SOME PHYSICAL AND CHEMICAL CHARACTERISTICS

OF PEANUT PODS AND KERNELS

IN AN IRRIGATION STUDY

By

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INTRODUCTION

The peanut (*Arachis hypogeae*) develops its fruit underground by the elongation of the gynophore after fertilization. The gynophore and the young pod do some absorption activities during their development. Heredity probably plays a major role in fruit development, yet soil moisture is a very important factor which may modify both the physical and the chemical components of the fruit.

The size of the pods and kernels, internal structure of pods and the protein and oil content of the kernels are influenced by the moisture condition in the soil during maturation. Some physical characteristics of the pod and kernel include, size, thickness and histological structures. These factors are important in harvesting and processing peanuts. Broken kernels, split pods and kernels and lack of uniform size result in shelling losses. Requirements for pod and kernel characteristics are different for the various growers and processors. Growers need a pod with sufficient thickness for protection of kernels during curing and picking while shellers desire a thin shell. The large-sized kernels are favorable for the processor while the shellers need a uniform size. The oil and protein are important constituents of the kernels. High protein content is desired for peanut butter and other products, and high oil content is important in preparing salted nuts and peanut butter.

The objectives of this study were to determine the relationship between soil moisture, and characteristics of peanut pods and kernels by investigation and analysis through a statistical approach, of samples from irrigation levels.

LITERATURE REVIEW

Studies concerning the physical and chemical characteristics of irrigated peanuts are rather new. Fragmentary information concerning this subject was found in some published and unpublished works.

According to Gregory, Smith and Yarbrough (5) /1, the peanut pod varies in size from about 1 x 0.5 to 8 x 2 centimeters and may contain from one to six kernels. The kernels are suspended from the inner ventral (upper) surface of the pericarp. The attachment and hence the hilum always lies toward the apex of the seed bearing segment.

According to Thompson and Russell (11), the characteristic reticulation underlying the veins are ridges of mechanical tissue arising as outward extensions of the sclerenchymatous mesocarp layer. This layer is continuous except at the sutures. The endocarp consists of a parenchymatous tissue which surrounds the ovules during development. The cells of the endocarp lose their contents and their walls collapse as the pod matures.

Tong (12) stated that the structure of the pod consist of many layers of spongy cells in the outer portion, spiral lignified parenchymatous and sclerenchymatous cell layers in the middle por-

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/1 Figures in parenthesis refer to Literature Cited.

tion and a colorless paper-like pith layer in the inner portion.

Thompson and Russell (11) further stated that in a cross sectional examination of the peanut pod that Richter had observed that the mechanical tissue of the mesocarp was interrupted along the sutures. He further demonstrated that this was the line of normal dehiscence by cutting the pod into rings and passing them over suitable sized chickpeas. The peas were allowed to swell; the rings were always broken along the ventral suture.

Giles (4) reported a need to define the "state of maturity" to secure needed quality and to determine criteria for that quality, both in terms of physical and chemical properties.

Young (13) recognized the need for an evaluation of existing shelling machinery and its effects on quality. He suggested a "belt-wide" laboratory to be used for study and development of new machinery.

Boswell (2) recognized the need for an evaluation of strains and products from specific agronomic treatments, and to conduct these studies in the advanced or semi-final stage of breeding.

After the penetration of the peg (gynophore) into the soil, many multicellular hairs may be found on the peg surface. According to Harris and Bledsoe (6), Pettit and Waldron suggested that the hairs of the peg and pod were like "root hairs" in structure and function.

Harris and Bledsoe (6) also mentioned the work of Reed who observed few rosettes of hairs and no root-tip hairs on field-grown peanuts. Harris and Bledsoe (6) further stated that the peanuts are usually grown on well-drained soils which are sandy in nature. This ecological relationship suggests that liberal amounts of oxygen might be beneficial and that excessive moisture is not desirable for the best development of peanuts. Harris and Bledsoe (6) reported that Shibuya indicated that oxygen in the pegging area is necessary for fruit production, but the amount required was not determined. However, data relative to drought resistance, water and oxygen requirements of the peanut plants were not available.

Water is assumed to enter plants largely through the root hairs according to Harris and Bledsoe (6). Adventitious roots, root-like hairs on the pegs and sometimes on the fruit, may be present, but the relationship of those structures to water absorption has not been established. However, it has been shown that pegs and developing fruit do absorb some mineral elements.

The peanut plant absorbs anions from the soil solution. Anions with the possible exception of the phosphate ion, are not retained in any appreciable quantities in well-drained soils and unless used by crops are usually leached out of the soil rather rapidly.

According to Matlock (8) the quality of the raw peanut product was improved by using supplemental water to avoid drought stress. There is some evidence to show that the spanish peanuts require about 25 inches of moisture during a growing season for optimum yield.

