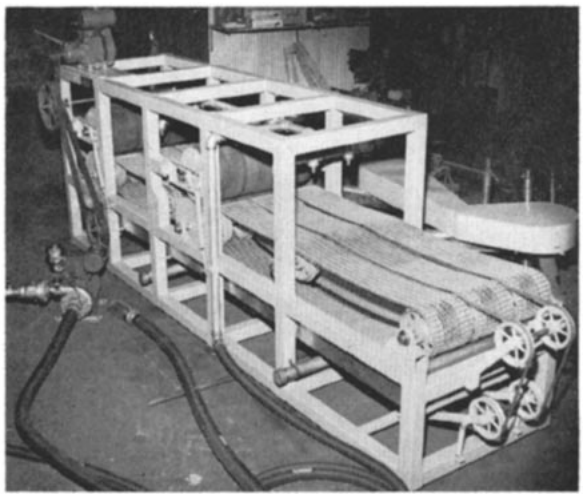

Figure 1. Fiber washer squeeze roll viewed from the left side showing feed table of open-mesh chain belt, spray nozzles, squeeze rolls, and engine drive.

placed on the belt, washed under spray nozzles, and squeezed between rollers. This process is repeated a sufficient number of times until the fiber is clean and only the usable fiber remains. The washing machine[3] consists of a series of spray nozzles and squeeze rollers alternately washing and squeezing the water from the fiber. After the washed fiber is passed through the final pair of squeeze rolls, it must be dried artificially in a heated drier or spread out and dried under the sun.

[1] Received for publication Nov. 20, 1963.

[2] Agronomist, United States Agency for International Development, Khartoum, Sudan.

[3] Diamond Huller, Winona, Minnesota, manufactured the washing machine.