MOISTURE AND GYPSUM EFFECTS ON PLANT DEVELOPMENT AND POD-FILL OF GROUNDNUTS (*Arachis hypoqaea* L.)

BY

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THESIS CERTIFICATION

This thesis entitled *MOISTURE AND GYPSUM EFFECTS ON PLANT DEVELOPMENT AND POD-FILL OF GROUNDNUTS (Arachis hypogaea L.) IN NIGERIA by* BALARABE TANIMU meets the regulations governing the degree of Master of Science (*Agronomy*) of Ahmadu Bello University and is approved for its contribution to scientific knowledge and literary presentation.

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ABSTRACT

In seeking a solution to the problem of 'blindnuts' often reported in parts of the Sudan ecological zone of Nigeria, investigations were carried out for two seasons at Ladanawa (12°32'N; 07°38'E) backed by one season of observation at Samaru (Northern Guinea savanna, 11 ll'N; 07°38'E) to observe the effects of moisture and gypsum on groundnut development and fill. Despite difficulties of management experienced in the conduct of the trials treatment effects were generally consistant between seasons and locations.

The application of supplementary irrigation generally increased the amount of vegetative growth as measured by height, foliage cover and number of vegetative branches. It was evident that the most important factor which adversely affected groundnut pod-fill and yield was inadeguate moisture availability particularly at the time of peg formation and pod development. The use of gypsum without first ensuring the supply of adequate moisture did not help much in alleviating the problem of groundnut pod-fill.

CHAPTER I

A. INTRODUCTION

1. ORIGIN OF GROUNDNUT

Groundnut (Arachis hypogaea L.) is a member of the family leguminosaea, and the genus consists of species originating from Brazil (Anonymous, 1973). Groundnut was first brought to Africa by Portuguese traders. The crop is now extensively grown in most parts of Africa and is particularly important in West Africa (Harkness, 1959).

2. GROWTH HABITS

There are two extreme forms of the groundnut plant: the bunch and the runner (spreading) types with many intermediates (Anonymous, 1978). In contrast to bunch varieties where the stems are upright and mature pods are grouped around the base, stems of the runner varieties are prostrate and run over the surface of the soil, bearing pods over a substantial area around the parent plant. In general varieties can be grouped into three maturity groups: early varieties with a maturity period of 100 - 110 days; late varieties which require 120 - 140 days to mature, and medium maturing varieties requiring 110 - 120 days.

3. ECONOMIC IMPORTANCE

Groundnut is produced in many places around the world, but areas of high production include South Eastern Asia, West Africa and North America. Among African countries with substantial production are Nigeria, Senegal and the Sudan (Yayock, 1978a). An estimated 0.8 - 1.2 million hectares of land are planted with groundnuts annually in Nigeria and over 80% of these are north of latitude 10^{o}N. The land area devoted to groundnut by the average farmer is in the range of 0.25 - 1.0 hectare (Harkness, et al., 1976)

The estimated annual national output of groundnut in Nigeria under normal conditions is about one million metric tonnes of kernels. For example groundnut products, including kernels, cakes and oils, accounted for 20% of the total Nigerian export earnings each year in the decade 1956 - 1966 (Harkness, 1970). However, the export of groundnut and its products has gone down considerably in the last decade. Indeed, since the drought of 1972 and 1973, followed by the devastating rosette disease of 1975 and 1976, Nigeria has had to become a net importer of groundnut particularly in the form of oil. For example, Nigeria imported about 200,000 tonnes of vegetable oils worth about ₦77 million in the fiscal year 1980 (personal communication, Nigerian Groundnut

Board). However, various rehabilitation programmes are underway to revive the cultivation of this crop in the country.

4. DECLINING GROUNDNUT PRODUCTION

Since the peak years of 1965 and 1966, the production of groundnut in Nigeria has declined progressively (Harkness, et al., 1976). Yayock (1978a) attributed the decline to such factors as increased local consumption, reduction in the number of farming families, drought and rosette epidemics. In addition to these factors, certain locations and particularly on intensively cropped soils which had hitherto supported good groundnuts are no longer readily productive. For example, there have been increasing reports of unusually high incidences of unfilled groundnut pods (Blindnuts or pops) at such old farm centres as Dambatta ($12^{o}27'N$, $08^{o}31'E$) and Ladanawa ($12^{o}32'N$, $07^{o}45'E$). The problem of blindnuts has been so severe as to cause serious concern amongst state and national officials charged with increasing groundnut production.

The problem of blindnut has often been thought of as being due solely to plant nutrition, although attempts to prove this in the field have hardly yielded any direct

evidence to this effect. Recent Screen house work (Balasubramanian and Yayock, 1981) suggest that moisture may be a major cause of blindnut problem in the sense that its inadequancy is believed to result in low mineralisation and/or availability of such nutrient elements as calcium and magnesium which are important in pod development. Coincidentally, areas where the problem of blindnut seems most widespread and severest are those with inadequate and/or unpredictable rainfall.

Thus, in order to verify the observation about the possible importance of moisture and availability of nutrients on groundnut plant development and pod fill, it is necessary that studies be carried out under field conditions. To this end, the present study is aimed at investigating the effect of moisture and gypsum on pod development and yield of groundnut. It is only when the role of such nutrient elements as calcium is established vis-a-vis soil moisture status that any meaningful management practice and/or breeding programme can be embarked upon in the attempt to eliminate or at least reduce the extent and intensity of the occurrence of blindnuts.

B. LITERATURE REVIEW

1. NUTRITIONAL FACTORS AFFECTING GROUNDNUT POD-DEVELOPMENT

Like all other crop plants, groundnut requires mineral nutrients for both vegetative and reproductive growth and development. The presences of nutrient elements in adequate and balanced amounts is essential for the crop's good performance and yield. The problems of blindnut on such intensively farmed drift-sandy soils as in Ladanawa and Dambatta are suspected to be due to lack of adequate available nutrients (Balasubramanian and Yayock, 1981). Deficiency of nutrients may not be entirely due to the absence of elements in the soil per se, but may be caused by absorption problems resulting from droughty conditions. The review of literature that follows attempts to highlight the importance of various major nutrient elements on groundnut production, particularly with regard to pod development and pod fill.

a) Nitrogen

Nitrogen is the most important of all plant nutrients, the deficiency of which results in reduced plant vigour and smaller groundnut leaves than normal. Lack of nitrogen also results in few root nodules (Burkhart and Collines, 1941).

Whilst large amounts of this nutrient usually cause plants to become dark green in colour and such rapid growth as to cause succulent vegetation and plants that may not flower and fruit well.(Mathur, 1961: quoting Ali *et al.*, 1939). Groundnut and most legumes normally fix the nitrogen they need and rarely require the addition of fertilizer nitrogen (Yayock *et al.*, 1979). However, the application of a starter dose of about 20 kg ha^{-1} of calcium ammonium nitrate to soils with low nitrogen could be beneficial (personal communication, Balasubramanian, 1980).

b) Phosphorus

Phosphorus-containing fertilizers are the only fertilisers at the moment recommended for application to groundnuts in Nigeria (Anonymous, 1976). Of the major phosphorus sources, single superphosphate is generally recognised as the most important for groundnut (Seshadri, 1956; Wahhab and Muhammad, 1958; Accuna and Sanchez, 1969). In Nigeria, the rate of application is 100 kg ha^{-1} of single superphosphate (18% P_2O_5) but results of recent field trials indicate that applications at 200 kg ha^{-1} gives increased yields where moisture conditions are favourable (Fed. Dept. of Agric., 1980).

Phosphorus is reported to hasten pod maturity and root development (Burkhart and Collins, 1941) whilst considerable quantities of phosphates promote fruit formation, seed size and reduce the proportion of empty pods (Mathur, 1967).

c) Potassium

Colwell and Brady (1945) reported that potassium played no role in aiding the filling of pods and that under certain conditions it lowered both the shelling percentage and the percentage of ovarian cavities filled. If placed in the rooting zone, potassium tended to inhibit seed development. However, when applied in combination with calcium in the fruiting zone, favourable effects were observed (Middleton, et al., 1945). Thus, it was concluded that increased yields from the use of potash may be expected when there is an adequate supply of calcium to bring about good filling of pod and when the level of soil potassium is extremely low in the soil (Colwell et al., 1945).

d) Calcium

Besides its neutralising effect of hydrogen ions, calcium is one of the essential nutrient elements through which some other elements are mobilised into the plant

(Worthen and Aldrich, 1956). During germination available calcium in the growing medium is of vital significance as evidenced by the fact that groundnuts germinated in a medium deficient in calcium failed to develop beyond the early seedling stage (Burkhart and Collins, 1941). The young primary root broke down completely within a few days after planting and before the plummule emerged from the enclosing cotyledons, showing an in efficient re-utilisation of internal calcium.

Calcium deficiency symptoms in groundnuts first appear in fully developed leaves as localised pitted areas on the lower surfaces of the leaves (Worthen and Aldrich, 1956). The root system absorbs calcium from the soil which moves freely from the stem to the leaves and flowers (Burkhart and Collins, 1941). However, a special need for calcium develops after the pegs enter the soil. Immediately the pegs enter the soil, the calcium stops moving from the main stem and leaves to the pegs (Worthen and Aldrich, 1956). Yet the pegs must get calcium if they are to develop into well-filled pods (Brady et al., 1945; Cox and Reid, 1964; Harris and Brolmann, 1966; Walker et al., 1976; Logathan et al., 1977; Kesling et al., 1978 and Walker et al.,

1976). Suzuki (1967) found that calcium needed to be added to the soil to reduce sterility in groundnuts. Failure of the fruits to obtain adequate calcium results in an abnormal conditions in the seed, identified as 'dark plumule' (Bracho et al., 1971).

Groundnut pods are so sensitive to the supply of calcium that the plant has been used with considerable success to measure the release of calcium from various soil colloids (Brady et al., 1945). Burkhart and Collins (1941) found that calcium already in the plant tissue could not move to other parts of the plant for use when there is calcium deficiency in the soil.

i) Calcium and Pod Fill

The application of calcium - containing fertilisers to groundnuts whose pegs have stayed for quite a long period of time in the soil does not have any effect. It is normally recommended that calcium be added to the soil immediately after the pegs enter the soil. Harris (1968) defined the most critical period for calcium (gypsum) application at 15 - 35 days after the pegs reach the soil. He reports further that the pods nearest the main stem are more poorly filled than those of comparable age further

out on the stems, and this is attributable to peg competition for carbonhydrates. The fact that supplying calcium to only one side of the plant did not improve the quality of pods on the opposite side of the plant is offered as an indirect evidence of the lark of movement of calcium from one side of the plant to the other (Harris, 1968).

ii) Calcium Interaction with Other Nutrient Elements

Excess sodium is reported to interfere with the uptake of calcium by groundnut (Pal and Bangarya, 1958; Reid and Cox, 1963). As has been pointed out earlier, excess potassium application reduces the effect of calcium in groundnut (Hallock and Garren, 1968). Potassium was found not only to depress calcium uptake, but it also greatly reduced yield and quality of the kernels (Colwell et al., 1945). Mass action of highly mobile cations like H^+, K^+, Na^+ would be expected to reduce the uptake of calcium, particularly by the fruiting organs where soil tissue contact is limited (Hallock and Garren, 1968). As a result of the frequency of unfilled pods in groundnuts produced under low available soil calcium levels and because of possible adverse effects of fertiliser salts and weather on the uptake of calcium by the pod, calcium fertilisation (liming)

is suggested in most areas where the crop is produced (Davis and Brogder, 1951).

e) Sulphur

Sulphur deficiency in groundnuts results in lighter green colour than normal, reduced nodulation and plant size, increased premature leaf-fall, reduced rate of development of pods as well as a reduction in the strength with which the pods are attached to the plants (Burkhart and Collins, 1941). In Nigeria, evidence of sulphur deficiency in groundnuts is common even in newly opened fallows (Bromfield, 1973), and responses to sulphur have been reported in some parts of the main growing areas (Goldsworthy and Heathcote, 1963). The deficiency is corrected using single superphosphate which contains 12% S in addition to 8% P and 20% Ca.

f) Magnesium

Magnesium has been demostrated to be a factor in fruit production and is important in physiological processes of the plant (Mathur, 1967: quoting Arant et al., 1951). Magnesium is one of the components of chlorophyll molecules which play a significant role in photosynthesis. Magnesium has therefore an indirect role in fruit formation since its

effect is on photosynthesis and phtosynthesis is responsible for the production of carbonhydrates in plants.

g) Boron

Boron influences the absorption of all the macro elements and its deficiency changes the ratio of N, P and K (Mathur, 1967: quoting Mastre, 1956). Boron deficiency also decreases the yield and quality of seed and sometimes causes striking foliar symptoms (Harris, 1968). The absence of boron causes a high incidence of hollow heart disease which is practically eliminated by application of fertiliser boron (Mathur, 1967). Applied boron increased quality of groundnut oil by decreasing its acid value (Asoka-Raj, 1969; Hill and Morrill, 1974). The presence of excess boron in the plant tissue may cause toxicity that will result in death of the plant.

2. ENVIRONMENTAL FACTORS

a) Moisture

Water has important effects on the amounts and kinds of nutrients found in the soil and on the availability of nutrients of the plants (Russell, 1959). Water in excess normally brings about leaching or water logging depending upon the

nature of the soil. Both water logging and leaching indirectly affect pod filling and fruit quality in groundnut because they depress the availability and uptake of nutrients from the soil. About 80% of the groundnut fresh weight is water and any reduction of the plant water status below this level causes visible wilting and affects the rate of many plant functions (Gillier, 1972). Droughted plants have been shown to have smaller tops, fewer branches and fewer flowers. Calcium and boron deficiency symptoms occur markedly with severe drought (Gillier, 1972).

Many workers including Burkhart and Collins (1941); Fergus et al., (1949); Worthen and Aldrich, (1956); Reid and Cox (1963); Mathur, (1967) and Hallock and Garren, (1968) have shown the importance of water in relation to calcium absorption. The suggestion is that drought condition decreases the absorption of calcium and this in turn affects the production of sound mature pods; in effect drought enhences the production of unfilled pods. In addition, Rogers (1968) observed dark plummule abnormality in seed from the plant that had been subjected to severe drought.

b) Temperature

Abnormally low or high temperatures are reported to adversely affect groundnut flowering and pod production. For example, Yayock (1978b) suggested that poor pod-set observed in Nigeria in 1976 and 1978 was probably due more to lower-than-normal temperatures particularly at peak flowering stage than any other environmental considerations. Possible adverse effects of temperature on groundnut flowering include delay in flowering (Beerde, 1963), increasing rate of flower abortion reduction in the number of opened flowers (Fortainer, 1957), reduction of fertilisation percentage (Beerde, 1963) and reduction in the number of pegs (Jacobs, 1951).

