UPTAKE OF NUTRIENTS BY SPANISH AND VIRGINIA VARIETIES OF GROUNDNUT IN RELATION TO GROWTH

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C E R T I F I C A T E - I

This is to certify that this Thesis "Uptake of nutrients by Spanish and Virginia varieties of groundnut in relation to growth" submitted for the award of the Degree of Master of Science in Agriculture, in the Major subject of Agricultural Chemistry of the Andhra Pradesh Agricultural University is a result of bonafide record of research work carried out by Sri M.A.Kareem, under my guidance and that the thesis has not formed in whole or in part, the basis for the award of any degree, diploma, or other similar degree or distinction.

The assistance and help received during the course of investigation have been fully acknowledged.

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CONTENTS

			Page
1.	INTRODUCTION	...	1
2.	REVIEW OF LITERATURE	...	5
3.	MATERIALS AND METHODS	...	18
4.	RESULTS AND DISCUSSION	...	31
5.	SUMMARY AND CONCLUSIONS	...	74
	BIBLIOGRAPHY		
	APPENDICES		

LIST OF TABLES

Table No.	Item	Between pages.
1.	Dry matter production at different stages of growth	31-32
2.	Percent content of nitrogen at different stages of growth	35-36
3.	Percent content of phosphorus at different stages of growth	36-37
4.	Percent content of potassium at different stages of growth	37-38
5.	Percent content of calcium at different stages of growth	38-39
6.	Percent content of magnesium at different stages of growth	39-40
7.	Percent content of sulphur at different stages of growth	40-41
8.	Iron content at different stages of growth	40-41
9.	Manganese content at different stages of growth	41-42
10.	Zinc content at different stages of growth	41-42
11.	Copper content at different stages of growth	42-43
12.	Boron content at different stages of growth	43-44
13.	Molybdenum content at different stages of growth	43-44
14.	Uptake of nitrogen at different stages of growth	44-45
15.	Uptake of phosphorus at different stages of growth	46-47
16.	Uptake of potassium at different stages of growth	47-48
17.	Uptake of calcium at different stages of growth	49-50

18.	Uptake of magnesium at different stages of growth	50-51
19.	Uptake of sulphur at different stages of growth	51-52
20.	Uptake of iron at different stages of growth	53-54
21.	Uptake of manganese at different stages of growth	54-55
22.	Uptake of zinc at different stages of growth	54-55
23.	Uptake of copper at different stages of growth	55-56
24.	Uptake of boron at different stages of growth	57-58
25.	Uptake of molybdenum at different stages of growth	57-58
26.	Rates of dry matter production and absorption of nutrients (put together) at various stages of growth of whole plant (TMV2)	59-60
27.	Rates of dry matter production and absorption of nutrients (put together) at various stages of growth of whole plant (Asiriya Mwitunde)	59-60
28.	Absorption of total nutrient elements (put together) at various stages of growth of whole plant (TMV2)	68-69
29.	Absorption of total nutrient elements (put together) at various stages of growth of whole plant (Asiriya Mwitunde)	68-69
30,	Distribution of dry matter and nutrient elements between vegetative and reproductive parts at harvest (on percent basis)	70-71
31.	Total quantity of nutrients absorbed by TMV2 and Asiriya Mwitunde.	70-72
32.	Yield data recorded at harvest by TMV2 and Asiriya Mwitunde.	81-82
33.	Relative returns from TMV2 & Asiriya	81-82

LIST OF FIGURES

Fig. No.	Item	Between pages
1.	Field plan of layout Field No. 135	30-31
2.	Dry matter production of whole plant vegetative parts and pods and absorption of total nutrients put-together at different stages of growth.	31-32
3.	Total uptake of macro-nutrients(N,P,& K) at different stages of growth of whole plant.	44.45
4.	Uptake of macro-nutrients (N,P, & K) by vegetative parts at various stages of growth.	45-46
5.	Total uptake of secondary nutrients (Ca, Mg & S) at different stages of growth of whole plant.	49-50
6.	Uptake of secondary nutrients(Ca,Mg & S) by vegetative parts at various stages of growth.	50-51
7.	Total uptake of micro-nutrients (Fe,Mn,Zn,Cu,B & Mo) at different stages of growth of whole plant.	52-53
8.	Uptake of micro-nutrients (Fe,Mn,Zn, Cu,B & Mo) by vegetative parts at various stages of growth.	53-54
9.	Rates of dry matter production and absorption of macro-nutrients(N,P & K) at various stages of growth of whole plant.	60-61
10.	Rates of absorption of secondary nutrients (Ca,Mg & S) at various stages of growth of whole plant.	62-63
11.	Rates of absorption of micro-nutrients (Fe,Mn,Zn, Bu, B & Mo) at various stages of growth of whole plant(TMV2)	64-65
11 (b)	-do- -do- (Asiriya Mwitunde)	64-65

