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Summary

Two seed lots of cotton (*Gossypium hirsutum*) were artificially deteriorated to provide sub-lots with high viability but a range of seed vigour. Standard germination of the sub-lots ranged from 72.0 % to 92 % and averaged 82.7 %. The cold test results of non-deteriorated seeds were closely related to standard germination results in both seed lots, but averaged 24 and 27 percentage points lower respectively in medium and low quality seeds. The results of accelerated-ageing root length after three days, Q O_2-uptake and conductivity tests also showed significant differences between different quality levels as well as between lots. The results of the vigour tests (except conductivity) were significantly correlated with seedling establishment in the field. High quality seeds emerged more rapidly and produced a higher final seedling establishment than deteriorated seeds. Seeds of hand picked and laboratory ginned lots were of better quality than mechanically harvested and commercially ginned seeds.

Résumé

Relations des essais de vigueur et des lots de semences avec l'installation des plantules de coton

On a détérioré artificiellement deux lots de semences de coton (*Gossypium hirsutum*) pour obtenir des sous-lots de haute viabilité mais présentant toute une gamme de vigueurs. La germination des sous-lots variait de 72,0 % à 92 % avec une moyenne de 82,7 %. Les résultats des essais au froid des semences non détériorées étaient étroitement liés aux résultats de germination dans les deux lots de semences, mais étaient en moyenne inférieurs de 24 et 27 points respectivement pour les semences de qualité moyenne et faible. Les résultats des tests de vieillissement accéléré établis sur la base de la longueur de la racine à trois jours, des quantités d'oxygène absorbées et de la conductivité révélaient également des différences significatives entre différents niveaux de qualité ainsi qu'entre les lots. Les résultats des tests de vigueur (sauf la conductivité) étaient en corrélation significative avec l'installation des plantules sur le terrain. Les semences de qualité élevée levaient plus rapidement et produisaient un nombre final de plantules plus élevé que les semences détériorées. Les semences de lots récoltés à la main et égrenés en laboratoire étaient de meilleure qualité que les semences récoltées mécaniquement et égrenées industriellement.

Zusammenfassung

Beziehungen von Triebkraftversuchen und Saatgutpartien zum Keimlingsbestand von Baumwollsaat

Zwei Saatgutpartien von Baumwollaat (*Gossypium hirsutum*) wurden künstlich in ihrer Leistung geschwächt, um zwei Teilpartien mit hoher Lebensfähigkeit, aber unterschiedlichen Triebkraftbereichen zu erhalten. Die Standardkeimfähigkeit der Teilpartien reichte von 72,0 % bis 92 % und betrug im Durchschnitt

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82,7 %. Die Ergebnisse von Kaltprüfungen nicht geschwächter Samen standen bei beiden Samenpartien in enger Beziehung zu den Ergebnissen der Standardkeimfähigkeit, lagen aber prozentual 24 bis 27 Punkte niedriger bei Samen von mittlerer und niedriger Qualität. Die Ergebnisse der Wurzellänge nach drei Tagen beschleunigter Alterung, die O_2-Aufnahme und auch Leitfähigkeitsprüfungen zeigten signifikante Unterschiede sowohl zwischen verschiedenen Qualitätsstufen als auch zwischen Partien. Die Ergebnisse von Triebkraftversuchen (Leitfähigkeit ausgenommen) waren signifikant korreliert mit dem Keimlingsstand im Feld. Samen von hoher Qualität liefen schneller auf und wiesen einen höheren Endbestand an Keimlingen auf als geschwächte Samen. Samen von Hand ausgelesener und im Labor entkörnter Partien waren von besserer Qualität als mechanisch geerntete und handelsüblich entkörnte Samen.