CHAPTER II

MATERIALS AND METHODS

The investigation was carried out under field conditions during the 1980 and 1981 rainy season at Ladanawa ($12^{o}32'N$, $07^{o}45'E$) using a piece of land known to have a history of blindnut problem. As a back-up to the main project at Ladanawa, the trial was planted during the dry season at Samaru ($11^{o}11'N$, $07^{o}38'E$) with virtually the same treatments. The field used at Samaru has no known history of blindnut.

A. EXPERIMENTAL SITE

1) Ladanawa

Ladanawa is situated in an area suitable for groundnut production primarily in terms of adequate sunshine and loose sandy soils. Some properties of the soil sampled from the experimental area are as follows: pH = 3.95 in CaCl ; exchangeable cation (meq./100g) = 0.31 Ca, 0.17 Mg, 0.13 K, 0.01 Na, 0.08 H + Al, 0.70 effective CEC; Contents (%) = 0.221 Organic C, 0.02 total H, 2.0 silt, 78.0 fine sand, 0.0 clay, 20.0 coarse sand, 6.9 moisture at 0.1 bar, 2.7 moisture at 15 bars, and 4.2 available moisture.

Established rainfall in the Ladanawa area lasts for 3½ - 4 months, begining in mid-June and averages under 760mm per annum. The area also receives an average of about 220 kilo calories/cm^2/year of solar energy.

2) Samaru

Samaru is located well within the Northern Guinea savanna ecological zone. Some properties of the soil sampled from the experimental site are as follows: pH = 6.8 in water, 5.8 in KCl; Exchangeable cations (meq./100g) = 2.07 Ca, 0.69 Mg, 0.38 K and 0.03 Na, effective CEC = 3.5; contents (%) = 0.25 organic C, 24.0 clay silt = 38.0, 38.0 sand. The soil has a bulk density of about 1.67 gem^{-3} and a saturation percentage of 30.54.

Samaru has a mean annual rainfall of 1045mm which is distributed over 150 days between May and October (Kowal and Knabe, 1972).

B. TREATMENTS

1) Ladanawa

The study involved factorial combinations of three varieties of groundnut (Spanish 205, Samaru 61 and an adapted local variety, Yar Tsuguno), two rates of calcium (0

and 80kg Caha^{-1}) and moisture stress applied at four stages of growth.

a) Groundnut varieties

Spanish 205 is a USA Spanish variety which matures within 100 days and is very susceptible to leaf-spot and rosette. It possesses pods with a slight construction in the middle. The seeds are medium and sprout easily if not harvested as the crop matures.

Samaru 61 matures within 120 - 125 days and has erect habit, castle carry pod type with medium seed size. The variety is susceptible to both rosette and leaf-spot but yields up to 3,000kg ha^{-1} under good management.

Yar Tsuguno is a Ladanawa variety. It has a spreading habit and matures within 120 - 130 days. The seeds are as big as those of Samaru 61.

b) **Gypsum**

Calcium was supplied as chemical grade calcium sulphate or gypsum ($CaSO_4 . 2H_2O$). The gypsum was applied (672 kg ha^{-1}) at about four weeks after sowing by spreading the material on the soil surface.

c) Moisture Stress

Because the investigations were carried out during the rainy season, moisture treatment is defined in terms of water supplied to or with-held from the crop in addition to that supplied as rainfall. Consequently moisture treatment included:

W_1 —— stressing the plants throughout the growth period by providing no additional water on top of the normal rainfall.

W_2 —— stressing the plants at 6 - 10 weeks after sowing to coincide with the period of peak flower production by providing additional water at all but this period.

W_3 —— stressing the plants at 9 - 13 weeks after sowing to coincide with period of active peg and pod development by providing additional water at all but this period.

W_4 —— no stress throughout the growth period by providing water in addition to normal rainfall.

2) Samaru

Treatments used at Samaru were essentially the same as at Ladanawa, except that planting was done during the dry season under irrigation.

C. EXPERIMENTAL LAYOUT

Treatments were arranged in a split-plot design with moisture stress as the main plot while varieties and calcium were factorialy grouped into sub-plots. Whilst the trials at Ladanawa were replicated four times, at Samaru three replications were used. Plots were deliberately small at 2 x 1.5m to ensure effective irrigation, water being a difficult input especially at Ladanawa.

D. BASAL FERTILISER APPLICATION

The entire experimental area was fertilised with single superphosphate at 200kg ha^{-1} (18% P_2O_5), Muriate of potash at 70kg ha^{-1} (60% K_2O) and agricultural lime at 714kg ha^{-1}. The lime was applied immediately following the first rain on 20th May, 1980, and with irrigation on 10th April, 1981, whilst the superphosphate and potash were both applied at sowing. At Samaru on the other hand the lime was applied on 20th December 1980, whilst the superphosphate and potash were both applied at sowing.

E. SOWING

The experiment was sown on 13th June, 1980 and 25th April, 1981 at Ladanawa and 29th December, 1980 at Samaru.

Three seeds were placed in each hole 25cm apart on 75cm rows, on the flat. The germinating seedlings were thinned at 2 plants per stand at 10 - 14 days after sowing.

F. APPLICATION OF WATER

Even though the investigation was done during the rainy season at Ladanawa and inorder to ensure a good establishment of the crop, all plots received four litres of water every other day for the first four weeks of growth, in addition to what amounts were provided as rain-water (about 760mm over 3½ - 4 months). Once the imposition of moisture stress began after the first four weeks those plots that were not subjected to the treatment were regularly supplied with water every seven days, irrespective of rainfall.

G. WEED AND INSECT CONTROL

Weeds were controlled by hand-hoeing twice during the growth of the crop. A mild infestation of aphids (Aphis craccivora) necessitated the application of pirimor* at 1.0kg (a.i.) ha^{-1}.

*5 - 6 dimethyl-2-dimethylamine-4-pyrimidnyl dimethyl carbamate.

CHAPTER III

RESULTS

A. VEGETATIVE GROWTH AND DEVELOPMENT

1. Plant Height

There were significant varietal differences in the height of groundnuts in 1980 and 1981 at Ladanawa and in 1980 at Samaru. In general, Spanish 205 grew tallest, followed by Yar Tsuguno (Tables 1 - 12). However, in 1981 at Ladanawa, Samaru 61 grew taller than Yar Tsuguno during the early stages of growth but with a reverse trend as the crop grew older. The application of gypsum generally tended to decrease height, except at Ladanawa in 1980 where there was an increase; however, differences were not statistically significant.

The different moisture treatments gave varying results at varying periods of measurement and at the different location. In general plots that depended solely on rainfall yielded the shortest plants at Ladanawa in 1980. In 1981, however, such plots yielded some of the tallest plants while at Samaru differences were not detectable. Responses to the moisture x gypsum interactions were generally not significant. However, negative responses were mostly

Table 1. Mean effects of moisture stress and gypsum treatments on plant height (cm) of three varieties of groundnuts 55 days after sowing at Ladanawa 1980

	Sp. 205		S.61		Y-Tsuguno		MoisturexCa(±2.07)		Mean (±0.83) Moisture*
	0	80	0	80	0	80	0	80	
				kg ha^{-1} Ca					
Throughout	19.00	20.75	12.50	15.80	13.50	18.00	15.00	18.18	18.13
Peak Flowering (6-10 wks)	23.25	24.75	15.75	16.00	15.25	18.50	18.08	19.75	19.83
Pod Develop. (9-13 wks)	23.75	24.75	14.50	21.00	16.25	19.75	18.17	21.83	20.75
No Stress	26.25	28.00	22.25	24.50	21.00	25.50	23.17	26.00	21.33
Mean (±2.93) Var. x Ca.	23.06	24.56	16.25	19.25	16.50	20.44			
Mean (±1.04) Var.*	23.81		17.75		18.47				

Mean (±0.85)

Ca* = 10.05 cm at 0 kg ha^{-1} Ca

9.88 cm at 80 kg ha^{-1} Ca

* Significant differences at 5% level

Table 2. Mean effects of moisture stress and gypsum treatments on plant height (cm) of three varieties of groundnuts 74 days after sowing at Ladanawa, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		MoisturexCa(±2.36)*		Mean Moisture (±0.78)*
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	20.00	23.05	14.25	12.25	17.50	15.05	17.25	16.78	19.21
Peak Flowering (6-10 wks)	22.50	27.25	16.00	18.00	19.25	20.50	19.25	21.92	20.05
Pod Develop. (9-13 wks)	26.50	29.00	20.00	19.63	24.25	21.63	23.58	23.42	23.00
No Stress	31.25	30.75	27.50	25.50	33.25	22.50	30.67	26.25	23.85
Mean (±3.33) Var. x Ca.	24.44	27.60	18.81	18.84	19.56	19.92			
Mean (±1.18) Var.*	26.02		18.83		19.14				

Mean (± 0.96
Ca* = 20.94 at 0 kg ha^{-1} Ca
22.12 at 80 kg ha^{-1} Ca

* Significant differences at 5% level

Table 3. Mean effects of moisture stress and gypsum treatments on plant height (cm) of three varieties of groundnut 85 days after sowing at Ladanawa, 1980

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Mousture x Ca(±3.13)		Mean (±1.29) Moisture*
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	29.00	27.00	22.63	22.50	26.50	16.50	26.00	22.04	24.02
Peak Flowering (6-10 wks)	24.00	27.00	21.25	24.75	24.75	26.50	23.33	26.08	24.71
Pod Develop. (9-13 wks)	31.00	27.75	27.50	24.25	24.75	18.75	27.58	23.58	25.58
No Stress	34.75	37.00	26.25	32.00	31.75	23.50	30.92	30.83	30.88
Mean (±4.43) Var. x Ca.	29.69	29.06	24.38	25.91	26.81	20.69			
Mean (±1.57) Var.*	29.38		25.14		23.75				

Mean (±1.28)

Ca* = 26.96 at 0 kg ha^{-1} Ca

25.22 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 4. Mean effedts of moisture stress and gypsum treatments on plant height (cm) of three varieties of groundnut 101 days after sowing at Ladanawa, 1980

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca(±1.57)		Mean (±0.97) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	27.50	29.00	15.25	27.25	19.74	20.00	20.80	25.42	25.29
Peak Flowering (6-10 wks)	29.75	29.25	16.75	30.00	23.75	27.50	23.72	28.92	25.79
Pod Develop. (9-13 wks)	30.25	30.25	19.74	29.75	23.75	30.25	24.58	30.08	26.46
No Stress	31.25	39.75	25.25	33.75	32.75	41.50	29.75	38.33	33.13
Mean (± 2.22) Var. x Ca*	29.68	32.06	19.25	30.19	25.00	29.81			
Mean (±2.45) Var.	30.88		24.72		27.41				

Mean (±1.64)

Ca* = 24.65 at 0 kg ha^{-1} Ca

30.69 at 80 kg ha^{-1} Ca

* Significant differences at 5% level

Table 5. Mean effects of moisture stress and gypsum treatments on plant height (cm) of three varieties of groundnut 35 days after sowing at Ladanawa, 1981.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±1.35)		Mean (±1.17)
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								Moisture
Throughout	10.05	10.53	8.40	7.51	8.50	9.59	8.98	9.21	9.10
Peak Flowering (6-10 wks)	8.50	9.90	8.80	7.33	7.88	7.59	12.59	8.27	10.43
Pod Develop. (9-13 wks)	13.30	9.88	8.65	7.58	10.31	8.53	10.68	8.66	9.67
No Stress	9.70	7.58	7.67	7.50	7.33	9.05	8.23	8.04	8.14
Mean (±0.65) Var. x Ca.	10.38	9.47	8.40	7.48	8.51	8.69			
Mean (±0.46) Var.*	9.93		7.94		8.60				

Mean (±0.37)
Ca. = 9.10 at 0 kg ha^{-1} Ca
8.55 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 6. Mean effects of moisture stress and gypsum treatments on plant height (cm) of three varieties of groundnut 50 days after sowing at Ladanawa, 1981.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±1.89)		Mean (±2.00) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	15.15	14.75	13.70	11.66	11.34	15.6	13.40	14.00	13.70
Peak Flowering (6-10 wks)	14.38	17.58	13.6	10.53	9.88	11.32	12.62	13.13	12.88
Pod Develop. (9-13 wks)	16.04	16.05	12.95	11.07	12.41	12.88	13.80	13.33	13.57
No Stress	19.08	11.25	10.61	13.14	9.40	12.65	13.03	12.35	12.69
Mean (±0.68) Var. x Ca.	16.16	14.91	12.72	9.84	10.76	13.11			
Mean (±0.55) Var.*	15.54		11.28		11.94				

Mean (±0.55)
Ca. = 13.21 at 0 kg ha^{-1} Ca
12.62 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 7. Mean effects of moisture stress and gypsum treatments on plant height (cm) of three varieties of groundnuts 64 days after sowing at Ladanawa, 1981

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±5.51)		Mean (±4.77) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	25.23	21.75	23.03	18.9	23.39	22.09	23.88	20.91	22.40
Peak Flowering (6-10 wks)	27.7	49.9	23.49	20.5	18.11	19.99	23.10	30.13	26.62
Pod Develop. (9-13 wks)	23.72	23.43	20.43	23.08	22.90	19.23	22.35	21.91	22.13
No Stress	28.53	20.96	20.82	24.5	18.75	18.97	22.70	21.48	22.09
Mean (±3.67) Var. x Ca.	26.30	29.01	21.94	21.75	20.79	20.07			
Mean (±2.59) Var.	27.66		21.85		20.43				

Mean (±2.12)
Ca. = 23.01 at 0 kg ha^{-1} Ca
23.61 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 8. Mean effects of moisture stress and gypsum treatments on plant height (cm) of three varieties of groundnuts 77 days after sowing at Ladanawa, 1981

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±7.46)		Mean (±6.46) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	30.8	35.95	15.64	26.33	28.92	26.82	25.12	29.70	27.41
Peak Flowering (6-10 wks)	35.85	36.75	27.99	25.7	28.46	41.05	30.77	34.50	32.64
Pod Develop. (9-13 wks)	27.78	28.1	26.73	25.48	26.02	27.62	26.84	27.07	26.95
No Stress	26.35	24.38	30.45	25.31	24.91	25.31	27.24	25.00	26.12
Mean (±2.54) Var. x Ca.	30.20	31.30	25.20	25.71	27.08	30.2			
Mean (±1.79) Var.	20.75		25.46		28.64				

Mean (±1.47)

Ca. = 27.49 at 0 kg ha^{-1} Ca
29.07 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 9. Mean effects of moisture stress and gypsum treatments on plant height (cm) of three varieties of groundnuts 90 days after sowing at Samaru, 1980.