I. INTRODUCTION.

India occupies the first place among the groundnut growing countries of the world both in acreage and production. But the total production when compared to the acreage is low due to the low per acre yields. Lack of adequate nutrients is one of the main reasons for low yields. Both macro and micro nutrients seem to be the limiting factors in attaining high yields.

Like all other plants, a groundnut plant also requires the raw food materials consisting of carbon, Hydrogen, oxygen, nitrogen, phosphorus, potassium, sulphur, calcium, magnesium, iron, manganese, zinc, copper, molybdenum and boron, which it absorbs from the soil and converts them in to pods and haulm. Of these elements the first three are made available to the plant from the natural sources viz., air and water. The next three elements nitrogen, phosphorus and potassium (macro nutrients) are required by the plant in substantial quantities. The remaining nine elements consisting of calcium, magnesium, and sulphur (secondary nutrients), iron, manganese, zinc, copper, boron and molybdenum (micro nutrients) are needed by the plant in comparatively small quantity and are usually present in soil in sufficient quantity to meet the plant requirements.

It is well established that good plant growth is obtained at an optimum ratio for each plant nutrient. Any imbalance in the nutrient uptake, due to deficiency or non-availability of macro nutrients will not only produce unhealthy plants but also result in poor yield. Further the deficiency of the micro nutrients tends to decrease the uptake of the macro and secondary nutrients and this inturn adversely affects the final yield. A number of cases have been reported from many parts of the world regarding crop failure and plant diseases resulting from the deficiencies of micro nutrients. Extensive work on vegetative and reproductive development and yield of groundnut has been conducted in different parts of the world.

Bouyer (1941) indicated that a crop of 1500 kilo-grams of pods per hectare requires 105, 15, 42, 27 and 18 kilo-grams of N, P_2O_5, K_2O, CaO and MgO respectively. It is absolutely necessary to make good the losses by proper use of manures and fertilizers. Experiments conducted on the manuring aspect at different places in the world have revealed that manuring, eventhough closely dependent on soil, climate and management practices, is unquestionably a factor in yield and that the recommendation of manurial schedules in any area is an economic proposition.

With all the available scientific information, research is to be undertaken in India, on the nutritional and uptake aspects of macro, secondary and micro nutrients on groundnut. The response of groundnut to the application of micro nutrients has to be studied in further detail as the range of application varies widely according to the particular element in question. Further there is a narrow range of concentration in which the crop grows successfully. Excess of micro nutrients is much more serious than excess of common macro and secondary nutrients and the toxic effects are as bad as deficiency of micro nutrients in plants.

Until recently, little attention has been given to the fact that groundnut varieties exhibit marked differences in nutrient requirements. Inconsistent results were often obtained in fertiliser experiments not only between two varieties and different localities but also at a single location for a single variety that is why it has been named as an "unpredictable legume". Further mineral nutrition studies, in most cases, have dealt with groundnut plant as a whole only in respect of yields. Information on studies showing the quantitative correlation between the different nutrient elements and their requirements at different stages of growth of the plant, which contribute to the better understanding of plant nutrition is scanty in literature.

The present study is an attempt to understand the growth and uptake of macro, secondary and micro nutrients in two high yielding varieties of groundnut viz., Asiriya Mwitunde (Virginia variety) and TMV2 (Spanish variety) which are popular in Andhra Pradesh, as no work seems to have been done on these lines for the above groundnut varieties in India.

II. REVIEW OF LITERATURE.

1. Studies of Ishi-Zuka and Tanaka (1964) showed that the process of plant nutrient uptake varies in different localities even with the use of a common standard cultural practice ~~method~~. This holds good with groundnut. The plant growth pattern as well as the process of nutrient uptake differs greatly with locality and is a function of climate, soil properties, amount of fertilizer applied, variety and method of cultivation.

Soils vary widely in their capacity to supply nutrients necessary for the optimum growth of plants. Most soils contain enough nutrients to support some kind of plant life but soil releases only a very small percentage. For profitable crop production higher levels of nutrients are needed. Frequently low levels of crop production can be traced to an inadequate supply of nutrients fromthe soil.