Introduction

The standard germination should provide optimum conditions for germination that seldom occur in the field and better methods for predicting seedling establishment of cotton (*Gossypium hirsutum* L.) seed lots are needed than are presently available. Vigour is an aspect of seed quality which controls field stand establishment ability and vigour tests are required to obtain reliable assessments of field performance. Delouche (1967) and others (Grabe, 1966; Heydecker, 1969) have discussed the necessity of evaluating seed vigour in cotton seed. Wiles (1960) reported that low vigour seed may be responsible for poor stands. Wanjura, Hudspeth and Bilbro (1969) found that early emerging cotton seedlings had a higher survival rate and produced a higher yield per plant than later emerging seedlings. Recently, Buxton, Melick, Patterson and Pegelow (1979), concluded that the incorporation of association between field emergence and vigour term called percentage transfer (ratio of plant axis weight to total weight of seedling) and ET_{50} (relationship between time to 50 % emergence and total emergence) into seed testing will not aid in predicting potential for cotton seed emergence. Similar results from poorly stored and low vigour seed on field stand and other plant characteristics has been reported by Edje and Burris (1971) in soybeans [*Glycine max* (L.) Merr.].

The objectives of this study were to compare the applicability of cold test, accelerated ageing, root length of three-day-old seedlings, respiration rate and electrical conductivity as vigour tests in relation to cotton seedling establishment in the field.

Materials and methods

Seed source

All experiments were performed on two seed lots (lot 1 – mechanically harvested and commercially ginned and lot 2 – hand picked and laboratory ginned) of cotton 'Stoneville 213', produced on Mississippi State University farm. Seeds were acid delinted and gravity graded for uniformity. They were adjusted to approximately 13 % moisture contents, sealed in air tight jars and placed in an incubator at 40 °C. One jar of each seed lot was removed from the incubator on alternate days, unsealed, labelled and placed in a cold room at 7 °C. Seeds from each jar were tested for germination (Association of Official Seed Analysts, 1970) and, based on commercially acceptable germination values, seeds incubated for 0, 10 and 14 days were rated as high, medium and low

vigour seeds, respectively. The vigour of the three samples was then evaluated as follows.

Cold test

Screened soil from a cotton field mixed with sand in equal portion by volume was placed about 5 cm deep in the bottom of plastic boxes (18 cm wide, 25 cm long and 10 cm deep). Four replications of 100 seeds each from high, medium and low vigour levels of both lots were planted, and covered with another 3 cm of the soil-sand mixture. Moisture contents of the mixtures were then adjusted to 60 % of saturation by adding a predetermined amount of water. The boxes were covered and incubated at 13 °C for 72 hours, then moved to a constant 30 °C room. After six days, the seedlings were counted and evaluated as in the standard germination test.

Accelerated ageing test

Small copper screen baskets containing about 200 seeds of high, medium and low vigour rated seeds from each seed lot were placed in an accelerated ageing chamber as described by Byrd and Delouche (1971). The seeds were exposed to 42 °C and 100 % relative humidity for 144 hours. Following treatment, they were tested for their germinability.

Root length

Vigour rated seeds from each seed lot were planted on germination towels, in a straight line with radicle ends oriented in the same direction. The rolled paper towels were placed in a slant tray water reservoir germinator at a constant 25 °C, with radicle ends of seed downward. The position of seeds in all five replications were numbered from 1 to 10 to identify the individual seeds. The root lengths of normal seedlings were measured after three days of incubation.

Respiration

Respiration was measured in seeds imbibed for eight hours as µl O_2 absorbed or as µl CO_2 evolved per hour per seed. Samples of 15 seeds were placed in a 100 ml reaction vessel with 5 ml of distilled water in a Gilson differential respirometer. Basically, the respiration technique as described by Woodstock and Grabe (1967) was used. The respiration was measured for a 30 minute period by closing the respirometer system. The results have been expressed as the total µl O_2 consumed per hour/seed by dividing the amount of O_2 in each flask by one-half the number of seeds in the flask.

Seed coat permeability

The relative seed coat permeability from different vigour rated seeds of each lot was measured by using a Serfass conductivity bridge (Model RCM 1581) as described by Presley (1958). Two replicates of 25 seeds each from every sample were soaked in 100 ml of distilled water at a constant 30 °C for one hour. The seed and steep water were stirred briefly during the steeping period. After five minutes, the conductivity cell was

dipped in the beaker to record readings on multiplier setting using the multiplier switch and then on the main scale using the dial control switch. Resistance in ohms was obtained by multiplying the reading from the multiplier setting (divided from 1 to 100 kg) with the reading from the main scale (divided from 0.5 to 10.5). Three determinations were made from each sample.