Moisture Stress	Sp. 205		S. 64		Y-Tsuguno		Moisture x Ca (±1.709)		Mean (±3.23) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	9.53	11.24	10.37	6.37	10.11	9.03	10.00	8.88	9.44
Peak Flowering (6-10 wks)	11.97	8.61	5.80	8.24	10.69	5.86	9.49	7.57	8.53
Pod Develop. (9-13 wks)	11.70	8.22	6.90	10.70	7.73	6.60	8.78	8.51	8.64
No Stress	11.31	22.37	10.00	11.77	14.46	9.57	11.92	14.57	13.25
Mean (±1.48) Var. x Ca.	11.13	12.61	8.27	9.27	10.75	7.77			
Mean (±1.08) Var.*	11.87		8.77		9.26				

Mean (±0.96)
Ca. = 10.05 at 0 kg ha^{-1} Ca
9.88 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 10. The mean effects of moisture stress and gypsum treatments on plant height (cm) of three groundnut varieties 103 days after sowing at Samaru, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±0.41)		Mean (±1.22) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	11.30	12.88	10.93	8.17	9.03	7.93	10.42	9.66	10.04
Peak Flowering (6-10 wks)	9.90	12.4	9.77	7.90	9.77	8.08	9.81	9.37	9.59
Pod Develop. (9-13 wks)	13.70	12.82	7.78	9.63	7.42	7.93	9.63	10.13	9.88
No Stress	12.49	8.18	9.90	10.43	8.68	7.47	10.36	8.69	9.53
Mean (±0.36) Var. x Ca.	11.85	11.51	9.60	9.03	8.73	7.85			
Mean (±0.21) Var.									

Mean (±0.21)
Ca. = 10.06 at 0 kg ha^{-1} Ca
9.46 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 11. The mean effects of moisture stress and gypsum treatments on plant height (cm) of three groundnuts varieties 117 days after sowing at Samaru, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±1.11)		Mean (±2.00) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	10.58	21.06	17.60	17.32	16.30	15.80	17.83	18.06	17.95
Peak Flowering (6-10 wks)	25.80	21.73	18.33	19.43	20.33	19.87	21.49	20.34	20.92
Pod Develop. (9-13 wks)	20.77	20.20	16.49	15.83	13.97	19.03	17.08	18.35	17.72
No Stress	22.25	21.27	10.17	19.39	18.51	14.62	16.98	18.43	17.70
Mean (±0.96) Var. x Ca.	22.10	21.07	15.65	18.00	17.28	17.33			
Mean (±0.68) Var.*	21.58		16.82		17.31				

Mean (±0.56)
Ca. = 18.34 at 0 kg ha^{-1} Ca
18.80 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 12. The mean effects of moisture stress and gypsum treatment on plant height (cm) of three groundnut varieties 130 days after sowing at Samaru, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±2.07)		Mean (±3.38)
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								Moisture
Throughout	28.91	17.87	27.63	28.72	26.90	27.91	27.81	24.83	26.32
Peak Flowering (6-10 wks)	29.27	31.42	23.93	27.39	28.03	27.77	27.08	28.86	27.97
Pod Develop. (9-13 wks)	28.30	33.12	26.74	17.37	25.37	25.20	26.80	25.23	26.02
No Stress	32.97	30.60	28.57	27.17	31.10	24.83	30.88	27.53	29.21
Mean (±1.79) Var. x Ca.	29.86	28.25	26.71	25.16	27.85	28.14			
Mean (±1.27) Var.*	29.06		25.94		28.00				

Mean (±1.30)
Ca. = 28.14 at 0 kg ha^{-1} Ca
27.18 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

observed even in those plots in which water was supplied throughout especially at Ladanawa in 1981.

2. Foliage Spread

Significant differences in foliage spread existed 85 days after sowing with Samaru 61 having the greatest spread, followed by Yar Tsuguno in 1980 at Ladanawa, while in 1981, Spanish 205 had the widest foliage cover, followed by Yar Tsuguno just as it was at Samaru, although in the later differences were not significant (Tables 13 - 24). Gypsum application generally reduced the amount of spread for the three groundnut varieties, except at Ladanawa in 1981 where the response of Yar Tsuguno was not statistically significant.

Moisture treatments affected the spread of foliage differently at different periods of observation. In general, however, plots which were irrigated throughout resulted in more spreading plants than the other moisture treatments. Differences were generally not significant except at Ladanawa in 1980 at 74 and 85 days after sowing. None of the treatment interactions had any significant effect on the spread of foliage.

Table 13. Mean effects of moisture stress and gypsum treatment on foliage spread (cm) of three groundnut varieties 55 days after sowing at Ladanawa, 1980

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±0.85)		Mean (±0.39 Moistur
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	13.00	13.50	13.25	12.25	9.50	8.50	11.92	11.42	11.67
Peak Flowering (6-10 wks)	13.25	12.25	15.75	14.50	11.75	7.75	18.58	11.50	12.54
Pod Develop. (9-13 wks)	12.25	14.00	14.25	16.00	12.00	8.50	12.83	12.83	12.83
No Stress	14.00	14.75	13.25	14.75	8.75	10.75	12.00	13.42	12.71
Mean (±1.20) Var. x Ca	13.13	13.63	14.13	14.38	10.50	8.88			
Mean (±0.42) Var.	13.38		14.25		9.69				

Mean (±0.35) Ca = 12.50 at 0 kg ha^{-1} Ca
12.29 at 80 kg ha^{-1} Ca

* Significant differences at 5% level

Table 14. Mean effects of moisture stress and gypsum treatments on foliage spread (cm) of three groundnut varieties 74 days after sowing at Ladanawa, 1980.

	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±0.97)		Mean (±0.53)
	0	80	0	80	0	80	0	80	Moisture
	kg ha^{-1} Ca								
Throughout	18.50	17.75	20.00	18.50	24.00	20.00	20.83	18.75	19.79
Peak Flowering (6-10 wks)	18.50	17.50	20.50	20.00	23.75	18.75	20.92	18.75	19.83
Pod Develop. (9-13 wks)	17.50	18.50	19.00	19.75	24.25	18.50	20.25	18.92	19.67
No Stress	20.00	19.25	22.00	27.75	27.75	19.75	22.58	22.25	22.42
Mean (±1.37) Var. x Ca.	18.63	18.25	20.50	20.25	24.44	19.25			
Mean (±0.48) Var.	18.44		20.38		21.84				

Mean (±0.40) Ca = 21.19 at 0 kg ha^{-1} Ca
19.25 at 80 kg ha^{-1} Ca

* Significant differences at 5% level

Table 15. Mean effects of moisture stress and gypsum treatments on foliage spread (cm) of three varieties of groundnut 85 days after sowing at Ladanawa, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±4.71)		Mean (±2.12) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	56.75	27.00	44.00	37.25	41.00	35.50	47.25	33.25	40.25
Peak Flowering (6-10 wks)	29.00	50.75	68.75	50.00	43.75	43.75	57.17	48.17	47.67
Pod Develop. (9-13 wks)	46.50	47.75	52.00	48.00	45.25	42.50	47.92	46.08	47.00
No Stress	36.50	41.00	58.25	56.25	40.75	50.75	45.17	49.33	47.25
Mean (±6.67) Var. x Ca	42.19	41.63	55.75	47.88	42.69	43.13			
Mean (±2.40) Var.*	41.91		51.81		42.91				

Mean (±1.92)
Ca = 46.88 at 0 kg ha^{-1} Ca
44.21 at 80 kg ha^{-1} Ca

* Significant differences at 5% level

Table 16. Mean effects of moisture stress and gypsum treatment on foliage spread (cm) of three varieties of groundnut 101 days after sowing at Ladanawa, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±3.05)		Mean (±2.91) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	55.75	51.50	56.75	44.75	51.00	58.25	54.50	51.83	53.21
Peak Flowering (6-10 wks)	58.75	55.00	64.00	53.28	46.25	42.50	56.33	50.26	53.29
Pod Develop. (9-13 wks)	63.00	57.50	51.00	57.25	53.00	44.50	55.67	53.08	54.38
No Stress	56.50	57.00	43.25	55.25	64.75	66.75	55.00	59.67	57.83
Mean (±4.31) Var. x Ca	58.50	55.50	53.88	53.63	53.75	53.00			
Mean (±1.52) Var.	57.00		53.76		53.38				

Mean (±1.24)
Ca = 55.60 at 0 kg ha^{-1} Ca
53.71 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 17. Mean effects of moisture stress and gypsum treatments on foliage spread (cm) of three varieties of groundnuts 35 days after sowing at Ladanawa, 1981.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±2.82)		Mean (±2.44)
	0	80	0	80	0	80	0	80	Moisture
	kg ha^{-1} Ca								
Throughout	18.65	20.55	26.76	16.99	22.58	25.21	22.66	20.92	21.79
Peak Flowering (6-10 wks)	23.68	21.25	23.60	18.77	20.78	28.37	22.80	22.80	22.75
Pod Develop. (9-13 wks)	21.62	20.45	22.78	23.34	27.19	20.41	23.86	21.37	22.62
No Stress	19.60	14.78	22.18	30.34	25.05	24.89	22.28	23.34	22.81
Mean (±1.36) Var. x Ca.	20.89	19.26	23.83	22.36	23.9	24.73			
Mean (±0.96) Var.*	30.52		23.10		24.32				

Mean (±0.79)

Ca = 22.87 at 0 kg ha^{-1} Ca
22.12 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 18. Mean effects of moisture stress and gypsum treatments on foliage spread (cm of three varieties of groundnuts 50 days after sowing at Ladanawa, 1981.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±4.14)		Mean (±3.3 Moistu
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	29.53	33.25	32.80	34.58	35.80	37.31	32.71	35.05	33.88
Peak Flowering (6-10 wks)	39.1	36.6	36.33	33.12	34.51	46.08	34.98	38.60	36.75
Pod Develop. (9-13 wks)	32.30	32.35	38.86	31.16	45.88	33.78	39.01	32.43	35.72
No Stress	36.7	29.33	36.88	38.71	33.80	39.80	35.79	35.95	35.87
Mean (±1.89) Var. x Ca.	33.16	32.88	36.23	34.39	37.50	39.24			
Mean (±1.33) Var.*	33.02		35.31		38.37				

Mean (±1.09)

Ca = 35.63 cm at 0 kg ha^{-1} Ca
35.50 cm at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 19. Mean effects of moisture stress and gypsum treatments on foliage spread (cm) of three varieties of groundnuts 64 days after sowing at Ladanawa, 1981

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (+7.02)		Mean (±6.08)
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								Moisture
Throughout	48.28	40.90	49.44	44.35	56.78	49.29	51.50	44.86	48.18
Peak Flowering (6-10 wks)	44.65	53.64	36.58	51.34	42.02	53.13	41.08	52.70	46.89
Pod Develop. (9-13 wks)	46.28	36.25	56.25	44.82	55.29	48.27	52.61	43.11	47.86
No Stress	49.08	42.52	56.04	50.18	47.92	59.17	51.01	50.62	50.82
Mean (±2.52) Var. x Ca	47.07	43.34	49.58	47.67	50.50	52.47			
Mean (±1.79) Var.	45.21		48.63		50.99				

Mean (±1.46)

Ca = 49.05 cm at 0 kg ha^{-1} Ca
47.83 cm at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 20. Mean effects of moisture stress and gypsum treatments on foliage spread (cm) of three varieties of groundnuts 77 days after sowing at Laḍanawa, 1981.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±3.54)		Mean (±3.07) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	57.3	51.18	57.28	55.81	48.63	63.2	54.40	56.56	55.48
Peak Flowering (6-10 wks)	48.48	51.7	61.65	58.52	57.12	67.45	55.75	59.22	57.47
Pod Develop. (9-13 wks)	50.9	45.03	56.30	56.16	58.17	51.87	55.12	52.02	53.57
No Stress	58.05	40.03	65.30	61.48	72.34	70.14	65.23	57.22	61.23
Mean (±3.06) Var. x Ca.	53.68	44.99	60.13	57.87	59.07	63.92			
Mean (±2.17) Var.	50.34		59.0		61.50				

Mean (±2.77)
Ca = 57.63 at 0 kg ha^{-1} Ca
56.26 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 21. The mean effects of moisture stress and gypsum treatments of foliage spread (cm) of three groundnut varieties 90 days after sowing at Samaru, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±2.17)		Mean (±4.26)
	0	80	0	80	0	80	0	80	Moisture
	kg ha^{-1} Ca								
Throughout	31.82	33.68	36.10	29.77	31.61	35.07	33.18	32.84	33.01
Peak Flowering (6-10 wks)	31.06	31.32	28.77	28.92	27.73	28.04	29.19	29.43	29.31
Pod Develop. (9-13 wks)	30.30	33.20	25.87	32.90	34.7	34.17	30.29	33.42	31.86
No Stress	35.17	37.13	35.63	30.03	29.56	30.22	33.45	32.46	32.96
Mean (±1.88) Var. x Ca.	32.09	33.83	31.59	30.41	30.90	31.88			
Mean (±1.33) Var.*	32.96		31.00		31.39				

Mean (±1.09)
Ca. = 31.53 at 0 kg ha^{-1} Ca
32.04 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 22. The mean effects of moisture stress and gypsum treatments on foliage spread (cm) of three groundnut varieties 103 days after sowing at Samaru, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±1.68)		Mean (±2.69) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	31.33	32.20	25.53	29.19	23.30	32.83	26.72	31.41	29.07
Peak Flowering (6-10 wks)	29.17	34.46	32.73	28.72	30.72	30.17	30.88	31.12	31.00
Pod Develop. (9-13 wks)	35.43	38.87	30.50	30.37	31.10	28.43	32.34	32.56	32.45
No Stress	31.07	30.87	30.57	32.50	33.03	31.17	31.56	31.51	31.54
Mean (±1.45) Var. x Ca.	31.75	34.1	29.83	30.20	29.54	30.65			
Mean (±1.03) Var.*	32.93		30.01		30.10				

Mean (±0.84) Ca. = 30.37 at 0 kg ha^{-1} Ca
31.65 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 23. The Mean effects of moisture stress and gypsum treatments on foliage spread (cm) of three groundnut varieties 117 days after sowing at Samaru, 1980

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±2.37)		Mean (±3.86) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	35.23	43.82	28.27	38.82	45.57	45.40	36.36	42.68	39.52
Peak Flowering (6-10 wks)	43.43	54.10	43.77	50.80	45.00	43.12	44.07	49.34	46.71
Pod Develop. (9-13 wks)	40.47	40.37	46.15	47.50	39.70	45.80	42.11	44.56	43.33
No Stress	52.78	42.13	45.10	40.96	49.82	45.03	49.23	42.71	45.87
Mean (±2.05) Var. x Ca.	42.98	45.11	40.82	44.52	45.02	44.84			
Mean (±1.45) Var.*			44.04		42.67		44.93		

Mean (±1.18)
Ca. = 42.94 at 0 kg ha^{-1} Ca
44.82 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 24. The mean effects of moisture stress and gypsum treatments on foliage spread (cm) of three groundnut varieties 130 days after sowing at Samaru, 1980

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±3.034)		Mean (±6.50)
	0	80	0	80	0	80	0	80	Moisture
	kg ha^{-1} Ca								
Throughout	55.80	67.45	58.23	57.53	63.43	54.27	59.20	59.80	59.50
Peak Flowering (6-10 wks)	56.30	79.79	62.37	5187	67.10	58.27	61.92	63.31	62.62
Pod Develop. (9-13 wks)	60.57	54.30	66.87	54.37	62.50	62.67	63.31	57.11	60.21
No Stress	67.40	57.57	61.87	53.23	68.26	64.63	65.84	58.48	62.16
Mean (±2.89) Var. x Ca.	60.02	64.78	62.34	54.25	65.32	59.96			
Mean (±2.05) Var.*	62.40		58.30		62.64				

Mean (±1.67)
Ca. = 62.56 at 0 kg ha^{-1} Ca
59.66 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

3. Number of Vegetative Branches per Plant

There were no significant varietal differences in the number of vegetative brnahces per plant, except in 1981 at Ladanawa (Tables 25 - 27). In general, however, Yar Tsuguno had the most number of branches, followed by Spanish 205 except at Samaru where this later variety was surpassed by Samaru 61. The application of gypsum tended to promote the development of more branches, but the increases were not statistically significant.