Matlock (8) mentioned the work of Krober and Collins who reported that weather damaged soybeans were more costly to refine and may produce an inedible grade of oil. He reported that some believed that irrigated peanuts have thicker shells, thinner seedcoats, smaller kernels and in some cases fewer, sound mature kernels than non-irrigated peanuts grown with no prolonged soil moisture stress.

Many quality factors of peanuts can be improved by irrigating during prolonged soil moisture stresses and inferior quality does not necessarily result when irrigation is practiced during any given season according to Matlock (8).

Beavers (1) studied some physical characteristics of the spanish peanut pod and kernel. He concluded that non-irrigated peanuts, without prolonged drouth stress had heavier kernels, and pods that were longer, wider and thicker and which required more weight to crack than the irrigated peanuts. The data indicated that similar results may be obtained by measuring the pod thickness, along either the dorsal distal suture (position one) or the ventral basal suture (position four). Similarily, the size of the kernel may be obtained in sized seed by measuring either the length or width. In most instances the basal end of the peanut pod was wider than the distal end but the point of first breakage was along the distal suture which was the thinnest position measured on the pod. Pod thickness position one was positively correlated for each irrigation treatment with the pod thickness of position four, pod diameter and pod cracking strength.

The result of the chemical analyses /1 for an irrigation experiment at the Perkins Station, Perkins, Oklahoma in 1957, showed that protein content decreased as irrigation increased but the oil content increased slightly as irrigation levels increased. A summary of the results are shown below:

/1 Samples were analyzed by Donald C. Abbott, Department of Biochemistry, February, 1958.

Treatment	Protein (on dry basis) percent	Oil (on dry basis) percent
W1	32.5	51.1
W2	27.5	53.7
W3	26.1	54.4
W4	24.4	54.2

Il'ina (7) conducted studies to define the periods of high sensitivity of peanut plants to soil moisture. He concluded that the soil moisture requirement of the peanut plant varied with its growth and development, being least at the sprouting phase and up to the formation of the floral organs. Soil moisture was most profitably used for crop growth during floral formation and during flowering. Yields from plants with optimal soil moisture during floral formation and flowering were comparable to those of plants abundantly supplied with water at all stages of plant growth.

MATERIALS AND METHODS

The peanuts for these studies were obtained from an irrigation and fertility test at the Perkins Agronomy Station. Only those plots receiving the same fertility treatment were used for the study.

Four irrigation treatments were arranged in a randomized block design with four replications. The Argentine variety was used in this study. The four irrigation treatments consisted of four soil moisture stress levels; no irrigation (W1), and irrigated when the soil moisture in the estimated root zone receded to seven (W2), nine (W3) and eleven (W4) percent on an oven dry basis. These particular percentages correspond to soil moisture tensions for the latter three treatments of seven, three and one atmosphere, respectively, as determined by the pressure membrane apparatus. These percentage were determined by soil and irrigation specialists.

Peanut plants for this study were harvested by hand on October 17, 1958 from the ends of the two center rows of each four row plots. The plants from each plot were allowed to cure on indoor racks. Two-seeded peanut pods were removed from the plants by clipping so as to leave about one half inch of the peg attached to the pod. The pod samples were obtained from the first or second nodes of the plants where the fruits were considered to be relatively matured. The pods for each plot were placed in a kraft bag.

Three days preceeding the measuring of various physical characteristics, the pod samples in their respective bags were moved to a laboratory where temperature and humidity could be controlled. A constant temperature of approximately 70°F. and a relative humidity of 65 percent were maintained in the laboratory.

Thirty six, two-seeded pods from each plot were used to determine the physical characteristics.

A caliper graduated in millimeters was used to measure the length of the pod and diameter of the basal end of each pod. A fraction stop micrometer, graduated in thousandths of an inch was used to measure the pod thickness at two different positions of each half-shell. (Figure 1).

