Peanut Science (1981) 8, 145-148

Influence of Cultural and Harvest Practices on Peanut Seed Quality[1]

D. E. McLean and G. A. Sullivan*[2]

ABSTRACT

Managing peanut (*Arachis hypogaea* L.) production for maximum yields often results in poor quality seed being produced. The objectives of this study were (1) to identify relationships between production practices and seed quality and (2) to evaluate the impact of harvesting and handling procedures on seed germination quality. Combining significantly reduced germination by an average of 9% for three years. Artificial drying had little effect on average seed quality. Percentage germination was significantly correlated with soil fertility, soil particle size, pod moisture, seed calcium, market grade and hull damage with the most consistent correlations occurring between seed calcium and germination. In general, the correlations were small, and no single production factor accounted for a large proportion of the variability found for seed quality.

Key Words *Arachis hypogaea* L., Seed Production, Germination, Mechanical Injury, Soil Fertility.

Producing high quality peanut seed (*Arachis hypogaea* L.) requires meticulous crop management. However, even the best farmer often fails to produce an abundant and viable seed yield. The failure to produce seeds with germination sufficient to meet certification requirements is a common problem to peanut seed producers. The occurrence of abnormal and dead seeds often reduces germination below 70%, the minimum requirement for certification in North Carolina.

Blackstone et al. (3) evaluated the effects of pre-harvest, curing, storage and shelling methods on runner peanut seed germination. Germination showed a wide variation among farmers and geographic areas, but most production practices expected to affect germination failed to show a significant relationship. Walker and Carter (17) reported that previous fertilization rates had no significant effect on the subsequent germination of spanish and runner peanuts. Sullivan et al. (13) and Cox et al. (4) reported improved germination of Virginia-type peanuts followed adequate applicaitons of gypsum. Hallock (9) found that gypsum treatments increased germination whereas potassium and nitrogen treatments without gypsum reduced germination. Young and Moore (18) found that seed quality declined with later digging dates. Dickens and Khalsa (7) reported that peanuts combined from inverted windrows received less mechanical damage and were of better germination quality than peanuts dried in random windrows. Turner (16) found that the orientation of the seeds in the pod results in more impact damage to the apical seed than the basal seed.

The objectives of this investigation were to i) determine the relationships of soil fertility, soil particle size, pod moisture, seed calcium, market grade, and hull damage to seed germination and quality; and ii) evaluate the effects of harvesting and drying procedures on seed germination and quality.

Materials and Methods

A representative soil sample was taken in August each year from each field to a depth of 15 cm. The Soil Testing Section, Agronomic Division, North Carolina Department of Agriculture determined pH, exchangeable Al, P, K, Ca, Mg, Mn, $S(SO_4)$, and organic matter for each soil sample. All fields were located with peanut seed producers in North Carolina.

Particle size analysis to determine sand, silt, and clay content was done by the hydrometer method (6).

Peanut seeds (cv. "Florigiant") were collected during harvest from 60 fields in 1976, 40 fields in 1977, and 40 fields in 1978. A 2.3 kg fruit sample was hand-pickedfrom random plants at digging (#1), and just prior to combining (#2); a 4.5 kg samples was scooped from the combine basket (#3), and a 9 kg sample was sent through the normal drying process (#4). Samples 1, 2, and 3 were dried in a forced air direr without heat to approximately 10% moisture.

All samples were shelled with a laboratory sheller (5) and stored in a seed warehouse in paper bags at ambient temperature.

A 500 g pod sample, collected from each field at digging and at combining, was sealed in a plastic bag and later dried. Moisture content was calculated on a wet weight basis as follows:

% moisture = (wet wt. - dry wt./wet wt.) x 100.

Seeds collected after drying (#4) were submitted to a plant analysis service laboratory at North Carolina State University where they were ashed. Total seed calcium was measured by atomic absorption.

A 1000 g sample was graded according to market specifications:

Sound mature Kernels (SMK) - whole kernels which ride a 6.0 x 25.4 mm (15/64 x 1 in) slotted screen;

Extra Large Kernels (ELK) - whole kernels which ride a 8.5 x 25.4 mm (21.5/64 x 1 in) slotted screen;

Sound Splits (SS) - split or broken undamaged kernels, no portions smaller than 1/4 of a whole kernel.

In 1976 only, 200 g samples collected before and after combining were analyzed for hull damage. This was a visual observation, recorded as weight percentage.

Seeds collected at digging were tested in 2 replications of 100 seeds/replication in a germination test. Seeds collected precombing, post-combining, and post-drying were tested in 3 replications of 100 seeds/replication.