Although the number of vegetative branches was not significantly affected by moisture stress, plants which were continuously supplied with additional water produced more branches than those dependent only on rainfall. None of the treatment interactions exerted any significant effect on the number of vegetative branches in all the trials.

B. POD DEVELOPMENT AND FILL

1. Number of Flower per Plant

Significant differences were observed between varieties i in number of flowers produced per plant in both locations, with Spanish 205 significantly producing the highest number of flowers (Tables 28 - 41). Differences between Samaru 61

Table 25. The mean effects of moisture stress and gypsum treatments on total number of vegetative branches of three groundnut varieties at Ladanawa, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (+2.5)		Mean (±1.3)
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	16.0	12.7	11.7	9.4	10.4	17.4	12.7	13.2	12.8
Peak Flowering (6-10 wks)	16.1	15.6	13.5	10.3	24.2	16.3	17.9	14.1	16.1
Pod Develop. (9-13 wks)	13.4	20.8	11.7	17.0	16.5	19.1	13. 9	19.0	16.4
No Stress	15.8	19.4	20.0	17.1	15.9	13.0	17.2	16.5	16.9
Mean (±3.5) Var. x Ca	15.3	17.1	14.2	13.5	16.8	16.5			
Mean (±1.2) Var.	16.2		13.8		16.6				

Mean (±1.0)
Ca = 15.4 at 0 kg ha^{-1} Ca
15.7 at 80 kg ha^{-1} Ca

*Significant differences at 5% level

Table 26. Mean effects of moisture stress and gypsum treatments on the total number of vegetative branches of three varieties of groundnuts at Ladanawa, 1981.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±1.48)		Mean (±1.29)
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								Moisture
Throughout	6.8	8.48	6.98	6.21	7.57	7.53	7.12	7.71	7.27
Peak Flowering (6-10 wks)	7.2	8.18	8.20	8.21	8.28	10.92	7.10	9.10	8.50
Pod Develop. (9-13 wks)	6.38	6.1	6.86	10.18	13.49	7.63	8.91	7.97	8.44
No Stress	7.43	7.19	9.48	9.33	9.53	9.78	8.15	8.77	8.46
Mean (±0.72) Var. x Ca.	6.95	7.49	8.63	8.48	9.22	8.97			
Mean (±0.51) Var.*	7.22		8.56		9.10				

Mean (±0.42)

Ca = 8.27 at 0 kg ha^{-1} Ca
8.31 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 27. The mean effects of moisture stress and gypsum treatments on the total number of vegetative branches of three groundnut varieties at Samaru, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (+0.99)		Mean (±1.4) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	10.4	9.6	14.1	14.3	12.9	12.4	12.5	12.1	12.3
Peak Flowering (6-10 wks)	9.0	11.3	7.5	11.0	13.2	13.8	9.9	12.0	11.0
Pod Develop. (9-13 wks)	13.1	13.2	13.3	15.8	13.4	14.7	13.3	14.6	13.9
No Stress	11.6	11.4	12.0	10.2	14.8	15.0	12.8	12.2	12.5
Mean (±0.9) Var. x Ca.	11.0	11.4	11.7	12.8	13.6	14.0			
Mean (±0.6) Var.*	11.2		12.3		13.8				

Mean (±0.5)
Ca. = 12.1 at 0 kg ha^{-1} Ca
12.7 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 28. Mean effects of moisture stress and gypsum treatments on the number of flower of three groundnut varieties produced on the 55th day after sowing at Ladanawa, 1980

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±3.2)		Mean (±1.1) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	45.5	19.0	2.0	3.3	1.0	3.0	16.2	8.4	12.3
Peak Flowering (6-10 wks)	21.8	31.0	10.0	4.8	3.8	4.0	11.8	13.3	12.5
Pod Develop. (9-13 wks)	16.3	36.8	7.0	10.8	4.8	3.3	9.3	16.9	13.1
No Stress	33.0	20.8	5.3	11.3	6.3	5.8	14.8	12.6	13.7
Mean (±4.5) Var. x Ca	26.9	27.7	7.5	6.1	3.9	3.9			
Mean (±1.6) Var.	27.3		6.8		3.9				

Mean (±1.3)

Ca = 25.50 at 0 kg ha^{-1} Ca
25.08 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 29. The mean effects of moisture stress and gypsum treatments on the number of flowers of three groundnut varieties produced on the 74th day after sowing at Ladanawa, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±2.3)		Mean (±1.4) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	29.5	13.3	8.0	12.5	3.0	10.3	13.5	12.0	12.6
Peak Flowering (6-10 wks)	21.8	20.5	7.5	23.5	10.0	17.3	13.1	20.4	16.7
Pod Develop. (9-13 wks)	20.0	26.3	28.3	13.3	12.8	7.5	20.3	15.7	18.0
No Stress	14.0	32.0	17.5	20.5	18.5	8.0	16.7	20.2	18.4
Mean (±3.96) Var. x Ca.*	21.3	23.0	15.3	17.4	11.1	10.3			
Mean (±1.4) Var.*	22.1		16.3		10.9				

Mean (±1.1)

Ca = 15.9 at 0 kg ha^{-1} Ca

17.1 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 30. Mean effects of moisture stress and gypsum treatments on flower number of three varieties of groundnuts produced on the 35th day after sowing at Ladanawa, 1981.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (+1.09)		Mean (±0.95 Moistur
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	2.48	2.78	3.55	3.75	3.97	3.44	3.33	3.32	3.33
Peak Flowering (6-10 wks)	2.98	3.48	4.03	4.73	2.19	2.98	3.07	3.73	3.30
Pod Develop. (9-13 wks)	3.65	2.35	3.77	2.80	2.42	4.06	3.28	3.07	3.18
No Stress	3.60	3.15	5.34	7.53	4.08	4.01	4.34	4.90	4.62
Mean (±0.49) Var. x Ca.	3.18	2.94	4.17	4.70	3.17	3.62			
Mean (±0.35) Var.*	3.18		4.44		3.40				

Mean (±0.28)

Ca = 3.51 at 0 kg ha^{-1} Ca
3.75 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 31 Mean effects of moisture stress and gypsum treatments on flower number of three varieties of groundnuts produced on the 50th day after sowing at Ladanawa, 1981.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±1.86)		Mean (±1.61) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	4.55	5.65	5.91	4.21	6.29	4.96	5.57	4.94	5.26
Peak Flowering (6-10 wks)	7.83	5.67	5.67	6.29	4.53	5.03	6.01	5.66	5.84
Pod Develop. (9-13 wks)	8.12	6.20	5.52	5.90	7.13	4.88	6.92	5.66	6.29
No Stress	7.10	6.03	4.59	4.23	5.09	7.81	5.59	6.02	5.81
Mean (±0.78) Var. x Ca.	6.90	5.89	5.42	5.16	5.75	5.67			
Mean (±0.55) Var.*	6.40		5.29		5.71				

Mean (±0.39)

Ca. = 6.00 at 0 kg ha^{-1} Ca
5.60 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 32. Mean effects of moisture stress and gypsum treatments on flower number of three varieties of groundnuts produced on the 64th day after sowing at Ladanawa, 1981.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±2.21)		Mean (±1.91) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	9.98	8.85	4.93	6.12	6.49	6.03	7.13	7.00	7.07
Peak Flowering (6-10 wks)	8.59	7.48	9.11	6.51	4.79	6.70	7.50	6.90	7.20
Pod Develop. (9-13 wks)	10.63	8.98	6.61	5.92	7.02	4.54	8.09	6.48	7.29
No Stress	7.13	17.90	5.34	7.81	4.63	4.34	5.70	9.98	7.84
Mean (±0.68) Var. x Ca.	9.08	10.78	6.50	6.59	5.73	5.40			
Mean (±0.48) Var.*	9.93		6.55		5.56				

Mean (±0.39)

Ca. = 7.10 at 0 kg ha^{-1} Ca
7.55 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 33 Mean effects of moisture stress and gypsum treatments on flower number of three varieties of groundnuts produced on the 77th day after sowing Ladanawa, 1981.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±6.05)		Mean (±5.24) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	25.45	20.33	12.43	11.32	13.49	17.19	17.12	16.28	16.70
Peak Flowering (6-10 wks)	23.65	26.70	13.86	11.43	16.99	16.63	18.07	18.25	18.16
Pod Develop. (9-13 wks)	30.25	25.20	20.50	13.08	21.60	14.71	24.12	17.66	20.89
No Stress	32.73	20.65	13.33	11.83	13.19	14.31	19.73	15.60	17.66
Mean (±1.88) Var. x Ca.	28.02	23.22	14.96	11.92	16.31	15.71			
Mean (±1.33) Var.	25.62		13.44		16.01				

Mean (±1.09)

Ca = 19.76 at 0 kg ha^{-1} Ca
16.95 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 34. The mean effects of moisture stress and gypsum treatments on groundnut flower number of three groundnut varieties produced on the 90th day after sowing at Samaru, 1980

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (+3.7)		Mean (±5.2)
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								Moisture
Throughout	24.0	22.6	17.0	15.6	11.7	15.1	17.6	17.8	17.7
Peak Flowering (6-10 wks)	16.0	14.9	9.5	8.9	16.6	15.3	14.0	13.0	13.5
Pod Develop. (9-13 wks)	20.4	12.3	5.2	18.9	6.0	20.3	10.5	17.2	13.8
No Stress	20.8	15.0	17.6	12.5	18.1	12.5	18.8	13.3	16.1
Mean (±3.2) Var. x Ca.	20.3	16.2	12.3	14.0	13.1	15.8			
Mean (±2.3) Var.*	18.3		13.1		14.5				

Mean (±1.9)
Ca. = 15.0 at 0 kg ha^{-1} Ca
15.3 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 35. The mean effects of moisture stress and gypsum treatments on flower number of three groundnut varieties produced on the 97th day after sowing at Samaru, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±2.6)		Mean (±2.9) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	15.4	21.8	10;0	9.8	9.7	9.5	11.7	13.7	12.7
Peak Flowering (6-10 wks)	11.7	18.5	6.9	6.0	8.3	7.4	9.0	10.6	9.8
Pod Develop. (9-13 wks)	29.7	22.3	3.9	14.3	7.0	7.7	13.5	14.8	14.1
No Stress	20.9	23.3	10.1	7.3	5.8	8.6	12.3	13.1	12.7
Mean (±2.5) Var. x Ca.	19.4	21.5	7.7	9.4	7.7	8.3			
Mean (±1.8) Var.*	20.5		8.5		8.0				

Mean (±1.4) Ca. = 11.6 at 0 kg ha^{-1} Ca
13.1 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 36. The mean effects of moisture stress and gypsum treatments on flower number of three groundnut varieties produced on the 103th day after sowing at Samaru, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (+1.6)		Mean (±3.4)
	0	80	0	80	0	80	0	80	Moisture
	kg ha^{-1} Ca								
Throughout	22.1	12.9	7.6	17.5	7.2	10.7	12.3	13.7	13.0
Peak Flowering (6-10 wks)	21.2	21.3	8.6	8.8	10.4	7.6	13.4	12.6	13.0
Pod Develop. (9-13 wks)	29.2	19.9	13.6	9.6	14.7	6.9	19.2	12.1	15.7
Nos Stress	29.7	27.7	10.7	7.9	8.2	6.6	16.2	14.1	15.1
Mean (±1.3) Var. x Ca.	25.6	20.5	10.1	11.0	10.1	8.0			
Mean (±0.9) Var.*									

Mean (±0.8)
Ca. = 15.3 at 0 kg ha^{-1} Ca
13.2 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 37. The mean effects of moisture stress and gypsum treatments on flower number of three groundnut varieties produced on the 110th day after sowing at Samaru, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±1.8)		Mean (±3.8) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	17.3	19.2	9.7	6.7	9.7	8.1	12.2	11.3	11.8
Peak Flowering (6-10 wks)	18.7	23.8	6.1	9.6	7.5	8.2	10.8	13.9	12.3
Pod Develop. (9-13 wks)	19.1	13.9	8.8	7.6	7.4	9.7	11.8	10.4	11.1
No Stress	17.2	15.4	7.1	10.3	5.7	5.7	10.0	10.5	10.2
Mean (±1.5) Var. x Ca.	18.1	18.1	7.9	8.6	7.6	7.9			
Mean (±1.1) Var.*	18.1		8.2		7.8				

Mean (±9.9) Ca. = 11.2 at 0 kg ha^{-1} Ca
11.5 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 38. The mean effects of moisture stress and gypsum treatments on flower number of three groundnut varieties produced on the 117th day after sowing at Samaru, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (1.4)		Mean (±4.0) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	8.8	8.0	7.3	8.6	8.9	7.9	8.3	8.2	8.3
Peak Flowering (6-10 wks)	11.1	18.0	8.0	8.1	5.2	9.9	8.1	12.0	10.1
Pod Develop. (9-13 wks)	11.3	15.2	7.5	8.7	10.9	5.3	9.9	9.7	9.8
No Stress	10.3	11.6	9.0	9.5	9.1	7.3	9.5	9.5	9.5
Mean (±1.2) Var. x Ca.	10.4	13.2	8.0	8.7	8.5	7.6			
Mean (±0.9) Var.*	11.8		8.4		8.1				