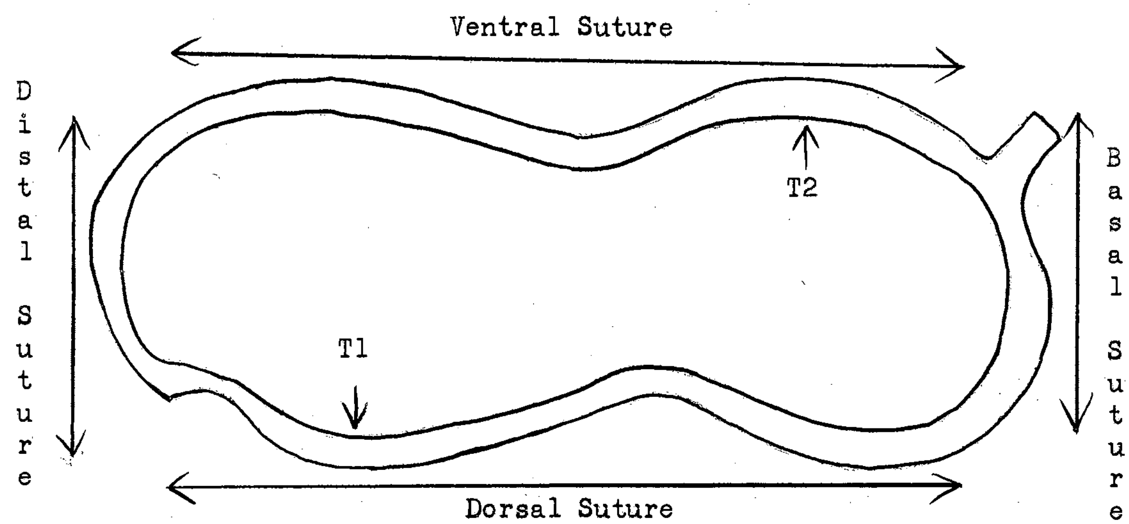


FIGURE I. LONGITUDINAL SKETCH OF THE PEANUT POD SHOWING POSITIONS (T1 and T2) WHERE SHELL THICKNESS DETERMINATIONS WERE MADE.

With the distal suture to the left and the dorsal suture at the bottom, position one (T1) was located at the dorsal distal suture and position two (T2) at the ventral basal suture.

The cracking device described by Beavers (1) was used to determine the relative cracking strength of the pods. The readings obtained were converted to pounds of force required to crack a pod using the formula described by Beavers (1).

The measurement of the cracking force was made with the ventral suture up and dorsal suture down. The pod was placed on the center of the cracking cap parallel to the horizontal weight bar. The pressure was exerted on the ventral and dorsal sutures.

Each peanut was used for several determinations including length, width and cracking strength. Following the cracking test the half of the shell nearest the operator was used for shell thickness measurements and the other half was saved for histological study. Each half saved for the histological study was assigned a number within each plot. The kernels were collected by plots for determining the oil and protein content.

The compactness of kernels in the shell was recorded for each of the pods as very compact (V), fairly compact (F) and loosely compact (L).

Statistical analyses including analyses of variance, multiple range, distribution curves and correlations were calculated as outlined by Snedecor (10) and Duncan (3).

Histological differences of certain pods selected from each irrigation treatment were studied by microscopic examination. The cross sections studied were near positions one and two.

Ten samples were selected from each treatment. Each half-pod for the histological study was selected on the basis of the data obtained in the cracking and the pod thickness determinations. An attempt was made to select pods requiring a high, medium and low pressure for cracking.

This phase of the study was conducted under the guidance of Dr. Imy V. Holt, Department of Botany and Plant Pathology. The micro-techniques used were modified from those outlined by Sass (9). A summary of the celloidin method used in this study follows:

Embedding -- The pod tissue was dehydrated in 95 percent alcohol. The materials were transferred to embedding bottles and covered by 2 percent celloidin solution. The bottles were placed on a warm box at a temperature of 53° C. Subsequently each of the 4, 6, 8 and 10 percent of celloidin solution were made at 24 hour intervals. When placed in 10 percent celloidin solution to barely cover the materials, slices of pyroxylin were added.

Hardening -- Each half pod surrounded by a mass of celloidin was scooped out using a spoon. The material was transferred to wide mouth bottles containing chloroform. The celloidin blocks remained in the chloroform until they sank to the bottom. Subsequently they were trimmed to a cube using a razor blade. They were then placed in another bottle containing clean chloroform. After the block sank they were transferred to vials containing a storing fluid.

Cutting -- The sliding microtome used in this study would give only single sections. The knife was flooded with 95 percent alcohol. The microtome was set to cut sections 15 micra thick. The surface of the material was flooded with storing fluid before each cut. A camel hair brush was used to remove the sections to a dish containing storing fluid. To utilize the four available dishes the samples were combined as follows: water treatments W1 and W2 for position one (T1), W1 and W2 for position two (T2), W3 and W4 for position one (T1), and W3 and W4 for position two (T2).

Staining -- The sections were stained in Safranin O-fast Green preceeded by a brief immersion in Hemalum to prepare the slides for photographing.

The moisture, protein and oil content of peanut kernels for each water treatment were determined. The samples for each plot collected following the cracking test were chopped into very fine particles and stored in bottles. The procedures for various analyses were provided by Professor Donald C. Abbott, Department of Biochemistry. A summary of the procedures used follows:

Moisture - Air oven method forced draft at 130°C for one hour.

Protein - Standard macro Kjeldahl procedure. Results expressed on basis of 6.25 factor for conversion of %N to % protein. Each determination was run in duplicate.

Oil - Ether extract of chopped meats for 24 hour extraction. Oil determined by direct weighing of the oil. Each determination was run in duplicate.

RESULTS AND DISCUSSION

The mean pod length, pod diameter, pod cracking strength and pod thickness at position one and two are presented in Table I for each water treatment.