Seeds were treated with a 3 Granox*: 2 Vitavax[3] fungicide mixture. Seeds of each replication were rolled into 4 moist towels (25 seeds/towel). The towels were placed upright in plastic bags, and seeds were allowed to germinate at 25 C for 3-4 days. During this period, ethylene from a ripe apple was used to break dormancy (10. 11. 15). After 3-4 days, diseased or decayed seeds were removed, mycelial growth was wiped away, and fresh warm water was sprayed on the seeds before returning them to the germinator.

On the 8th day seedlings were opened longitudinally with a scalpel to evaluate plumules and the seedlings were classified as either germina-

[1]Paper No. 167 of the Journal Series of the North Carolina State University Agricultural Extension Service, Raleigh, N. C. 27650.

[2]Agricultural Intern, USAID, Bamako, Mali, and Associate Professor, Crop Science Department, North Carolina State University, Raleigh, N. C. 27650.

[3]The use of trade names in this article does not imply endorsement of products named or criticism of similar ones not mentioned.

ble, abnormal, or dead.

Germinable seedlings had a normal primary root, hypocotyl and plumules; dormant seeds and diseased seedlings which did not appear to be the source of the fungal growth were included.

Abnormal seedlings had one or more essential plant parts missing or injured; or they were seedlings with stunted root and/or hypocotyl growth, and diseased seedlings which appeared to be the source of fungal growth.

Any ungerminated seeds which were mealy, flaccid or decayed were considered dead.

All germination data was transformed into arcsins prior to using Statistical Analysis System (SAS) procedures (2). For each year a least squares regression was applied to determine whether harvesting procedures affected germination, abnormality, and death. A protected t-test was used to test the significance of treatment means.

Correlations between soil chemical analysis variables, sand, silt and clay content, pod moisture, total seed calcium, market grade, and hull damage (1976 only) and the germination test results were computed.

Results and Discussion

Seeds collected at digging in 1976 and 1977 had a significantly lower percentage germination than seeds collected prior to combining (Table 1). Our handling techniques probably accounted for this reduced germination.

Table 1. Harvesting effects on germinable peanut seedlings in the germination test.[a]

		Times of Sampling			
Year	No.	At Digging	Pre-Combining	Post-Combining	Post-Drying
		(%)	(%)	(%)	(%)
1976	60	84.6a	89.1b	81.7c	78.8d
1977	40	83.3c	89.6b	81.3a	83.7c
1978	40	84.3a	86.2a	74.3b	76.6b

[a]Means in a horizontal row followed by the same letter are not significantly different at the .05 probability level.

Seed samples collected at digging were held for several days before drying, and their high moisture content could have resulted in heating damage during handling. Young (18) found poorer germination of peanuts artificially dried immediately after digging.

A highly significant ($P<.01$) decrease in germination occurred during combining for all years (Table 1). Pre-combining germination was reduced by 8-12% on the average as compared to post-combining.

For all years the percent of abnormal seedlings increased significantly during combining (Table 2). Most abnormal seedlings exhibited twisted hypocotyls and/or missing tap roots. Since the radicle of the peanut seed protrudes beyond the cotyledonary surface, massive root injury can result from combining (12). If the abnormal seedlings emerge in the field, they are more drought-sensitive, less vigorous, and lower yielding than normal seedlings (1, 8, 12, 14).

Table 2. Harvesting effect on peanut seed abnormality in the germination test.[a]

		Times of Sampling			
Year	No.	At Digging	Pre-Combining	Post-Combining	Post-Drying
		(%)	(%)	(%)	(%)
1976	60	11.5a	8.3b	16.2c	19.7d
1977	40	6.3ab	5.6a	7.8b	8.4b
1978	40	13.7a	12.3a	19.5b	17.8b

[a]Means in a horizontal row followed by the same letter are not significantly different at the .05 probability level.

In 1977 and 1978, the percentage of dead seeds increased after combining as compared to pre-combining (Table 3). The seeds damaged by combining were probably more susceptible to pathogen infestation. Certain pathogen populations may have been less prevalent in 1976 due to the comparatively dry growing season that year. This could explain the non-significant effect of disease on dead seeds after combining in 1976 in contrast to 1977 and 1978.

Table 3. Harvesting effects on peanut seed death in the germination test[a].

		Times of Sampling			
Year	No.	At Digging	Pre-Combining	Post-Combining	Post-Drying
		(%)	(%)	(%)	(%)
1976	60	3.7a	2.6b	2.1bc	1.5c
1977	40	10.4a	4.7b	10.9a	8.0c
1978	40	1.7a	1.6a	6.2b	5.6b

[a]Means in a horizontal row followed by the same letter are not significantly different at the .05 probability level.