Mean (±0.7)
Ca. = 9.0 at 0 kg ha^{-1} Ca
9.8 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 39. The mean effects of moisture stress and gypsum treatments on flower number of three groundnut varieties produced on the 124th day after sowing at Samaru, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±1.8)		Mean (±4.3) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	10.3	15.6	10.6	8.5	11.6	12.9	10.8	12.3	11.6
Peak Flowering (6-10 wks)	16.2	16.7	15.3	16.4	13.1	14.8	14.9	16.0	15.4
Pod Develop. (9-13 wks)	16.7	16.9	22.2	13.0	16.5	16.8	18.5	15.6	17.0
No Stress	11.1	16.4	10.5	9.4	12.2	15.4	11.3	13.7	12.5
Mean (±1.5) Var. x Ca.	13.6	16.4	14.7	11.8	13.4	15.0			
Mean (±1.1) Var.*	15.0		13.3		14.2				

Mean (±0.9)

Ca. = 13.9 at 0 kg ha^{-1} Ca
14.4 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 40. The mean effects of moisture stress and gypsum treatments on flower number of three groundnut varieties produced on the 130th day after sowing at Samaru, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±1.2)		Mean (±2.7) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	10.4	4.8	5.9	5.8	5.7	7.8	7.3	6.1	6.7
Peak Flowering (6-10 wks)	7.8	14.7	7.0	6.00	6.6	11.5	7.1	10.7	8.9
Pod Develop. (9-13 wks)	5.0	8.0	7.5	5.9	6.5	7.9	6.3	7.3	6.8
No Stress	6.5	4.5	4.8	6.9	11.4	9.0	7.6	6.8	7.2
Mean (±1.0) Var. x Ca.	7.4	8.0	6.3	6.2	7.6	9.1			
Mean (±0.7) Var.	7.7		6.2		8.3				

Mean (±0.6) Ca. = 7.1 at 0 kg ha^{-1} Ca
7.8 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 41 Mean effects of moisture stress and gypsum treatments on the number of immature pods and unformed pegs of three grouhdnut varieties at Ladanawa, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±2.3)		Mea (±1. Moist
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	7.7	11.0	17.6	18.4	7.4	17.3	10.8	15.6	13.2
Peak Flowering (6-10 wks)	10.7	9.8	12.5	16.2	8.2	13.1	10.4	13.0	11.7
Pod Develop. (9-13 wks)	8.5	7.4	13.0	11.3	8.5	15.1	10.0	11.3	10.
No Stress	12.2	10.0	10.2	13.3	20.5	11.0	14.3	11.1	12.
Mean (±3.3) Var. x Ca.	9.8	9.3	13.3	14.8	11.1	14.1			
Mean (±1.2) Var.	9.5		14.1		12.7				

Mean (±0.9) Ca = 11.4 at 0 kg ha^{-1} Ca
12.7 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

and Yar Tsuguno were not significant, even though both varieties performed differently at different periods of observation. The application of gypsum increased the number of flowers produced except at 55 days after sowing at Ladanawa in 1980 and 64 and 77 days after sowing in 1981 where there was no effect.

In general, plots which received supplementary irrigation throughout the growth period produced plants with the highest numbers of flowers. Differences between the various moisture stress treatments were not significant at either location. At 74 days after sowing in 1980 at Ladanawa, Spanish 205 and Samaru 61 produced significantly more flowers than Yar Tsuguno when gypsum was applied. In 1981, however, the gypsum x moisture interaction improved the number of flowers produced per plant although, the magnitude was not significant.

2. Number of Immature Pods and Unformed Pegs per Plant

Whereas variety Samaru 61 had the highest number of immature pods and unformed pegs at Ladanawa in 1980, Spanish 205hadd the highest in 1981 at the same location and at Samaru in 1980 (Tables 42 - 44). However, differences were

Table 42. Mean effects of moisture stress and gypsum treatments on immature pods and unformed pegs number of three varieties of groundnuts at Ladanawa, 1981.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±6.16)		Mean (±5.34) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	56.03	61.00	45.5	33.01	40.20	50.58	47.24	48.23	47.74
Peak Flowering (6-10 wks)	6.20	67.55	37.60	33.98	62.92	44.18	35.57	48.57	42.07
Pod Develop. (9-13 wks)	59.58	66.23	46.58	37.54	53.17	47.28	53.11	50.35	51.73
No Stress	57.35	45.65	26.70	47.39	37.63	45.11	40.56	46.05	43.31
Mean (±4.54) Var. x Ca	58.79	60.11	39.10	37.98	48.48	39.31			
Mean (±3.21) Var.*	59.43		38.54		43.90				

Mean (±2.62)
Ca. = 48.77 at 0 kg ha^{-1} Ca
45.80 at 80 kg ha^{-1} Ca

* Significant Differences at 5% level.

Table 43. The mean effects of moisture stress and gypsum treatments on groundnut immature pods and unformed pegs number of three groundnut varieties at Samaru, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±9.6)		Mean (±10.8)
	0	80	0	80	0	80	0	80	Moisture
	kg ha^{-1} Ca								
Throughout	65.0	6.14	53.2	68.2	59.7	54.1	59.3	61.2	60.3
Peak Flowering (6-10 wks)	61.5	101.2	44.3	51.3	58.4	52.3	54.7	68.3	61.5
Pod Develop. (9-13 wks)	112.0	82.7	64.6	69.4	66.8	54.9	81.1	69.0	75.1
No Stress	81.4	64.5	54.5	54.3	58.7	51.3	58.2	56.7	62.5
Mean (±8.3) Var. x Ca.	80.0	77.5	54.2	60.8	63.4	53.2			
Mean (±5.9) Var.*	78.7		57.5		58.3				

Mean (±4.8)
Ca. = 65.9 at 0 kg ha^{-1} Ca
63.8 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 44. Mean effects of moisture stress and gypsum treatments on the number of pods per plant of three groundnut varieties at Ladanawa, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±16.8)		Mean (±6.2)
	0	80	0	80	0	80	0	80	Moisture
	kg ha^{-1} Ca								
Throughout	22.3	20.3	4.7	8.3	7.4	7.4	11.5	11.8	11.6
Peak Flowering (6-10 wks)	27.3	17.1	8.7	9.4	2.5	7.4	12.9	11.3	12.2
Pod Develop. (9-13 wks)	19.5	19.1	11.6	9.8	11.8	7.6	14.3	12.2	13.2
No Stress	27.3	34.4	5.8	18.9	7.9	7.5	13.7	20.2	17.2
Mean (±23.8) Var. x Ca	24.1	22.7	7.7	11.6	7.4	7.3			
Mean (±8.4) Var.	23.4		9.6		7.4				

Mean (±7.8)

Ca = 13.4 at 0 kg ha^{-1} Ca
13.8 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 45. Mean effects of moisture stress and gypsum treatments on the number of mature pods of three varieties of groundnuts at Ladanawa, 1981.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (+7.38)		Mean (±6.40) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	39.43	26.40	20.59	30.21	20.66	32.04	26.89	29.55	28.22
Peak Flowering (6-10 wks)	44.25	35.68	19.68	26.98	30.88	25.82	31.60	29.49	30.55
Pod Develop. (9-13 wks)	37.78	31.55	23.69	23.68	38.65	18.89	33.37	24.71	29.04
No Stress	35.40	30.28	28.55	19.58	16.16	33.72	26.70	27.86	27.28
Mean (±3.56) Var. x Ca	39.20	30.98	23.13	25.11	26.59	27.62			
Mean (±2.52) Var.*	54.69		24.12		27.11				

Mean (±2.07)
Ca. = 29.64 at 0 kg ha^{-1} Ca
27.90 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

significant only in respect of the Ladanawa results. Gypsum application generally improved pod formation, except in 1980 at Ladanawa when fewer immature pods and unformed pegs were formed per plant when gypsum was applied. The overall effect of gypsum was however, not significant.

Moisture treatments did not significantly affect the number of immature pods and unformed pegs. Plots that depended solely on rainfall had the highest number of immature pods and unformed pegs in 1980 at Ladanawa; in 1981 at the same location and at Samaru, plots from which additional water was withdrawn at pod development stage produced the highest number of immature pods and unformed pegs. Applying additional moisture throughout resulted in the least number of immature pods and unformed pegs. The various treatment interactions did not affect the number of immature pods and unformed pegs significantly.

3. Number of Pods per Plant

Significant differences in the number of pods existed between the three groundnut varieties tested, with Spanish 205 having the highest number in both years at Ladanawa. There were more pods produced per plant at Samaru with Samaru 61 followed by Yar Tsuguno and Spanish 205, in that

order (Tables 45 - 47). Differences between Samaru 61 and Yar Tsuguno at Ladanawa were not statistically significant.

Compared with unfertilised (control) plots, the application of 80kg Ca ha^{-1} in the form of gypsum increased the number of pods produced per plant, although the differences were not significant. Moisture treatments did not cause significant change in the number of pods per plant; however, plots which were irrigated throughout produced plants with the highest number of pods.

The various treatment interactions did not significantly affect the number of pods produced per plant, although the use of gypsum under stress conditions tended to supress the number of pods produced.

4. Number of Kernels per Plant

Spanish 205 produced the highest number of kernels per plant in both years at Ladanawa while at Samaru, Samaru 61 yielded the highest kernels, followed by Yar Tsuguno (Tables 48 - 50). Differences were, however, significant only in respect of Ladanawa; even at this location Samaru 61 and Yar Tsuguno were at par with each other. Applying gypsum at 80kg Ca ha^{-1} increased the number of kernels per plant although not significantly higher than in the control treatment.

Table 46 The mean effects of moisture stress and gypsum treatments on the number of mature pods of three groundnut varieties at Samaru, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±5.3)		Mean (±8.0) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	28.2	26.5	38.5	41.0	29.8	33.7	32.2	33.7	33.0
Peak Flowering (6-10 wks)	23.3	36.8	23.1	31.4	44.3	42.3	30.2	36.8	33.5
Pod Develop. (9-13 wks)	27.4	32.7	43.8	38.2	39.9	34.4	37.0	35.1	36.1
No Stress	36.3	33.1	42.0	44.3	36.0	33.7	38.1	37.0	37.6
Mean (±4.6) Var. x Ca.	28.8	32.3	36.9	38.7	37.5	36.0			
Mean (±3.2) Var.*	30.5		37.8		36.8				

Mean (±2. 7)

Ca. = 34.4 at 0 kg ha^{-1} Ca
35.7 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 47 The mean effects of moisture stress and gypsum treatments on kernels per plant (gm) of three groundnut varities at Ladanawa, 1980.

Moisture Stress	Sp. 0	Sp. 80	S. 61 0	S. 61 80	Y-Tsuguno 0	Y-Tsuguno 80	Moisture x Ca (±22.1) 0	Moisture x Ca (±22.1) 80	Mean (±9.2) Moisture
				kg ha^{-1} Ca					
Throughout	30.60	31.9	4.8	9.9	9.4	9.4	14.9	17.1	16.0
Peak Floweringg (6-10 wks)	25.4	14.0	13.6	2.8	8.0	8.0	18.9	15.7	17.8
Pod Develop. (9-13 wks)	29.8	29.9	16.1	16.3	12.6	16.3	10.8	20.7	19.2
No Stress	45.1	53.7	10.4	27.3	9.9	9.3	21.8	30.1	26.0
Mean (±31.3) Var. x Ca.	37.1	35.2	11.3	15.9	9.6	9.4			
Mean (±11.1) Var.*	36.2		13.6		9.5				

Mean (±9.0)

Ca = 19.33 at 0 kg ha^{-1} Ca
20.15 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 48. Mean effects of moisture stress and gypsum treatments on the yield of kernels (gm) per plant of three varieties of groundnuts at Ladanawa, 1981.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±2.42)		Mean (±2.09) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	16.64	8.4	6.77	12.49	8.69	12.86	10.7	11.25	10.98
Peak Flowering (6-10 wks)	28.35	16.10	6.91	11.60	12.54	11.60	15.93	13.10	14.52
Pod Develop. (9-13 wks)	15.67	11.15	6.94	8.28	15.62	8.46	12.74	9.30	11.02
No Stress	14.98	10.90	11.70	8.13	5.88	15.57	10.85	11.53	11.19
Mean (±1.62) Var. x Ca.	18.91	11.64	8.08	10.13	10.69	12.12			
Mean (±1.14) Var.*	15.28		9.10		11.41				

Mean (±0.93)
Ca. = 13.18 at 0 kg ha^{-1} Ca
19.39 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 49. The mean effects of moisture stress and gypsum treatments on kernel weight per plant (gm) of three groundnut varieties at Samaru, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (+3.05)		Mean (+8.00) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	9.17	4.17	21.06	20.51	19.79	14.38	16.67	13.02	14.85
Peak Flowering (6-10 wks)	10.32	12.87	18.95	18.01	26.54	17.04	18.60	15.97*	17.29
Pod Develop. (9-13 wks)	11.17	12.03	15.72	15.57	22.71	15.60	16.53	14.42	15.48
No Stress	5.25	8.36	23.49	32.51	26.12	27.47	18.29	22.78	20.54
Mean (±2.64) Var. x Ca.	8.98	9.36	19.81	21.65	23.79	18.64			
Mean (±1.87) Var.*	9.17		20.73		21.21				

Mean (±1.53)
Ca. = 17.53 at 0 kg ha^{-1} Ca
16.55 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 50. The mean effects of moisture stress and gypsum treatments on the shelling percentage of three groundnut varieties at Ladanawa, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (+22.1)		Mean (±9.2)
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	82.5	78.0	89.6	72.3	62.6	62.4	79.9	74.3	75.2
Peak Flowering (6-10 wks)	78.6	74.2	80.0	72.6	55.9	54.2	77.5	69.4	72.7
Pod Develop. (9-13 wks)	76.4	78.2	69.4	64.2	69.0	70.7	72.5	72.9	72.7
No Stress	68.6	78.8	50.5	59.8	63.2	70.0	65.0	72.7	68.9
Mean (±31.3) Var. x Ca.	64.5	77.5	73.3	68.4	64.7	64.2			
Mean (±11.1) Var.	72.2		67.9		64.4				

Mean (±9.0)

Ca = 67.5 at 0 kg ha^{-1} Ca
70.0 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Plants supplied with supplementary irrigation throughout produced the highest number of kernels while those which depended solely on rainfall had the least number. Withholding supplementary irrigation either at peak flowering stage or at pod development resulted in reduced kernels per plant. However, in 1981 at Ladanawa, plants subjected to stress at flowering yielded most. Except where gypsum was applied in plots supplied with moisture throughout, none of the other treatment interactions exerted any significant influence on the number of kernels produced per plant.

5. Shelling Percentage

Values of shelling percentage were highest in Spanish 205, followed by Samaru 61 and Yar Tsuguno, in that order at Ladanawa (Tables 51 - 53). However, at Samaru, Yar Tsuguno had the highest shelling percentage, followed by Samaru 61 and Spanish 205, in that order.