TABLE I

MEAN POD LENGTH, POD DIAMETER, POD CRACKING STRENGTH AND POD THICKNESS AT POSITION ONE AND TWO FOR EACH WATER TREATMENT AT PERKINS, 1958

	Pod Length (cm.)	Pod Diameter (cm.)	Cracking Strength (lbs.)	Pod Thickness (.001 inch) Position One (T1)	Position Two (T2)
W1	2.34	1.17	8.6	35.2	43.5
W2	2.18	1.12	7.9	35.3	43.8
W3	2.15	1.13	7.0	36.0	42.0
W4	2.17	1.11	6.0	33.2	38.8

These means were calculated from 36 pods in each plot or 144 for each treatment. The analyses of variance for each variable are shown in Table II.

TABLE II

ANALYSES OF VARIANCE FOR POD LENGTH, POD DIAMETER, POD CRACKING STRENGTH AND POD THICKNESS AT POSITIONS ONE AND TWO FOR THE IRRIGATION TREATMENTS AT PERKINS, 1958

		Pod Length	Pod Diameter	Pod Cracking Strength	Pod Thickness Position One	Pod Thickness Position Two
Source	d.f.	M.S.	M.S.	M.S.	M.S.	M.S.
Total	575	--	--	--	--	--
Replication	3	0.229	0.025	124.025	434.29	620.296
Treatments	3	0.673	0.100	703.852**	192.97	766.920
Exp. Error	9	0.176	0.058	98.694	218.73	305.86
Sample Error	560	0.103	0.009	20.585	39.65	46.94
C.V. (%)		18.8	21.2	63.0	42.3	41.5

** Exceeds 1% level of significance.

The differences among mean pod length and diameter for the four water levels were not statistically significant. However the mean pod size for the low irrigation levels (W1 and W2) were longer and wider than those for high water treatments. Their relative size are shown by representative pods in Figure II.

In this study, it appears that the non-irrigated treatment resulted in peanuts which were longer and wider than those of the irrigated treatments.

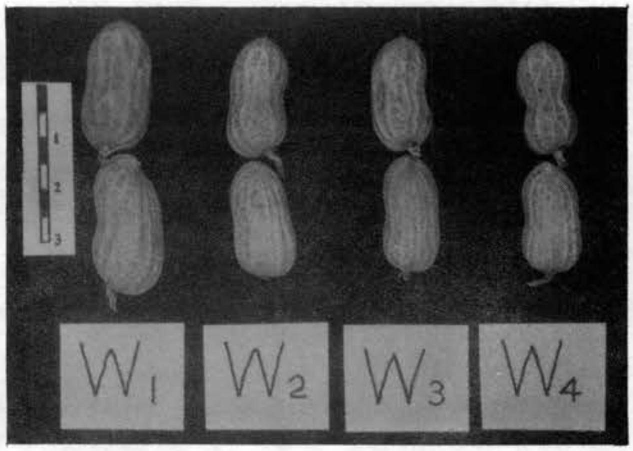


FIGURE II. RELATIVE SIZE OF PEANUT PODS FOR EACH IRRIGATION LEVELS AT PERKINS, 1958.

The differences among the means of relative pod cracking strength were highly significant. A multiple range test of ranked means for cracking strength is shown in Table III.

TABLE III

MULTIPLE RANGE TEST OF RANKED MEANS FOR RELATIVE CRACKING STRENGTH OF PODS FOR FOUR IRRIGATION TREATMENTS AT PERKINS, 1958 /1

W4	W3	W2	W1
13.1	15.0	16.7	18.2

/1 Any two means underscored by the same line are not significantly different.

The cracking strength of W1 was significantly greater than that of W3 and W4. There was no significant differences between the means of W1 and W2 nor the means of W3 and W4. The frequency distribution curves of cracking strength converted from scale reading into pounds were prepared to illustrate the differences among irrigation levels (Figure III).

Two points of information are evident from the frequency distribution curves. First, the distribution curve of the W4 treatment had the greatest number of pods requiring 2.5 pounds of pressure for cracking. In fact, several peanuts in the W4 treatment required less than 2.5 pounds which was the smallest measurement that could be made. Second, the kurtoses of all curves were not balanced and smooth. This probably was due to the small sample size or other factors such as the lack of uniformity in their maturity. The relative cracking strength apparently decreased as the irrigation level increased.

Though there were no significant differences among irrigation treatments for the mean pod thickness at position one (T1) and two (T2), there was a tendency for the thickness of the pod to increase as the irrigation level was decreased. The relationships between positions one and two indicate that the latter was usually thicker (Table I). Some exceptions were found after examining the data. Very few cases were noted where the thickness of position one (T1) was equal to or thicker than that of position two (T2) on the same shell. The exceptions when T1 equals T2 or T1 was slightly thicker than T2 are summarized in Table IV.