Drying affected germination differently each year (Table 1). In 1977 and 1978, an increase in germination was observed. This increase resulted from a decrease in dead seeds (Table 3). Immediate drying by the farmer would have destroyed some existing fungi.

No explanation for the increase in the percentage of abnormal seedlings after drying for 1976 is known (Table 2). Results from drying varied tremendously from location to location. Severe reductions in percentage germination were observed for a few growers.

Although several factors were correlated with percentage germination, the small correlation coefficients indicated that no single factor accounted for much of the varability in seed germination (Table 4). Since soil factors were significant, the effect of these variables on seed quality should be carefully investigated.

The soils used in this study were typical of those used in eastern North Carolina for peanut seed production. The soils tested low to medium for all elements except phos-

phorus (Table 5). They are sandy and maintenance of high fertility is difficult due to leaching. While average pH values were adequate, the range suggests that the low pH is a problem with many farmers.

Table 4. Significant correlation coefficients of quantitative variables with germination test results.

Significant Variables	Year		
(Correlation Coefficient)	1976	1977	1978
Soil pH	.18	-	-
Soil Al	-.14	.14	-
Soil P	.11	-	-
Soil Ca	.13	-	-
Soil Mg	.10	-	-
Soil Mn	.11	-	-.25
Soil OM	-	.14	-
Soil S	-	-.13	.17
Sand (%)	-	-	-.12
Silt (%)	-	-	.14
Seed Ca	.32	.43	.41
Sound, mature kernels	.13	.25	-
Sound splits	-.24	-	-
Extra large kernels	-	.41	-
Seed moisture at digging	-.13	-.40	-.26
Seed moisture at combining	-	-.32	-.13

Table 5. Means and ranges of soil test variables.[1]

	1976		1977		1978	
Variable	mean	range	mean	range	mean	range
pH	5.4	4.6-6.5	5.7	4.7-6.4	5.6	4.9-6.1
Al (me/100g)	1.2	0.5-2.6	1.0	0.4-2.4	1.2	0.4-2.8
P (index)	99	35-275	75	15-100	93	53-100
K (index)	35	13-83	33	8-63	29	11-66
Ca (index)	46	20-86	48	27-82	53	27-100
Mg (index)	35	6-81	30	5-60	31	11-99
Mn (index)	21	8-50	27	4-84	39	14-99
S (SO_4) (index)	163	10-450	91	40-101	89	40-100
OM%	1.1	0.4-2.9	0.7	0.3-1.8	0.8	0.5-3.2

[1]Fertility index values were used to express levels of nutrient availability as determined for most crops in North Carolina. The index ranges were as follows: low fertility = 0-25, medium fertility = 26-50, and high fertility = 51-100.

Table 6. Means and ranges of sand, silt, and clay content of seed fields.

	1976		1977		1978	
Variable	mean	range	mean	range	mean	range
Sand (%)	83	59-96	82	65-94	83	59.7-96.1
Silt (%)	14	3-36	14	4-31	14	2.2-33.4
Clay (%)	3	0.3-9.5	4	0.7-9.9	3	1.7-6.9

The moisture content of the seeds when dug ranged from 15 to 65% (Table 7). A 20% moisture content is recommended for combining, and the seed moisture ranges indicate wide variation in moisture at combining among seed growers. The correlations between pod moisture at the time of digging and combining and germination were significant and negative, but the correlation coefficients were small (Table 4). These data support the data developed by Dickens and Khalsa (7) that high moisture at combining reduces percentage germination.

Table 7. Means and ranges of pod moisture at digging and combining.

	% moisture		% moisture	
Year	@ digging	Range	@ combining	Range
1976	43.8	18.2-64.8	24.7	13.4-48.0
1977	45.4	29.9-58.3	18.5	7.5-30.7
1978	38.9	14.6-53.1	19.2	5.2-30.8

Previous studies by Cox et al. (4) established that germination sharply decreases when seed contain less than 420 ppm total seed calcium. The total seed calcium means were above this level; however, the range was from 197 to 872 ppm (Table 8). There was a significant positive correlation between seed calcium and germination (Table 4). Seed calcium is a critical element in obtaining good germination quality. The r-value between percentage germination and seed calcium was higher in all years than any other variable measured.

Table 8. Means and ranges of total seed calcium.

Year	Mean	Range
	(ppm)	(ppm)
1976	558	274-800
1977	625	410-872
1978	440	197-708

Hull damage evaluated before and after combining revealed a sharp increase in damage in the combining process (Table 9). A significant correlation existed between hull damage at combining and seed abnormality in the germination test.

Table 9. Visible hull damage, germination and abnormality pre- and post-combining in 1976.