Application of gypsum tended to increase the shelling percentage, but not significantly. The application of additional moisture had little effect on shelling percentage in all the three varieties although moisture tended to increase the values of the shelling percentage.

Table 51. The mean effects of moisture stress and gypsum treatments on the shelling percentage of three varieties of groundnuts at Ladanawa, 1981.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±17.26)		Mean (±15.36) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	60.93	52.24	56.70	82.06	54.65	51.67	57.43	61.99	59.71
Peak Flowering (6-10 wks)	79.12	62.65	53.73	56.56	51.14	60.76	77.08	59.99	68.54
Pod Develop. (9-13 wks)	61.45	55.50	54.60	38.39	55.93	53.21	57.33	49.70	53.52
No Stress	7.79	57.67	46.34	65.94	47.69	73.73	37.27	65.18	51.53
Mean (±12.06) Var. x Ca.	67.17	57.02	52.64	60.74	52.35	59.84			
Mean (±10.22) Var.*	62.09		56.69		56.10				

Mean (±7.03)
Ca. = 50.50 at 0 kg ha^{-1} Ca
59.2 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 52. The mean effects of moisture stress and gypsum treatments on shelling percentage of three groundnut varieties at Samaru, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±4.00)		Mean (±7.03) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	60.65	34.61	57.10	54.93	65.25	63.68	61.00	51.04	56.02
Peak Flowering (6-10 wks)	55.93	46.46	56.13	49.13	60.77	40.04	57.61	45.29	51.45
Pod Develop. (9-13 wks)	24.46	25.60	36.16	38.16	58.22	45.92	39.67	36.56	38.12
No Stress	24.59	74.18	58.48	62.47	71.75	68.94	51.61	68.53	60.07
Mean (±3.00) Var. x Ca.	41.41	45.21	52.01	51.23	64.00	54.65			
Mean (±2.24) Var.*	43.31		51.62		59.32				

Mean (±1.92)

C_a. = 52.47 at 0 kg ha^{-1} Ca
50.36 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 53. The mean effects of moisture stress and gypsum treatments on haulm yield (kg ha^{-1}) of three varieties of groundnut at Ladanawa, 1980

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±340)		Mean (±211)
	0	80	0	80	0	80	0	80	Moisture
	kg ha^{-1} Ca								
Throughout	1600	2000	1750	3000	2750	3250	2033	2750	2392
Peak Flowering (6-10 wks)	2350	2875	3125	3000	2125	3500	2200	3125	2663
Pod Develop. (9-13 wks)	2525	2075	3000	2125	2167	4000	2564	2733	2704
No Stress	3875	2425	2000	3000	3375	4120	3083	3182	3132
Mean (± 170) Var. x Ca.	2588	2344	2219	2781	2604	3718			
Mean (± 481) Var.*	2466		2500		3203				

Mean (± 141.5)

Ca = 2498 at 0 kg ha^{-1} Ca
2948 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

The interaction of moisture and gypsum resulted in remarkable increases in the shelling percentages. Other treatment interactions had no appreciable effects on shelling percentage.

C. ECONOMIC YIELD

1. Haulm Yield

The variety Yar Tsuguno produced the highest haulm at Ladanawa, followed by Samaru 61 (Tables 54 - 56). At Samaru, Samaru 61 yielded the highest haulm, followed by Yar Tsuguno, with Spanish 205 producing the least haulm. Gypsum application resulted in considerable increase in the yield of haulm, with Yar Tsuguno responding most at both locations; however, Samaru 61 responded most at Ladanawa in 1980.

Generally plants subjected to stress throughout yielded least haulm, although there were no significant differences between the various moisture treatments. Gypsum x moisture interaction tended to increase haulm yield in plots receiving supplementary irrigation throughout; differences were not significant.

2. Pod Yield

Significant differences in pod yield existed between the three groundnut varieties tested, with Spanish 205 producing

Table 54. The mean effects of moisture stress and gypsum treatments on haulm yield (kg ha^{-1}) of three varieties of groundnuts at Ladanawa, 1981.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (±289.5)		Mean (±251) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	1175	800	2050	1475	1675	2400	1633	1558	1596
Peak Flowering (6-10 wks)	2395	1050	1900	2150	2325	2350	1833	1850	1842
Pod Develop. (9-13 wks)	1075	1050	1800	2450	1975	1875	1617	1779	1704
No Stress	1075	1300	1950	1525	1800	2425	1608	1750	1673
Mean (±156.25) Var. x Ca.	1148	1050	1925	1900	1945	2263			
Mean (±106.25) Var.*	1099		1913		2104				

Mean (±86.75)

Ca. = 1673 at 0 kg ha^{-1} Ca
1738 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 55. The mean effects of moisture stress and gypsum treatments on haulm yield (kg ha^{-1}) of three varieties of groundnuts at Samaru, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (+77.4)		Mean (±512) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	1120	1520	1040	1120	1040	960	1067	1200	1133
Peak Flowering (6-10 wks)	1040	1120	1840	2960	1200	1600	1360	1893	1627
Pod Develop. (9-13 wks)	1520	1040	1560	1120	1360	1600	1813	1245	1533
No Stress	1280	1200	1280	1200	1120	2240	1227	1547	1387
Mean (±208) Var. x Ca.	1040	1220	1680	1600	1180	1600			
Mean (±152) Var.*	1130		1640		1390				

Mean (±120)
Ca. = 1367 at 0 kg ha^{-1} Ca
1480 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 56. The mean effects of moisture stress and gypsum treatments on pod yield (kg ha^{-1}) of three varieties of groundnut at Ladanawa, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (133)		Mean (±57)
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								Moisture
Throughout	1515	1508	330	576	624	663	826	916	
Peak Flowering (6-10 wks)	1407	1477	1158	850	1067	796	1211	1041	
Pod Develop. (9-13 wks)	3056	1000	923	890	180	582	1053	826	
No Stress	2144	2444	681	1726	700	670	1175	1613	
Mean (±188) Var. x Ca.	1780	1609	775	1011	643	678			
Mean (± 66) Var.*	1695		893		661				

Mean (± 68)
Ca. = 1066 at 0 kg ha^{-1} Ca
1099 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

highest at Ladanawa and Samaru 61 at Samaru (Tables 57 - 59). Differences between Samaru 61 and Yar Tsuguno at Ladanawa were not statistically significant. The application of gypsum increased pod yield, although differences were not significant.

Moisture treatments did not cause significant change in pod yield although plots which were irrigated throughout produced highest. The various treatment interactions did not significantly affect pod production, although the use of gypsum under stress conditions tended to supress yield.

Table 57. The mean effects of moisture stress and gypsum treatments on pod yield (kg ha^{-1}) of three varieties of groundnuts at Ladanawa, 1981.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (+293)		Mean (±254) Moisture
	0	80	0	80	0	80	0	80	
	kg ha^{-1} Ca								
Throughout	1366	804	597	761	795	1245	919	937	928
Peak Flowering (6-10 wks)	1792	1285	643	1026	1226	955	1096	1081	1092
Pod Develop. (9-13 wks)	1278	1005	636	1079	1397	795	1103	9510	1031
No Stress	901	945	1263	626	617	1353	9395	915	1502
Mean (±137) Var. x Ca.	2067	1001	785	873	1001	1087			
Mean (±97) Var.*	1539		829		1044				

Mean (±79)
Ca. = 988 at 0 kg ha^{-1} Ca
1284 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

Table 58. The mean effects of moisture stress and gypsum treatments on pod yield (kg ha^{-1}) of three varieties of groundnuts at Samaru, 1980.

Moisture Stress	Sp. 205		S. 61		Y-Tsuguno		Moisture x Ca (+225)		Mean (±149)
	0	80	0	80	0	80	0	80	Moisture
	kg ha^{-1} Ca								
Throughout	605	482	1475	1494	1213	903	1098	9510	1029
Peak Flowering (6-10 wks)	738	1108	1350	1459	1747	1702	1278	1423	1351
Pod Develop. (9-13 wks)	1826	1871	1730	1632	1560	1360	1706	1625	1667
No Stress	854	694	1607	2082	1456	1864	1306	1548	1426
Mean (±195) Var. x Ca.	1006	1501	1667	1494	1458	1457			
Mean (±137) Var.*	1254		1604		1476				

Mean (±112)

Ca. = 13410 at 0 kg ha^{-1} Ca
1389 at 80 kg ha^{-1} Ca

* Significant differences at 5% level.

CHAPTER IV

DISCUSSION

In 1980 favourable weather conditions, particularly in terms of adequate rainfall, prevailed at Ladanawa such that moisture effects were probably not as fully expressed as if rainfall was inadequate. Growth of the crop was luxiriant even though it was mildy infested by aphids at about four weeks after sowing - and controlled using pirimor at 1 litre per hectare.

Because the trial at Samaru was planted during the dry season (December 1980) germination took about 35 days and the plants remained small in size for some time as a result of low temperatures. It was difficult to maintain the recommended population of 47,000 plants primarily because of the cold Harmattan temperatures prevailing during the period November - February. With the onset of warmer weather in March the crop grew vigorously. However, an incident of rodents attack further affected the plant-stand.

The trial planted under irrigation during the 1981 dry season (April) at Ladanawa germinated poorly probably due

to prevailing high temperatures between April and May. But with the onset of rains in June the crop grew well.

A. VEGETATIVE GROWTH AND DEVELOPMENT

Plant height, foliage spread and the number of vegetative branches per plant were the parameters used for the measurement of vegetative growth. In general treatments which result in early vegetative growth are more likely to yield better than when initial growth is limited.

i) Varietal differences

Spanish 205 was the tallest variety in all trials, followed by Yar Tsugune and Samaru 61, in that order. In terms of foliage spread, Samaru 61 had the widest foliage cover except at Samaru where Yar Tsuguno was the widest. Yar Tsuguno had the highest number of vegetative branches in all the trials. Differences between varieties were significant for height and cover of foliage and probably genetically controlled. For example, as an early maturing and genetically improved variety, Spanish 205 made relatively little vegetative growth compared with Samaru 61 and Yar Tsuguno over the reproductive phase and had more of its dry matter diverted into reproductive growth. This seem a

highly desireable characteristics in the sense that it ensured high efficiency in converting available growth into the economically important component. Although Samaru 61 is also an improved variety, the fact that it is late-maturing and spreading were probable reasons for its shorter plant height and greater foliage cover compared with Spanish 205.

That Yar Tsuguno had more foliage cover than Samaru 61 at Samaru could be explained in terms of their ecological adaptation. Whereas Samaru 61 is a variety recommended for the Sudan savanna zone (Ladanawa area), it is probably not as adaptive in the Northern Guinea zone, including the Samaru area. That Yar Tsuguno had greater numbers of vegetative branches than Samaru 61 probably explains the greater foliage cover relative to the other varieties.

ii) Effects of moisture

The application of supplementary irrigation to both trials in Ladanawa increased the amount of vegetative growth as measured by height, foliage cover and number of vegetative branches per plant. This is in line with the findings of Gillier (1972). There were significant increases in the heights and foliage cover of the groundnuts at Ladanawa in

1980; increases in 1981 were only slight and not statistically significant. In terms of the number of branches produced, the increases recorded were not significant in both trials.

At Samaru measurements of vegetative growth and development were inconsistent. The different stress treatment did not significantly affect the vegetative growth and development of the plants. Stress was found to have no significant effect on plant height, foliage cover and number of vegetative branches per plant. The reason may probably be the difficulty in the accurate control of water application.

iii) Effects of gypsum

It was observed that in all trials both at Ladanawa and Samaru, gypsum increased plant height and the number of branches per plant, but reduced the foliage cover. In a series of experiments conducted under screen-house conditions by Balasubramanian and Yayock (1981) they found that the dry weights of total plant tissue was not significantly increased by gypsum application. Indeed, their finding showed a reduction in the weight of this variable with application of gypsum.

iv) Treatment interactions

The only treatment interaction that significantly affected the vegetative growth and development of groundnuts was that between moisture and fertiliser gypsum. Results show that in all trials and at both locations moisture x gypsum interaction increased vegetative growth and development in all groundnut varieties. There tended to be decreased growth in plots where plants were subjected to stress throughout even though they were supplied with gypsum at 80kg Ca ha^{-1}. Increased vegetative growth was found where adequate moisture was supplied in the presence of gypsum. This shows the importance of adequate moisture for the desolution and making available the nutrient elements to plants for absorption as reported by Russell (1959).

B. POD DEVELOPMENT AND FILL

i) Varietial differences

At Ladanawa, Spanish 205 produced the highest number of flowers per plant, the lowest number of immature pods and unformed pegs, the highest number of pods per plant and the highest shelling percentage. The high-yielding traits exhibited by this variety could be attributed to its higher genetic make up relative to Yar Tsuguno.

In contrast, Spanish 205 had the lowest number of pods per plant and the lowest pod-fill as measured by shelling percentage at Samaru. This apparent difference in the behaviour of the variety is probably abnormal although the incident of rodent attack at Samaru probably caused relatively more damage to Spanish 205, being an early-maturing variety.

ii) Effects of moisture

In all trials the availability of adequate moisture was observed to increase pod development and fill whilst water-stress conditions resulted in poor pod development and fill. It was also observed that the adverse effect of water stress was acute in those plants to which supplementary irrigation was withdrawn at the period of peak pod development. This is in line with the screen-house findings of Balasubramanian and Yayock (1981).

iii) Effects of gypsum

Gypsum alone only slightly improved pod development and fill. In most cases its application without adequate moisture reduced the amount of pod development and fill; but where adequate moisture was supplied pods developed better.

iv) Treatment interactions

The only treatment interaction that gave significant increases in the attributes measured for the pod development and fill is the moisture x gypsum interaction. It was observed that gypsum in the presence of adequate moisture did improve the development and fill of pods at both locations in all the trials, but the reverse is true under stress conditions. This is in line with the findings of Russell (1959). This implies that in the presence of adequate moisture, the availability of calcium in the soil increases.

ECONOMIC YIELD

The disparity in haulm and pod yields as a result of location could be attributed ecological adaptation. At Ladanawa, the local variety Yar Tsuguno yielded more haulm and Spanish 205 yielded more pods than any of the other varieties. Samaru 61 yield more pods and haulm at Samaru than the two varieties. At both locations the application of gypsum generally improved the yield of haulm and pods, thus indicating the importance of adequate available calcium in the economic yield.

The presence of adequate amounts of moisture and its interaction with gypsum also improved the yield of both haulm and pods at both sites. Balasubramanian and Yayock (1981) have also reported a reduction of haulm, pod and kernel yields as a result of moisture stress. They emphasised that adverse effects of moisture deficient were more severe on pod and kernel yields than on the production of haulm and total dry matter.