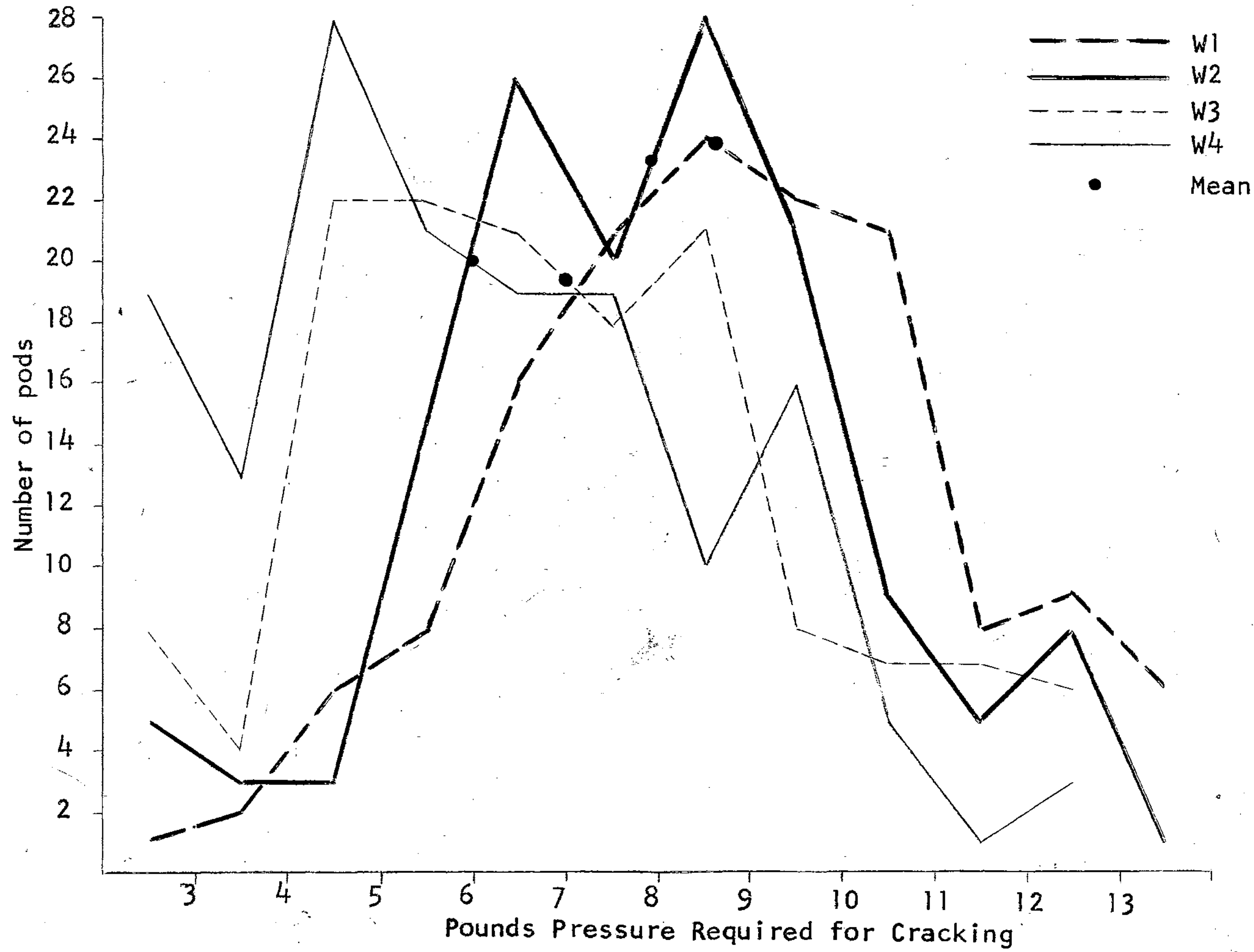


FIGURE III. FREQUENCY DISTRIBUTION CURVES OF CRACKING STRENGTH UNDER IRRIGATION LEVELS AT PERKINS, 1958.

TABLE IV.

ABNORMAL RELATIONSHIP BETWEEN POD THICKNESS FOR POSITION ONE AND TWO UNDER IRRIGATION LEVELS AT PERKINS, 1958

	T1 = T2	T1 > T2	Total
W1	0	1	1
W2	4	3	7
W3	9	2	11
W4	5	10	15

The tendency for the number of exceptions to increase with higher water levels is probably due, in part, to the higher degree of immaturity at the higher levels.

Assuming that the stage of development of the pod at position one was earlier than that at position two, the pods which were not fully matured would be expected to have a thinner shell at position two.

The correlation coefficients for each of the four irrigation treatments for combinations of cracking strength and pod thickness for positions one and two are shown in Table V.

Pod thickness for position one was positively correlated with that of position two. The thickness of positions one and two were positively correlated with pod cracking strength. It was apparent that the thick-shelled peanut requires greater cracking pressure.

It would appear that the thickness of the pod was one of the important factors which affected pod cracking strength. The relationship between these two variables indicates that pod cracking strength was the dependent variable which varied according to pod thickness, the independent variable.

The results of the observations made on the compactness of the kernels in the shell are shown in Figure IV and Table VI.