	Visible hull damage			
Time of Sampling	Mean (%)	Range (%)	Germination (%)	Abnormality (%)
Pre-combining	0.9	0-10.0	89.1	8.3
Post-combining	12.6	0-31.8	81.7	16.2

Conclusions

Combining significantly reduced seed germination as compared to pre-combining and increased the percentage of abnormal seedlings for all years. Decreased germination in 1977 and 1978 was attributable, in part, to dis-

ease build-up following mechanical injury.

Drying can severely reduce germination on individual farms, but, on the average, drying did not reduce germination as much as combining. It is speculated that when pathogen populations are high, prompt drying by the seed grower may have increased germination by arresting fungal growth.

No single production practice or variable measured accounted for a major proportion of the variability observed in seed germination. Survey results suggest that fertility levels were not optimum for peanut production, and that adequate seed calcium is necessary for producing peanut seeds with high germination.

Acknowledgements

The financial assistance of the North Carolina Certified Peanut Seedsmen and the North Carolina Peanut Growers Association is greatly appreciated.

Literature Cited

1. Anderson, A. M. 1960. Comparative value of normal and questionable seedlings of peanuts and soybean by greenhouse tests. Proc. Int. Seed Test. Assoc. 25:365-378.

2. Barr, A. J., J. H. Goodnight, J. P. Sall, J. T. Helwig. 1979. A User's Guide to SAS 76. SAS Institute, Inc., Raleigh, N. C. 329 pp.

3. Blackstone, J. H., H. S. Ward, Jr., J. L. Butt, I. F. Reed and W. F. McCreery. 1954. Factors affecting germination of runner peanuts. Agricultural Experiment Station of the Alabama Polytechnic Institute. Bulletin No. 289. Auburn, Alabama. 31 pp.

4. Cox, F. R., G. A. Sullivan, and C. K. Martin, 1976. Effect of calcium and irrigaiton treatment on peanut yield, grade and seed quality. Peanut Sci. 3:81-85.

5. Davidson, J. I. and F. P. McIntosh. 1973. Development of a small laboratory sheller for determining peanut milling quality. J. Am. Peanut Res. Educ. Assoc., Inc. 5:95-113.

6. Day, P. R. 1965. Particle fractionation and particle-size and analysis, pp. 545-567. *In* Methods of Soil Analysis. Monograph No. 9 Am. Soc. Agron., Inc., Madison, Wisconsin.

7. Dickens, J. W. and J. S. Khalsa. 1967. Windrow orientation and harvesting damage to peanuts. Oleagineux. 2:741-746.

8. Gavrielit-Gelmond, H. 1971. Growth and development of the peanut plant (*Arachis hypogaea* L.) in relation to seedling evaluation in the germination test. Proc. Int. Seed Test. Assoc. 36:121-130.

9. Hallock, D. L. 1980. Soil or foliar applied nutrient effects on mineral concentrations and germinability of peanut seed. Peanut Sci. 7:50-54.

10. Ketring, D. L. and P. W. Morgan. 1969. Ethylene as a component of the emanations from germinating peanut seeds and its effect on dormant Virginia-type seeds. Plant Physiol. 44:326-330.

11. Ketring, D. L. and P. W. Morgan. 1971. Physiology of oil seeds. II. Dormancy release in Virginia-type peanuts by plant growth regulators. Plant Physiol. 46:488-492.

12. Sullivan, G. A. and A. Perry. 1976. Comparative yield performance of plants developing from normal and abnormal seedlings of peanuts. Peanut Sci. 3:31-39.

13. Sullivan, G. A., G. L. Jones and R. P. Moore. 1974. Effects of dolomitic limestone, gypsum and potassium on yield and seed quality of peanuts. Peanut Sci. 1:73-77.

14. Teter, N. C. and L. I. Miller. 1957. Effect of radicle injury on growth and development of the peanut plant. Phytopathology 47:34.

15. Toole, O. K., W. K. Bailey, and E. H. Toole. 1964. Factors influencing dormancy in peanut seeds. Plant Physiol. 39:822-831.

16. Turner, W. K. 1964. Impact damage to peanuts and its effects on germination, seedling development, and milling quality. Proc. National Peanut Res. Com. pp. 41-43.

17. Walker, M. E. and R. L. Carter. 1971. The effect of fertilization and storage temperatures on percent nitrogen, oils, and germination of Spanish and Runner peanut seed. Univ. of Georgia. College of Agriculture Exp. Sta. Bulletin 88. 17 pp.

18. Young, J. H. and R. P. Moore. 1972. Factors affecting planting quality of seed peanuts. II. Effect of harvest methods. Oleagineux 27:89-93.

Accepted October 31, 1981