PRACTICAL IMPLICATION OF STUDY

From the results of the present study, it might be inferred that applying fertiliser gypsum alone without adequate moisture would not normally reduce or eliminate the occurrences of blindnuts. Since the areas where the problem of blindnut is most acute are those also experiencing most annual problems of rainfall inadequacy and for uncertainty, one of the practical means of combating high incidences of blindnut occurrences is by conserving what little amount of water that falls in the form of rains. The conservation of water could be in terms of damming as much of that amount that would normally be lost in the form of run-off and this can be utilised in supplementing that received as rainfall.

Watermight also be conserved by applying such crop management practices as mulching. Crop residues such as cereals stalks, grasses and groundnut shells could be spread on groundnut fields, although the value of such materials as livestock feed is recognised as limiting their use for moisture conservation. Additional benefits to be derived by conserving moisture in this way would include control of weeds, lowering of soil temperatures and a reduction of soil erosion. It is necessary, however, that the feasibility of increasing moisture availability and hence availability of soil nutrients to groundnuts under dry Sudan savanna conditions would need to be field-tested before it is embarked upon by the generality of farmers.

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Appendix 1. Analysis of variance table for groundnut plant height (cm) 55 days after sowing at Ladanawa, 1980

Source of variation	DF	SS	MS	F
Replications	3	70.21	23.40	-
Moisture stress	3	141.21	41.07	2.80^{NS}
ERROR (A)	9	150.41	16.71	-
Calcium	1	189.85	189.85	5.52*
Variety	2	702.16	351.08	10.20*
Calcium x variety	2	24.18	12.09	0.35^{NS}
Moisture stress x calcium x variety	15	774.34	51.62	1.50^{NS}
ERROR (B)	60	2064.63	34.41	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences

NOTE

DF = Degree of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 2. Analysis of variance table for groundnuts plant height (cm) 74 days after sowing at Ladanawa, 1980

Source of variation	DF	SS	MS	F
Replications	3	970.00	323.33	-
Moisture stress	3	184.00	61.33	1.546^{NS}
ERROR (A)	9	357.00	39.67	-
Calcium	1	857.71	857.71	11.158*
Variety	2	609.31	304.66	3.772*
Calcium x variety	2	311.73	155.87	1.986^{NS}
Moisture stress x calcium x variety	15	1016.00	67.73	0.863^{NS}
ERROR (B)	60	4709.00	78.48	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences

NOTE:

DF = Degress of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 3. Analysis of variance table for groundnuts plants height (cm) 85 days after sowing at Ladanawa, 1980

Source of variation	DF	SS	MS	F
Replications	3	160.00	53.00	-
Moisture stress	3	363.00	121.00	8.38*
ERROR (A)	9	130.00	14.44	-
Calcium	1	33.37	33.37	0.452^{NS}
Variety	2	980.83	490.41	6.645*
Calcium x variety	2	47.66	23.83	0.323^{NS}
Moisture stress x calcium x variety	15	256.84	85.61	1.159^{NS}
ERROR (B)	60	266.46	44.41	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 4. Analysis of variance table for groundnuts plant height (cm) 101 days after sowing at Ladanawa, 1980

Source of variation	DF	SS	MS	F
Replications	3	69.50	23.17	-
Moisture stress	3	143.00	47.67	2.09^{NS}
ERROR (A)	9	205.00	22.78	-
Calcium	1	72.38	72.38	3.676^{NS}
Variety	2	549.13	274.57	13.94*
Calcium x variety	2	249.62	124.81	6.339*
Moisture stress x calcium x variety	15	480.64	80.11	4.068*
ERROR (B)	60	1181.50	19.11	-
Total	95			

* = Significant difference at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 5. Analysis of variance table for groundnuts foliage spread (cm) 55 days after sowing at Ladanawa, 1980

Source of variation	DF	SS	MS	F
Replications	3	42.20	14.10	-
Moisture stress	3	20.40	6.80	1.85^{NS}
ERROR (A)	9	33.10	3.68	-
Calcium	1	2.42	2.42	0.42^{NS}
Variety	2	375.63	187.81	32.72^{*}
Calcium x variety	2	21.21	10.60	1.85^{NS}
Moisture stress x calcium x variety	15	96.80	6.45	1.12^{NS}
ERROR (B)	60	344.20	5.74	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 6. Analysis of variance table for groundnut foliage spread (cm) 74 days after sowing at Ladanawa, 1980

Source of variation	DF	SS	MS	F
Replications	3	36.63	12.21	-
Moisture stress	3	60.00	20.00	2.999^{NS}
ERROR (A)	9	60.00	6.67	-
Calcium	1	90.09	90.09	12.012*
Variety	2	186.81	93.41	12.454*
Calcium x variety	2	126.82	63.41	8.455*
Moisture stress x calcium x variety	15	20.95	1.93	0.257^{NS}
ERROR (B)	60	499.22	7.50	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degress of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 7. Analysis of variance table for groundnut foliage spread (cm) 85 days after sowing at Ladanawa, 1980

Source of variation	DF	SS	MS	F
Replications	3	649.00	216.33	-
Moisture stress	3	902.00	300.69	2.79^{NS}
ERROR (A)	9	968.00	107.56	-
Calcium	1	170.67	170.67	0.96^{NS}
Variety	2	1903.52	951.76	5.35*
Calcium x variety	2	164.76	82.38	0.927^{NS}
Moisture stress x calcium x variety	15	1908.78	318.13	1.789^{NS}
ERROR (B)	60	10665.6	177.76	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 8. Analysis of variance table for groundnut foliage spread (cm) 101 days after sowing at Ladanawa, 1980

Source of variation	DF	SS	MS	F
Replication	3	453.00	151.00	-
Moisture stress	3	888.00	296.00	1.44^{NS}
ERROR (A)	9	1842.00	205.00	-
Calcium x variety	2	260.00	552.00	0.6997^{NS}
Moisture stress x calcium x variety	15	2024.00	134.90	1.82^{NS}
ERROR (B)	60	4459.00	74.32	-
Total	95			

NS = No significant differences.

NOTE:

DF = Degress of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 9. Analysis of variance table for groundnut branch number per plant at Ladanawa, 1980

Source of variation	DF	SS	MS	F
Replications	3	612.49	204.17	-
Moisture stress	3	191.61	63.87	1.695^{NS}
ERROR (A)	9	339.17	37.69	-
Calcium x variety	5	120.38	40.13	0.82^{NS}
Moisture stress x calcium x variety	15	709.86	78.87	1.61^{NS}
ERROR (B)	60	1762.08	48.95	-
Total	95			

NS = No significant differences.

NOTE:

DF = Degress of freedom
SS = Sum of squares
MS = Mean sum of squares
F = F-Test value.

Appendix 10. Analysis of variance table for groundnut flower number per plant produced on the 55th day after sowing at Ladanawa, 1980

Source of variation	DF	SS	MS	F
Replications	3	586.00	198.67	-
Moisture stress	3	11	3.67	0.13^{NS}
ERROR (A)	9	253.00	28.11	-
Calcium	1	1.00	1.00	0.012^{NS}
Variety	2	10416.00	5208.00	64.77*
Calcium x variety	2	21.40	10.20	0.13^{NS}
Moisture stress x calcium x variety	15	734.00	244.67	3.015^{NS}
ERROR (B)	60	4869.00	81.15	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences.

NOTES:

DF = Degress of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 11. Analysis of variance table for groundnut flower number per plant 74 days after sowing at Ladanawa, 1980

Source of variation	DF	SS	MS	F
Replications	3	250.40	83.50	-
Moisture stress	3	506.60	168.90	3.32^{NS}
ERROR (A)	9	450.80	50.10	-
Calcium	1	35.04	35.04	0.558^{NS}
Variety	2	1991.81	995.91	15.866*
Calcium x variety	2	27.89	13.95	0.222^{NS}
Moisture stress x calcium x variety	15	196.98	32.83	0.523^{NS}
ERROR (B)	60	3766.2	62.77	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 12. Analysis of variance table for groundnut unformed peg number per plant at Ladanawa, 1980

Source of variation	DF	SS	MS	F
Replication	3	299.55	99.85	-
Moisture stress	3	99.00	33.00	0.88^{NS}
ERROR (A)	9	337.30	37.48	-
Calcium x variety	3	131.33	43.78	1.04^{NS}
Moisture stress x calcium x variety	9	623.30	69.26	1.62^{NS}
ERROR (B)	36	1539.47	42.76	-
Total	63			

NS = No significant differences

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 13. Analysis of variance table for groundnut mature pods number per plant at Ladanawa, 1980

Source of variation	DF	SS	MS	F
Replication	3	2778.00	2426.00	-
Moisture stress	3	46043.00	15348.00	16.76*
ERROR (A)	9	3243.00	916.00	-
Calcium	1	472.00	472.00	0.21^{NS}
Variety	2	474208.50	237104.00	105.02*
Calcium x variety	2	7352.50	3676.25	1.63^{NS}
Moisture stress x calcium x variety	15	44282.9	7380.48	3.27*
ERROR (B)	60	135466	2257.8	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of square

F = F-Test value.

Appendix 14. Analysis of variance table for groundnuts haulm yield (kg) per hectare at Ladanawa, 1980

Source of variation	DF	SS	MS	F
Replication	3	5922.50	1974.17	-
Moisture stress	3	67720.90	22573.63	2.12^{NS}
ERROR (A)	9	95719.10	10635.46	-
Calcium	1	48600.00	4860.00	5.25*
Variety	2	110877.00	55438.50	5.994*
Calcium x variety	2	226021.00	113010.50	12.22*
Moisture stress x calcium x variety	15	171204.10	11413.61	1.23^{NS}
ERROR (B)	60	554908.40	9248.47	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degress of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 15. Analysis of variance table for groundnuts pod yield (kg) per hectare at Ladanawa, 1980

Source of variation	DF	SS	MS	F
Replications	3	2138.07	712.69	-
Moisture stress	3	20403.53	6801.18	15.44*
ERROR (A)	9	3964.52	440.50	-
Calcium	1	149.22	149.22	0.187^{NS}
Variety	2	105958.46	52979.23	66.31*
Calcium x variety	2	3737.37	1868.69	2.34^{NS}
Moisture stress x calcium x variety	15	1984.16	3307.86	4.14*
ERROR (B)	60	47936.41	798.94	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 16. Analysis of variance table for groundnuts kernel yield per plant at Ladanawa, 1980 (gm)

Source of variation	DF	SS	MS	F
Replication	3	19676.00	6558.67	-
Moisture stress	3	135468.00	45156.00	22.34*
ERROR (A)	9	18191.00	2021.3	-
Calcium x variety	5	1340013.90	268002.78	68.51*
Moisture stress x calcium x variety	15	272890.00	18192.66	4.65*
ERROR (B)	60	234701.40	3911.69	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 17. Analysis of variance table for groundnuts shelling percentages at Ladanawa, 1980

Source of variation	DF	SS	MS	F
Replication	3	299.55	99.85	-
Moisture stress	3	99.00	33.00	0.83^{NS}
ERROR (A)	9	337.30	37.48	-
Clacium x variety	3	131.33	43.78	1.04^{NS}
Moisture stress x calcium variety	9	623.30	69.26	1.62^{NS}
ERROR (B)	36	1539.47	42.76	-
Total	63			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 18. Analysis of variance for plant height 35 days after sowing at Ladanawa, 1981

Source of variation	DF	SS	MS	F
Replications	3	11.30	3.767	-
Moisture stress	3	37.38	12.46	2.265^{NS}
ERROR (A)	9	49.58	5.5	-
Calcium	1	7.21	7.21	1.08^{NS}
Variety	2	65.93	32.97	4.94*
Calcium x variety	2	6.48	3.24	0.485^{NS}
Moisture stress x calcium x variety	6	65.52	10.92	1.637^{NS}
ERROR (B)	60	400.11	6.67	NS
Total	95			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 19. Analysis of variance table for plant height 50 days after sowing at Ladanawa, 1981

Source of variation	DF	SS	MS	F
Replications	3	2.72	0.91	-
Moisture stress	3	17.86	5.95	0.566^{NS}
ERROR (A)	9	96.19	10.69	-
Calcium	1	0.005	0.005	0.00034^{NS}
Variety	2	261.30		8.92*
Calcium x variety	2	327.52	65.50	2.26^{NS}
Moisture stress x calcium x variety	6	222.45	14.829	1.01^{NS}
ERROR (B)	60	879.23	14.64	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 20. Analysis of variance table for plant height 64 days after sowing at Ladanawa, 1981.

Source of variation	DF	SS	MS	F
Replications	3	132.86	44.29	-
Moisture stress	3	356.00	118.67	1.30^{NS}
ERROR (A)	9	818.53	90.95	-
Calcium	1	10.93	10.93	0.05^{NS}
Variety	2	949.32	474.66	2.20^{NS}
Calcium x variety	2	51.63	25.82	0.12^{NS}
Moisture stress x calcium x variety	6	2278.80	379.80	1.77^{NS}
ERROR (B)	60	12906.00	215.00	-
Total	95			

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 21. Analysis of variance for groundnuts height 77 days after sowing at Ladanawa, 1981

Source of variation	DF	SS	MS	F
Replications	3	808.23	269,41	-
Moisture stress	3	626.17	208.72	1.25^{NS}
ERROR (A)	9	1500.92	166.77	-
Calcium	1	6.28	6.28	0.06^{NS}
Variety	2	214.27	107.14	1.04^{NS}
Calcium x variety	2	137.89	68.95	0.66^{NS}
Moisture stress x calcium x variety	6	748.21	124.70	1.21^{NS}
ERROR (B)	60	6178.24	102.97	-
Total	95			

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 22. Analysis of variance for groundnut spread 35 days after sowing at Ladanawa, 1981

Source of variation	DF	SS	MS	F
Replications	3	43.59	14.53	-
Moisture stress	3	5.45	1.82	0.0765^{NS}
ERROR (A)	9	214.16	23.79	-
Calcium	1	3.18	3.18	0.107^{NS}
Variety	2	294.52	147.26	4.76*
Calcium x variety	2	40.53	20.27	0.675^{NS}
Moisture stress x calcium x variety	6	862.59	143.77	4.844^{NS}
ERROR (B)	60	1780.88	29.68	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 23. Analysis of variance table for groundnuts spread 50 days after sowing at Ladanawa, 1981

Source of variation	DF	SS	MS	F
Replications	3	3.00	1.00	-
Moisture stress	3	105.00	35.00	0.68^{NS}
ERROR (A)	9	463.00	51.46	-
Calcium	1	1.00	1.00	0.0175^{NS}
Variety	2	458.00	229.00	4.026^{NS}
Calcium x variety	2	68.00	34.00	0.597^{NS}
Moisture stress x calcium x variety	6	980.00	163.33	2.87^{NS}
ERROR (B)	60	3412.00	46.87	-
Total	95			