Groundnut being a leguminous plant might not be expected to respond to large applications of nitrogen (Loehwing, 1928, Burkhat, Leland and Collins 1942, West 1942). However, there is considerable evidence which would indicate that nitrogen is important in groundnut nutrition(Sturkie, Schultz and

Albrecht 1943-44, Colwell, Brady and Piland 1945, Bledsoe, Roger, Comar and Harris 1949 and Prevot 1949).

The most important function of nitrogen in groundnut is the formation of new protoplasm and stimulation of vegetative growth (Colwell, Brady and Piland (1945), However the increased growth is often of little benefit because of the correspon-ding reduction in shelling percentage (Roger 1943-44). Excess of nitrogen usually causes groundnut to become dark green in colour, grow rapidly producing succulent vegetation that does not flower and fruit well (Colwell, Brady and Piland 1945). Batten (1942) recorded that the application of nitrogen on fairly fertile soil delayed the maturity and resulted in groundnuts of low quality. While lack of nitrogen in the groundnut plant results in stunted growth, yellow foliage, reddish colouration of stem and few nodules on the roots (Burkhat, Leland and Collins, 1942).

Krishna Rao (1962), made certain investigations on the mineral nutrition of groundnut by the method of foliar diagnosis. He concluded that the higher intensities of nutrition of groundnut crop was associated with higher yields. The critical foliar values may be taken to be 3.23%, 0.49% and 1.8% for nitrogen, phosphorus and potassium respectively. The nitrogen, phosphorus and potassium content of the leaf seems to decrease with advancing age of the crop and 20:40:20 pounds per acre of nitrogen, phosphorus and potassium were found to be the optimum dose for groundnut in Andhra Pradesh.

Bouyer (1940-41) concluded that groundnut removes a good quantity of nitrogen but comparatively little phosphorus. Since groundnut has a relatively low phosphorus requirements. In fact younger seedlings may some times develop phosphorus toxicity (York, 1952). Krishna Rao (1962) reported the critical foliar values for phosphorus as 0.49%. The N:P ratio touched the value 16 and about 15% nitrogen and 60% P205 were found mainly accumulated in the kernels.

Phosphorus is also a factor for growth. It increases the plants vigour and favours the formation of nodes and setting of fruits. Harper (1920) and Pate (1931) observed that considerable quantity of phosphorus was stored in the fruits and seeds; hence deficiency will adversely affect the yield and size of the seeds.

It is a well known fact that groundnuts are especially heavy feeders of potassium. It largely occurs in the plants as soluble organic and inorganic salts. Though potassium is absorbed in relatively large amount, the yield responses due to it are often very small or negligible even on potassium deficient soils. In fact groundnuts appear to be quite unique in their ability to absorb potassium and make satisfactory growth on soils, so deficient in available potassium that many other crops would fail to grow.

When potassium is deficient in the plant, the potassium from the older parts is transported to the actually growing regions where the demand is more.

Calcium fertilisation in groundnut received much more attention in the past. Several workers like Burkhat, Leland and Collins (1942), Hill (1947), Roger (1948) and Lochover (1966) observed favourable response to calcium. It is observed that legumes remove larger quantities of calcium from the soil. A normal nonleguminous crop seldom takes from the soil over 25 pounds of calcium, where as a leguminous crop often removes 100 pounds or more, Jones (1955) regarded a soil contaiing lime as suitable for the cultivation of groundnut. Most of the calcium of the plants occurs in the foliage and very little is found in the seed. It is found immobile as crystals of calcium oxalate in the plant tissues.Root development and growth in groundnut is associated with the lime nutrition.

The importance of magnes-ium has been underestimated until now, as it is present in smaller proportion with the micro nutrients. It is the only metallic constituents of chlorophyll, a deficiency of which in the soil may lead to slowing down of photosynthesis and to chlorosis of leaf. A large portion of this element is carried in the green foliage and there is considerable amount in the seed.

Sulphur is reported to have special significance in the nutrition of groundnut. It is absorbed in large amount by the groundnut plants. Its requirements are often as large as of phosphorus.

For good plant growth iron is essential, without which plants become chlorotic or yellow. In groundnut it is present in small amount and is quite immobile in growing plant.