TABLE V

CORRELATION COEFFICIENT FOR POD CRACKING STRENGTH, POD THICKNESS POSITION ONE AND TWO IN ALL COMBINATIONS UNDER IRRIGATION LEVELS AT PERKINS, 1958

Variables	W1	W2	W3	W4
Thickness position one vs. position two	.562**	.721**	.604**	.699**
Thickness position one vs. pod cracking strength	.491**	.603**	.596**	.611**
Thickness position two vs. pod cracking strength	.602**	.833**	.713**	.833**

** Exceeds 1% level of significance.

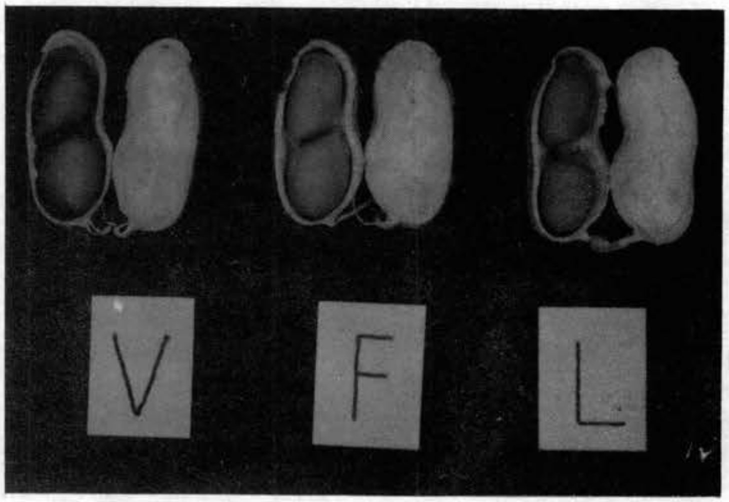


FIGURE IV. COMPACTNESS OF KERNELS IN THE SHELL FROM IRRIGATION STUDY AT PERKINS, 1958.

TABLE VI

THE NUMBER AND PERCENTAGE OF PODS SHOWING VARIOUS DEGREES OF KERNEL COMPACTNESS IN THE SHELL UNDER IRRIGATION LEVELS AT PERKINS, 1958

	Very Compact (V.)		Fairly Compact (F.)		Loosely Compact (L.)	
	No.	%	No.	%	No.	%
W1	69	48	43	30	32	22
W2	59	41	53	37	32	22
W3	46	32	57	40	41	28
W4	16	11	68	47	60	42

The data indicate that the percentage of the pods classed as very compact decreased as the water level increased (Table VI). Conversely, the percentage of the pods classed as loosely compact increased as the water level increased.

The very compact pods which also had a cracking strength above the mean for each water treatment are shown in Table VII.

TABLE VII.

THE NUMBER AND PERCENTAGE OF VERY COMPACT PODS WITH CRACKING STRENGTH ABOVE THE MEAN FOR EACH IRRIGATION LEVEL AT PERKINS, 1958

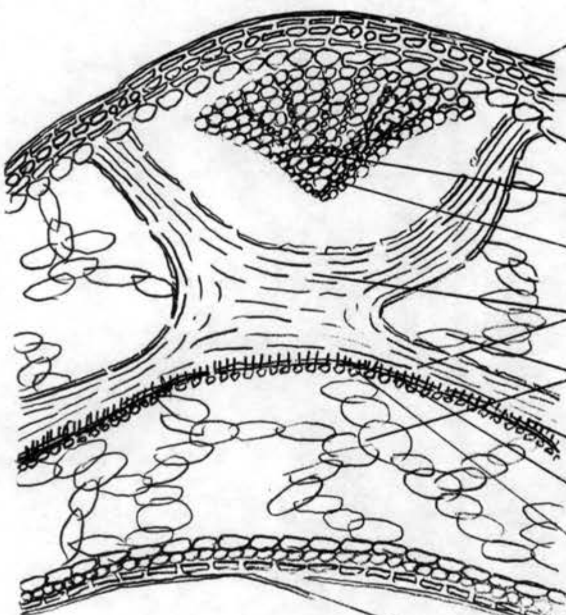
	Total No. of very Compact Pods	No. With Cracking Strength $> \bar{x}$	%
W1	69	54	78.3
W2	59	46	78.0
W3	46	37	80.4
W4	16	13	81.3

More than 78 percent of the very compact pods also had high cracking strength. Apparently, compactness of kernels in the shell was another factor which influenced the pod cracking strength. Under very compact conditions, the kernels themselves directly shared a portion of the pressure required to crack the pod.

In a histological study, by an examination of prepared slides, it was found that the pod of the peanut could be considered morphologically a modified leaf. The outer surface of the pod is the adaxial surface. The attachment of the leaf thence becomes the dorsal suture. The different layers and tissues of the pod are shown in Figure V.