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 24. Analysis of variance table for groundnut spread 64 days after sowing at Ladanawa, 1981

Source of variation	DF	SS	MS	F
Replications	3	765.00	255.00	-
Moisture stress	3	204.00	68.00	0.459^{NS}
ERROR (A)	9	1331.00	148.00	-
Calcium	1	50.00	50.00	0.49^{NS}
Variety	2	625.00	312.50	3.06*
Calcium x variety	2	120.00	60.00	0.588^{NS}
Moisture stress x calcium x variety	6	2492.00	166.00	1.627^{NS}
ERROR (B)	60	6125.00	102.00	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 25. Analysis of variance table for groundnuts spread (cm) 77 days after sowing at Ladanawa, 1981

Source of variation	DF	SS	MS	F
Replications	3	1687.00	562.33	-
Moisture stress	3	862.00	287.00	7.632*
ERROR (A)	9	338.00	37.60	-
Calcium	1	146.00	146.00	0.973^{NS}
Variety	2	2297.00	1148.5	7.656*
Calcium x variety	2	442.00	221.00	1.47^{NS}
Moisture stress x calcium x variety	6	1766.00	294.3	1.96^{NS}
ERROR (B)	60	9003.00	150.00	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 26. Analysis of variance table for groundnut number of vegetative branches at Ladanawa, 1981

Source of variation	DF	SS	MS	F
Replications	3	68.95	22.98	-
Moisture stress	3	26.19	8.73	1.32^{NS}
ERROR (A)	9	57.45	6.61	-
Calcium	1	2.08	2.08	0.248^{NS}
Variety	2	56.15	28.04	3.34*
Calcium x variety	2	3.58	1.79	0.213^{NS}
Moisture stress x calcium x variety	6	175.68	29.28	3.49^{NS}
ERROR (B)	60	502.77	8.38	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 27. Analysis of variance table for groundnuts flower number 35 days after sowing at Ladanawa, 1981

Source of variation	DF	SS	MS	F
Replications	3	53.75	17.92	-
Moisture stress	3	9.64	3.21	0.89^{NS}
ERROR (A)	9	32.47	3.61	-
Calcium	1	0.26	0.26	0.068^{NS}
Variety	2	11.63	5.82	1.522^{NS}
Calcium x variety	2	4.14	2.07	0.542^{NS}
Moisture stress x calcium x variety	6	41.84	6.97	1.825^{NS}
ERROR (B)	60	229.16	3.82	-
Total	95			

NS = No significant differences.

NOTE:

DF = Degrees of freedome

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 28. Analysis of variance table for groundnuts flower number 50 days after sowing at Ladanawa, 1981

Source of variation	DF	SS	MS	F
Replications	3	73.24	24.41	-
Moisture stress	3	18.83	6.28	0.605^{NS}
ERROR (A)	9	93.30	10.37	-
Calcium	1	2.89	2.89	0.296^{NS}
Variety	2	161.90	80.50	8.26*
Calcium x variety	2	3.20	1.60	0.164^{NS}
Moisture stress x calcium x variety	6	101.21	16.87	1.731^{NS}
ERROR (B)	60	584.41	9.74	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 29. Analysis of variance table for groundnuts flower number 64 days after sowing at Ladanawa, 1981

Source of variation	DF	SS	MS	F
Replications	3	158.14	52.71	-
Moisture stress	3	12.82	4.27	0.292^{NS}
ERROR (A)	9	131.60	14.62	-
Calcium	1	4.92	4.92	0.666^{NS}
Variety	2	19.90	9.95	1.348^{NS}
Calcium x variety	2	3.87	1.94	0.262^{NS}
Moisture stress x calcium x variety	6	78.76	12.13	1.779^{NS}
ERROR (B)	60	442.84	7.38	-
Total	95			

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 30. Analysis of variance table for groundnuts flowers number 77 days after sowing at Ladanawa, 1981

Source of variation	DF	SS	MS	F
Replications	3	3114.00	1038.80	-
Moisture stress	3	288.00	77.67	0.707^{NS}
ERROR (A)	9	987.00	109.7	-
Calcium	1	191.00	191.00	3.347*
Variety	2	2641.00	1320.5	23.33*
Calcium x variety	2	71.00	35.5	0.627^{NS}
Moisture stress x calcium x variety	6	486.00	81.00	1.431^{NS}
ERROR (B)	60	3396.00	56.6	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 31. Analysis of variance table for groundnut number of immature pods and unformed pegs per plant at Ladanawa, 1981

Source of variation	DF	SS	MS	F
Replications	3	4442.00	1480.67	-
Moisture stress	3	1150.00	383.00	3.36^{NS}
ERROR (A)	9	1024.00	114.00	-
Calcium	1	0.00	-	-
Variety	2	7328.00	3664.00	11.1*
Calcium x variety	2	37.00	18.50	0.06^{NS}
Moisture stress x calcium x variety	6	3295.00	549.17	1.66^{NS}
ERROR (B)	60	19898.00	330.00	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 32. Analysis of variance of groundnuts haulm yield at Ladanawa, 1981 (kg ha^{-1})

Source of variation	DF	SS	MS	F
Replications	3	14812.00	4937.33	-
Moisture stress	3	7503.00	2501.00	0.995^{NS}
ERROR (A)	9	22609.00	2512	-
Calcium	1	1001.00	1001.00	0.277^{NS}
Variety	2	181627.00	98813	25.17*
Calcium x variety	2	7977.00	3988.5	1.105^{NS}
Moisture stress x calcium x variety	6	45041.00	7506.83	2.08^{NS}
ERROR (B)	60	216504.00	3608	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 33. Analysis of variance table for groundnut pod pods yields at Ladanawa, 1981 (kg ha^{-1})

Source of variation	DF	SS	MS	F
Replications	3	595.00	198.67	-
Moisture stress	3	125.00	41.67	0.251^{NS}
ERROR (A)	9	1472.00	163.50	-
Calcium	1	80.00	80.00	0.394^{NS}
Variety	2	2102.00	1051.00	5.177*
Calcium x variety	2	497.00	248.50	1.224^{NS}
Moisture stress x calcium x variety	6	2425.00	404.17	1.990^{NS}
ERROR (B)	60	12209.00	203.00	-
6				
Total	95			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 34. Analysis of variance table for the weight of kernels (gm) per plant of three varieties of groundnuts at Ladanawa, 1981

Source of variation	DF	SS	MS	F
Replications	3	124.42	41.47	-
Moisture stress	3	93.90	31.30	1.782^{NS}
ERROR (A)	9	158.01	17.56	-
Calcium	1	28.49	28.49	0.682^{NS}
Variety	2	435.59	217.79	5.22*
Calcium x variety	2	227.98	113.99	2.73^{NS}
Moisture stress x calcium x variety	6	535.62	89.27	2.138^{NS}
ERROR (B)	60	2505.14	41.75	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 25. Analysis of variance table for groundnuts shelling percentages at Ladanawa, 1981

Source of variation	DF	SS	MS	F
Replication	3	4442.00	-	-
Moisture stress	3	1150.00	383.00	3.359^{NS}
ERROR (A)	9	1024.00	114.00	-
Calcium	1	0.00	-	-
Variety	2	7328.00	3664.00	11.103*
Calcium x variety	2	37.00	18.50	0.056^{NS}
Moisture stress x calcium x variety	6	3295.00	549.17	1.664^{NS}
ERROR (B)	60	19808.00	330.00	-
Total	95			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 36. Analysis of variance table for plant height (cm) of three groundnut varieties 90 days after sowing at Samaru, 1980

Source of variation	DF	SS	MS	F
Replications	2	32.00	16.00	-
Moisture stress	3	261.05	37.02	2.78^{NS}
ERROR (A)	6	187.85	31.31	-
Calcium x variety	5	199.11	39.82	1.52^{NS}
Moisture stress x calcium x variety	15	312.90	51.54	1.96^{NS}
ERROR (B)	40	1051.50	26.29	-
Total	71			

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 37. Analysis of variance table for plant height (cm) of three varieties of groundnuts 103 days after sowing at Samaru, 1980

Source of variation	DF	SS	MS	F
Replication	2	9.21	4.60	-
Moisture stress	3	4.01	1.34	0.298^{NS}
ERROR (A)	6	26.88	4.48	-
Calcium x variety	5	208.81	11.76	27.656*
Moisture stress x calcium x variety	15	58.52	3.901	2.578^{NS}
ERROR (B)	40	60.53	1.51	-
Total	71			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 38. Analysis of variance table for plant height (cm) of three varieties of groundnuts 117 days after sowing at Samaru, 1980

Source of variation	DF	SS	MS	F
Replication	2	81.11	40.55	-
Moisture stress	3	69.86	23.29	1.930^{NS}
ERROR (A)	6	72.31	12.05	-
Calcium x variety	5	251.75	50.35	4.54*
Moisture stress x calcium x variety	15	75.15	33.12	2.989^{NS}
ERROR (B)	40	443.59	11.08	-
Total	71	321.61		

* = Significant differences at 5% level
NS = No significant differences.

NOTE:

DF = Degrees of freedom
SS = Sum of squares
MS = Mean sum of squares
F = F-Test value.

Appendix 39. Analysis of variance table for plant height (cm) of three varieties of groundnuts 130 days after sowing at Samaru, 1980

Source of variation	DF	SS	MS	F
Replication	2	105.6	52.80	-
Moisture stress	3	76.28	25.43	0.743^{NS}
ERROR (A)	6	205.40	34.23	-
Calcium x variety	5	94.43	18.89	0.621^{NS}
Moisture stress x calcium x variety	15	532.65	46.45	1.543^{NS}
ERROR (B)	40	1538.13	38.45	-
Total	71			

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 40. Analysis of variance table for foliage spread (cm) of three varieties of groundnuts 90 days after sowing at Samaru, 1980

Source of variation	DF	SS	MS	F
Peplications	2	312.04	156.02	-
Moisture stress	3	163.49	54.49	1.824^{NS}
ERROR (A)	6	179.27	29.88	-
Calcium x variety	6	88.52	17.10	0.532^{NS}
Moisture stress x calcium x variety	15	368.48	24.57	0.579^{NS}
ERROR (B)	40	1696.95	42.42	-
Total	71			

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 41. Analysis of variance table for foliage spread (cm) of three varieties of groundnuts 103 days after sowing at Samaru, 1980

Source of variation	DF	SS	MS	F
Replications	2	54.50	27.25	-
Moisutre stress	3	65.07	21.69	0.347^{NS}
ERROR (A)	6	374.80	62.47	-
Calcium x variety	5	64.61	12.92	0.660^{NS}
Moisture stress x calcium x variety	15	327.94	21.86	0.865^{NS}
ERROR (B)	40	1010.10	25.25	-
Total	71			

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 42. Analysis of variance table for foliage spread (cm) of three varieties of groundnuts 117 days after sowing at Samaru, 1980

Source of variation	DF	SS	MS	F
Replications	2	1338.77	699.39	-
Moisture stress	3	350.54	116.85	1.951^{NS}
ERROR (A)	6	359.29	59.88	-
Calcium x variety	5	80.39	16.08	0.32^{NS}
Moisture stress x calcium x variety	15	988.76	65.92	1.302^{NS}
ERROR (B)	40	2023.91	50.60	-
Total	71			

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 43. Analysis of variance table for foliage spread (cm) of three varieties of groundnuts 130 days after sowing at Samaru, 1980

Source of variation	DF	SS	MS	F
Replications	2	43.15	21.58	-
Moisture stress	3	98.55	32.85	0.26^{NS}
ERROR (A)	6	761.55	126.93	-
Calcium x variety	5	924.16	184.83	1.83^{NS}
Moisture stress x calcium x variety	15	1798.8	119.92	1.19^{NS}
ERROR (B)	40	4021.74	100.54	-
Total	71			

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 44. Analysis of variance table for the number of vegetative branches per plant of three varieties of groundnuts at Samaru, 1980

Source of variation	DF	SS	MS	F
Replications	2	43.77	21.89	-
Moisture stress	3	70.12	23.37	4.126^{NS}
ERROR (A)	6	33.99	5.67	-
Calcium x variety	5	102.34	20.47	2.32^{NS}
Moisture stress x calcium x variety	15	127.16	8.48	1.00^{NS}
ERROR (B)	40	353.51	8.84	-
Total	71			

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sun of squares

F = F-Test value.

Appendix 45. Analysis of variance table for the number of flowers per plant of three varieties of groundnuts 90 days after sowing at Samaru, 1080

Source of variation	DF	SS	MS	F
Replications	2	163.73	81.87	-
Moisture stress	3	202.11	67.37	0.831^{NS}
ERROR (A)	6	486.33	81.06	-
Calcium x variety	5	490.9	98.18	0.792^{NS}
Moisture stress x calcium x variety	15	616.76	41.12	0.332^{NS}
ERROR (B)	40	4958.91	123.97	-
Total	71			

NS = No significant differences

NOTE:

DF = Degrees of freedom

SS = Sum of squares

SM = Mean sum of squares

F = F-Test value.

Appendix 46. Analysis of variance table for the number of flowers per plant of three varieties of groundnuts 103 days after sowing at Samaru, 1980

Source of variation	DF	SS	MS	F
Replications	2	72.65	36.33	-
Moisture stress	3	107.68	35.89	0.254^{NS}
ERROR (A)	6	847.75	141.29	-
Calcium x variety	5	3004.64	600.93	26.07*
Moisture stress x calcium x variety	15	781.37	52.09	2.26^{NS}
ERROR (B)	40	922.00	23.05	-
Total	71			

* = Significant differences at 5% level

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 47. Analysis of variance table for the number of flowers per plant of three groundnut varieties 117 days after sowing at Samaru, 1980

Source of variation	DF	SS	MS	F
Replications	2	626.15	313.08	-
Moisture stress	3	35.45	11.82	0.243^{NS}
ERROR (A)	6	291.50	48.58	-
Calcium x variety	5	259.83	51.97	2.869^{NS}
Moisture stress x calcium x variety	15	242.82	16.19	0.894^{NS}
ERROR (B)	40	724.45	18.11	-
Total	71			

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.

Appendix 48. Analysis of variance table for the number of flowers per plant of three varieties of groundnuts 130 days after sowing at Samaru, 1980

Source of variation	DF	SS	MS	F
Replications	2	30.29	15.15	-
Moisture stress	3	53.64	17.88	1.386^{NS}
ERROR (A)	6	77.40	12.90	-
Calcium x variety	5	73.55	14.71	1.135^{NS}
Moisture stress x calcium x variety	15	297.76	19.85	1.533^{NS}
ERROR (B)	40	517.83	12.95	-
Total	71			

NS = No significant differences.

NOTE:

DF = Degrees of freedom

SS = Sum of squares

MS = Mean sum of squares

F = F-Test value.