McHargue (1962) has reported that manganese is essential for plant growth. He found that legumes appear to be more sensitive to a deficiency of manganese than the non-legumes. He further stated that legumes usually contain the least amount of manganese and grasses the greatest amount. Laveque and Bolley (1956) reported that for groundnut grown in sand culture 110-440 p.p.m. was the intermediate range for manganese. Toxicity Symptoms appear at the range of 890 to 1090 p.p.m. Mandal & Sinha (1964) working in Bihar reported 313 p.p.m. in groundnut. Manganese is required only in small quantity because plants are able to use manganese over and over. Deficiency of manganese in groundnut results in chlorosis of plants, defoliation, loss of vigour and lower yields (Seshadri, 1961).

Plants use only a very small amount of zinc. A certain level of available zinc must be maintained at all times for good crop production. Gopal Krishnan _et al._, (1908) concluded that among trace elements zinc and boron appear to be more needed by groundnut crop for improving general growth and yield respectively. According to Bear (1954) Zinc in plants normally ranges between 25-100 p.p.m. and when its level falls below 25 p.p.m. deficiency may develop. Chapman (1966) reported that in most crops less than 20 p.p.m. in dry matter of leaves indicates deficiency or approaching deficiency of zinc. Jones (1957) had shown that zinc was concentrated in plants where growth was greatest such as leaves, shoots, tips etc.

Copper requirements of groundnut plant is very small. Lal & Subba Rao (1955) reported that the leaves of cereal had shown the maximum uptake (average 19 p.p.m.) of copper, while legume minimum (average 12 p.p.m.). Neelkantam & Mehta (1962) reported copper values ranging between 9.5 to 17.5 p.p.m. for legumes.

Boron occurs in most plants in smaller quantity ranging upto 200 p.p.m. McHargue <u>et al.</u>, (1940) reported that in leguminous plants boron requirements were three times more than cereals. This was further confirmed by Munsell & Brown (1943). Maistre (1956) gave a critical value of slightly above 0.005 p.p.m.

Boron in some way enables the plant to absorb more calcium and there is little transfer of boron from old tissues to younger growing parts (Colling, 1954).

Molybdenum is especially important in legumes for nodulation and nitrogen fixation. Plant (1950) reported that the leaves of legumes contain the maximum amount of molybdenum the average being 1.27 p.p.m. He reported minimum values for general plant growth as 0.12 p.p.m. Molybdenum deficiency was also reported in groundnut. When a small amount of molybdenum was applied to the soil the foliage of the groundnut plant turned to a dark green colour and the shoot growth was increased by its addition to nutrient solution. Further it increased herbage, dry matter, number and weight of nodules and nitrogen content in leaves and yield of unshelled nuts, in Senegal (Gill 1965).

Uptake and translocation of molybdenum by plant roots indicated that it at first enters the lower older leaves but the bulk of molybdenum is concentrated in the young growing organs of the plants. The uptake and translocation of molybdenum proceed at a sufficient rate throughout the plant; hence molybdenum is applied either to the roots or to the foliage of the plant (Minnis 1964) but seed treatment with molybdenum was superior to foliar application (Parker and Harris, 1962, Nowotny et al., 1965), as seed treatment increased symbiotic nitrogen fixation better than foliar application (Nowotny et al., 1965).

Absorption of nutrients in groundnut is slightly different from other crops. Besides the normal and usual absorption of ions from the root a considerable amount of moisture and nutrients are also absorbed by the gynophores (Burkhat and Collins 1942, Bledsoe et al., 1949, Pettit 1898, Reed, 1929, Waldron, 1919, Brady, Reed and Colwell, 1948). It has also been shown that pegs and developing fruits do absorb some mineral elements. (Bledsoe Roger, Comar and Harris, 1949, Burkhat, Leland and Collins, 1942).

Burkhat, Leland and Page (1941), Brady, Reed and Colwell (1948), Colwell and Brady (1945) indicated that to obtain the most beneficial effects, the nutrient must be applied to the zone of fruit formation rather than to plant roots. Placement of certain fertilisers like super phosphate too close to the seeds at planting may result in injury (Batten and Cumings, 1946). Harris (1947) reported that yields were increased when solution was used in the fruiting medium while, Brady, Reed and Colwell (1948) failed to get a favourable response. It was also shown that N^{15} (Vander, 1914) P^{32} and radio active cobalt (Harris, 1949) are absorbed in small quantities by the developing fruit and translocated to other parts of the plant.