Effects of high, medium and low vigour on seedling emergence rate and field establishment were studied by planting six replications of 50 seeds each in single-row plots using a randomised complete block design. Cumulative emergence of seedlings with cotyledons fully emerged from the soil was counted on 4, 6, 8 and 10 days after planting. Seedlings with a fully developed first true leaf were counted as established seedlings in the field. The results were expressed as percentage of total number of seeds planted. The significance of differences of the means were examined using Duncan's multiple range test and correlation coefficients of all the laboratory tests with seedling emergence and field stand establishment were calculated.

Results and discussion

Results of various laboratory tests on high, medium and low vigour seed classes of lot 1 and lot 2 are shown in table 1. Differences in seed quality brought about by the storage conditions were shown most clearly by the accelerated ageing test and least by the standard germination test. Significant differences in the means of the seed lots were shown also by cold test emergence, root length of three-day-old seedlings, electrical resistance of seed leachate and $Q\,O_2$ uptake after eight hours imbibition. All the vigour tests differentiated the seed lots better than the standard germination test.

Data on rate of emergence and stand establishment from seeds of three vigour levels of both lots showed that high vigour seed had highest survival and the greatest percentage of early emerging seedlings (table 2). A slightly higher early emergence percentage (four days after planting) in mechanically processed seed (lot 1) was probably due to greater seed coat permeability but later the hand-harvested seed (lot 2)

Table 1. Results of various laboratory tests of three selected vigour levels from each seed lot.

Laboratory tests	Lot 1			Lot #2		
	High	Medium	Low	High	Medium	Low
Standard germination (%)	86a*	80a	76b	92a	90a	72b
Cold test (%)	84a	56b	39c	91a	66b	56b
Accelerated ageing (%)	80a	39b	12c	92a	62b	44c
3 days root length (mm)	59a	50b	41c	76a	58b	40c
$Q\,O_2$/seed/hour	12.8a	9.7b	7.2b	14.4a	11.8a	8.6a
Electrical resistance (1000 ohms)	4.05a	2.65b	1.80c	7.75a	6.45b	6.30b

*Means within row of each lot not followed by the same letter differ significantly at $P = 0.05$.

Table 2. Rate of field emergence and stand establishment of three vigour levels from each seed lot.

Lot number	Vigour level	Cumulative emergence (%) at days after planting				Final seedling establishment
		4	6	8	10	
1	High	30.3a*	52.7a	66.0a	74.0a	77.0a
	Medium	27.0a	43.3b	51.0b	53.7b	56.0b
	Low	22.3b	38.0c	47.7b	50.3b	52.0b
2	High	27.3a	52.8a	67.4a	79.7a	86.0b
	Medium	21.3b	44.7b	58.3b	63.7b	68.0b
	Low	17.7c	34.3c	44.7c	52.0c	55.0c

*Means within columns of each lot not followed by the same letter differ significantly at P = 0.05.

showed greater total emergence and final seedling establishment. The percentages of cumulative emergence of high vigour seeds within lots were significantly higher than those of low vigour seeds.

The correlations between seedling establishment and the results of accelerated ageing, the cold test, the root growth test and the respiration test were all significant and better than that with the standard germination test. The correlation with the conductivity test was also better than with germination but it was not significant. The results showed that vigour tests which simulated adverse field conditions were effective in predicting field establishment and in detecting comparative deterioration levels among the seed lots.

Table 3. Simple correlations between various laboratory tests with field emergence and seedling establishment.

Laboratory tests	Correlation coefficients		
	Field emergence (%) at		Final seedling establishment
	4 days	10 days	
Standard germination	.825	.854	.852
Cold test	.997*	.989	.998*
Accelerated ageing	.999*	.998*	.998*
3 days root length	.998*	.998*	.997*
Q O_2/seed/hour	.998*	.998*	.997*
Electrical resistance (1000 ohms)	.959	.943	.944

*Denotes significance at P = 0.05.

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