As to the results of the pod development under water treatments, a change in structure was observed from that of lower irrigation treatments. Under lower irrigation treatments the sclerenchymatous and parenchymatous tissues of the mesocarp showed a higher degree of lignification (Figure VI). This information suggests that the aeration of the soil under lower water moisture is responsible for this condition and that it promotes the lignification of the peanut pod. The differences in pod structure under water treatments are presented in Figure VI.

A



B

FIGUREV. CROSS SECTION OF THE OVARY WALL NEAR A POSITION ONE SHOWING THE DIFFERENT TISSUES, (THE DRAWING IN B WAS PREPARED FROM THE PHOTOGRAPH A ABOVE).

W1 W3

W2 W4

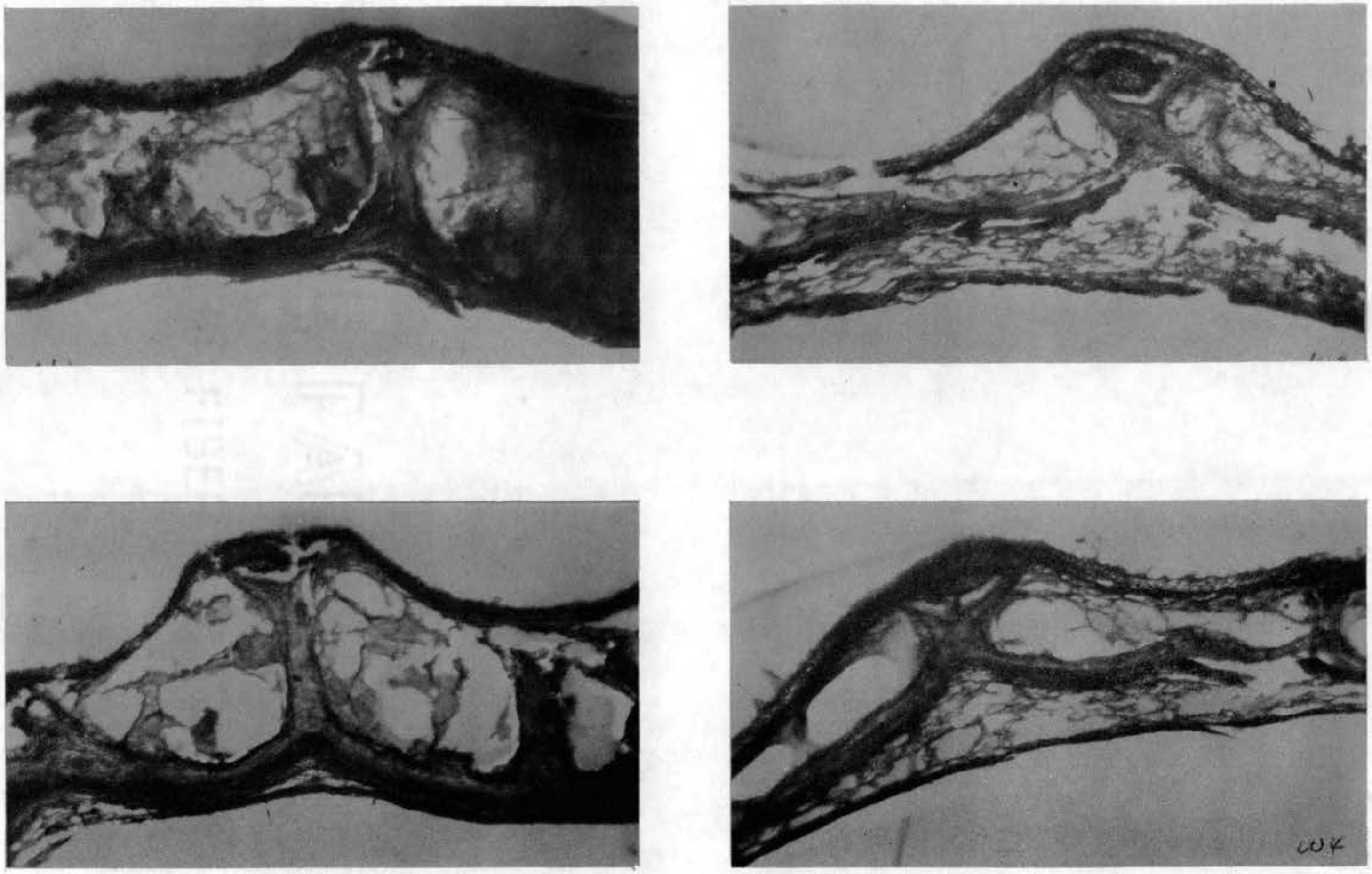


FIGURE VI. CROSS SECTION OF OVARY WALL SHOWING DIFFERENT DEGREE OF LIGNIFICATION OF THE MESOCARP FOR EACH WATER TREATMENT.

The means for protein, oil and moisture content of the peanut kernels for each irrigation level are shown in Table VIII.

TABLE VIII.