Bledsoe, Roger, Comar and Harris (1949) found Ca^{45} to be actively absorbed by the shells and seeds of developing fruits with some movement to other parts of the plants when the labelled Ca^{45} was applied to the fruiting medium, conversely when Ca^{45} was applied to the roots of the plants a small quantity of labelled calcium was found in the shell; but never more than traces could be detected in the seed of developing fruits.

It is both important and interesting to investigate the behaviour of the nutrients which are absorbed by the plants at various stages of growth. The study of micro nutrient requirements of groundnut crop has received very little attention. A survey of literature shows absence of information on either the content or the functions of these elements at different stages of growth in the groundnut plant. As early as 1941-42 Bouyer studied the absorption of major nutrients by groundnut. He studied the absorption of nitrogen, phosphorus, potassium, calcium and magnesium dividing the crop growth into three main phases, viz.,

1. Initial phase (from sowing to 30th day.
2. Phase of intense growth of vegetation (from the begining of 2nd month to the begining of fruiting period).
3. Fruiting phase.

He concluded that the groundnut plant removes a considerable amount of nitrogen and little amount of phosphorus. The groundnut absorbed the entire potassium requirement between the 40th and 60th day of its growth and there was practically no further absorption during the fruiting phase. The absorption of potassium during the initial phase was about 12 kilo-grams per hectare and the intense absorption take place during 40th and 60th day.

Unlike potassium, slow absorption of calcium continued even during the fruiting phase. He observed similar trend in respect of magnesium.

Prevot (1949) studied the mineral nutrition of groundnut in a field experiment with and without fertiliser inrelation to its cycle of growth. He indicated the importance of nitrogen in nutrition where as phosphate nutrition remains at a low level. He further indicated that nitrogen and potassium nutrition are closely correlated with growth. In the case of calcium on the contrary, after the 61st day the calcium content in leaves increased uniformly up to the end without showing any differences between the series with and without fertilisers. He has emphasised the importance of the nitrogen in the nutrition of groundnut. He has indicated that relatively large quantities of nitrogen are translocated from the leaves to the developing fruits, suggesting the importance of manuring the groundnut plant at a high level of nitrogen metabolism prior to the fruiting phase. Lachover and Feldchay (1961) in Israel indicated that there is a critical period in the 2nd month after sowing the groundnut crop when nitrogen and potassium requirements are higher;

thus localized soil deficiencies in nitrogen and
potassium would account for the lower yields.

III. MATERIAL AND METHODS.

1. LOCATION

The two varieties of groundnut crop under study were raised in Field No. 135 located at the Agricultural Research Institute Rajendranagar, Andhra Pradesh (18.59^{o}N latitude and 534 m. altitude) during January 1970 - July 1970.

2. SOIL

The experimental plot is located in a levelled, well-drained sandy loam area, typical of chalka type.

The soil is reddish brown in colour, slightly alkaline in reaction (pH 7.8 to 7.9), normal in soluble salt content (E.C.0.12 millimhos/cm @ 25^{o}c) medium in organic carbon (0.47%), high in available P_2O_5 (63 kg/ha) and available K_2O (375 kg/ha) content. Lime concretion are not seen on the surface and in the sub soil. The analytical data are furnished in Appendix. I.

3. SEASON

Details in respect of rain fall, temperature (both maximum and minimum), evoporation and sun shine hours recorded during the crop period are furnished in Appendix. II.

4. PESTS AND DISEASES

The crop was fairly free from pests and diseases. Preventive measures were taken against the attack of grubs etc.

A mild attack of Tikka leaf spot disease was noticed at the time of harvest but no sulphur dusting was done as the experiment was on the uptake of macro, secondary and micro nutrients.

5. EXPERIMENTAL DETAILS

(i) Layout.

The crop was sown as a bulk crop. It was replicated four times with a gross and net plot size of 1/200 and 1/250 hectare respectively.

The layout plan indicating the other details is enclosed.

(ii) Varieties.

Two varieties of groundnut TMV2 (spanish variety) and Asiriya Mwitunde (Virginia variety) were chosen for this study.

TMV2 was originally evolved at Tindivanum (Tamilnadu) in 1940. It is a an early maturing (110-115 days) bunch variety. The lateral branches are more or less upright with taller central portion. The nuts are small in size with small round kernel covered with light rosy coloured skin. It gives a shelling percentage of about 72% and oil content about 49% (Phattak and Singh 1960, I.C.O.C., 1961).