THE MEAN PERCENTAGE OF PROTEIN, OIL AND MOISTURE OF KERNELS FOR EACH IRRIGATION TREATMENT AT PERKINS, 1958.

	Protein % (Dry Weight Basis)	Oil % (Dry Weight Basis)	Moisture % (Dry Weight Basis)
W1	30.72	48.08	4.94
W2	28.05	49.30	5.14
W3	28.46	48.91	5.11
W4	26.94	48.14	5.13

The analyses of variance and the multiple range test for the protein content are given in Table IX and X.

TABLE IX.

ANALYSES OF VARIANCE FOR PROTEIN, OIL AND MOISTURE CONTENT UNDER IRRIGATION LEVELS

	Protein		Oil		Moisture	
	D.F.	M.S.	D.F.	M.S.	D. F.	M.S.
Total	31	--	31	--	15	--
Replication	3	0.049	3	5.289	3	0.014
Treatment	3	22.767**	3	2.845	3	0.035
Exp. Error	9	1.902	9	5.076	-	--
Sample Error	16	--	16	--	9	0.095
C.V. (Percent)		4.7		4.7		6.8

** Exceeds 1% level of significance.

TABLE X.

MULTIPLE RANGE TEST OF RANKED MEANS FOR PROTEIN CONTENT FOR FOUR TREATMENTS AT PERKINS, 1958 /1

W4	W2	W3	W1
26.94	28.05	28.46	30.72

/1 Any two means underscored by the same line are not significantly different.

There was no significant difference for the moisture content among water treatments. The protein content of treatment one (W1) was significantly higher than those of the other three treatments. There was no significant difference between treatments three (W3) and two (W2), but treatment three (W3) was significantly greater than treatment four (W4). Treatment two (W2) and four (W4) did not differ significantly. In this study, it appears that the lower irrigation treatment resulted in a higher protein content than that of the high irrigation treatment.

There was no significant difference among treatments for oil content. Similar results were obtained in the irrigation study at Perkins in 1957.

Some criticisms about this study which may be beneficial to future studies of this same subject follows:

The first criticism concerns sampling procedures. The peanuts in the high irrigation treatment had not reached full maturity at the time of collection. Since the results may be influenced by this factor, it would appear that data obtained from the samples collected only from mature plants would be more sensitive and meaningful. This may be accomplished by adjusting the harvesting period or by selecting fully matured individuals.

In this study an attempt was made to choose pods of comparable maturity on the basis of outward appearance, however, inspection of the pods' interior following the cracking test indicated that 8-15 percent more pods were immature in the high water treatments than in the W1 and W2 treatments. (Table XI.)

TABLE XI.

THE NUMBER OF PEANUT PODS IN EACH WATER TREATMENT CLASSED AS MATURE, MEDIUM MATURE AND IMMATURE.



	Mature		Medium Mature		Immature	
	No.	%	No.	%	No.	%
W1	54	37.5	64	44.4	26	18.1
W2	32	22.2	86	59.7	26	18.1
W3	30	20.8	76	52.7	38	26.5
W4	22	15.2	74	51.4	48	33.4

In this study it was found that irrigation prolonged the maturation of the peanut fruit.

The second criticism of this study concerns the lack of adequate identification while staining the sections in the histological study. The loss of identification marks on each half of the shell and the failure to keep the sections separate, due to lack of equipment, made it impossible to identify each sample. A remedial measure was conducted rather successfully by calibrating the thickness of pod sections using the microscope, to check their origin. Some bias was unavoidable.

SUMMARY AND CONCLUSIONS

Five physical characteristics, one histological characteristic and three chemical components were studied for the Argentine peanut variety in the irrigation test at Perkins Agronomy Station in 1958.

The non-irrigated peanuts had longer, wider and thicker pods which required more weight to crack, had more lignified mesocarp and higher protein content than the irrigated peanuts.

Significant positive correlations were obtained for each of the four irrigation treatments for combinations of cracking strength, pod thickness at positions one and two. Though there were no statistically significant differences among irrigation treatments for the mean pod thickness at positions one (T1) and two (T2) there was a tendency for thickness of the pod to increase as the irrigation level was decreased. The pod thickness at position two was usually thicker than that at position one.

Pod cracking strength is one of the most important factors in shelling, the result of this study has provided some information concerning this factor. The results showed that three factors affecting the pod cracking strength include thickness of pod, degree of lignification of the mesocarp and the compactness of the of the kernels in the shell.

The mean protein content in this study was significantly higher for the lower irrigation treatment (W1) than that of the high irrigation treatment (W4).

The high water treatments did not appear fully mature which may have been a factor that influenced the accuracy of the result. It is difficult to define and recognize a mature peanut because of its indeterminate growth. Perhaps larger samples would allow sufficient choice of pods that were of comparable maturity.

Irrigation tended to prolong maturation of the peanut. The data indicate that irrigation could be used to modify certain characteristics in development of the peanut.

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