Asiriya Mwitunde is an exotic high yielding variety evolved in Tanganiyaka (South Africa) and introduced from Tanzania in 1966 by the National Seeds Corporation. It has been found suitable for the rabi/summer season in the southern states of India. It is a late maturing (135-140 days) semi-spreading or runner type variety, suitable for both rainfed and irrigated conditions. This is shorter in duration than the spreading varieties. The lateral branches tend to be more prostrate with smaller central portion, assuming a sort of bow shaped pattern, with profuse branching. The nuts are comparatively bigger than TMV2 in size and often contain three seeded pods having bigger kernel covered with dark rosy skin. It gives a shelling percentage of about 80 and oil content about 56.5%. It is associated with seed dormancy of about 30 days. The variety is resistant to aphids and tolerant to tikka (Kulkarni, 1967, Naini and Ramanamurthy, 1969).

(iii) Manures and Fertilizers

Manurial schedule as recommended and followed is given below:-

N = 30 kg/ha. applied as ammonium sulphate.

P205 = 60 kg/ha. applied as super phosphate.

K20 = 30 kg/ha. applied as muriate of potash.

The above fertilizers were applied over a basal dressing of 25 cart loads of F. Y. M. per hectare.

Entire dose of nitrogen, phosphorus, and potassium was applied at the time of sowing.

(iv) Spacing

The spacing adopted for these varieties was:-

	Row to row.	Plant to plant.	Population/hac.
TMV2	15 cm	15 cm	444444
Asiriya Mwitunde	22.5 cm	22.5 cm	197532

6. FIELD OPERATIONS

(i) Preparatory tillage:

Farm yard manure at the rate of 25 cart loads per hectare was applied and the field was prepared thoroughly by ploughing twice with mouldboard plough and once with country plough followed by a harrow. The field was laid out in to the plots, drainage and irrigation channels were provided as shown in the layout plan.

(ii) Seeds and sowing

Kernels from the healthy pods were treated with Capton at the rate of three gram per kilo-gram of kernel to protect against seed borne diseases.

Sowing was done on 22-1-1970 by hand dibbling as per the spacing mentioned above. The fertilizers were spread uniformly in each plot and mixed well before sowing.

(iii) Germination

Due to very low temperature prevailing immediately after sowing, sprouting was slightly late; but the germination was good (93 and 98% in spreading and bunch types respectively).

On the 20th day after sowing, thinning and gap filling were done allowing only one seedling per hill.

(iv) Inter cultivation

Clean cultivation is very essential in groundnut cultivation. At the 20th day age of the crop, push hoe was run in between the lines to remove the weeds and to earth up.

Hand weeding was done on 20-2-1970 (30th day) followed by second hoeing on 25-2-1970 (35th day).

Second hand weeding was done on 22-3-1970 (60th day).

(v) Irrigation

The crop was irrigated as and when found necessary. In all 12 and 14 irrigation were given to TMV2 and Asiriya Mwitunde respectively during the entire crop cycle on the following dates 22-1-70, 30-1-70, 10-2-70, 20-2-70, 28-2-70, 8-3-70 20-3-70, 30-3-70, 12-4-70, 20-4-70, 28-4-70, 15-5-70 26-5-70 and 8-6-70.

(vi) Crop protection

Rogar at the rate of 20 milli-litre in 9 litres of water was sprayed twice at an interval of ten days on 24-3-1970 and 3-4-1970 respectively. The crop was healthy and free from pests and diseases.

(vii) Harvesting

TMV2 and Asiriya Mwitunde were harvested on 20-5-70 and 10-6-70 respectively. The earmarked yield rows being harvested separately from each plot. Pods were stipped separately for each plot, cleaned and the fresh and oven dry weights recorded.

7. SAMPLING

(i) Soil samples

Soil samples were collected from the surface and sub soil layers before application of manures and fertilizer and sowing and from the surface layer after the harvest of the crop.

The samples were air dried, prepared and passed through 0.2 mm. sieve and analysed for soil reaction, electrical conductivity, total and available nitrogen, available phosphorus and, potassium, calcium and magnesium.

(ii) Plant samples

Whole plant samples were collected, both for macro and micro nutrients analysis, from each plot adopting destructive sampling technique, starting from (10-2-70) 20th day after sowing at regular intervals of 20 days. Ten plants were collected in the initial stages from each plot, in subsequent stages till harvest the number of plants were reduced to five.

Samples proposed for the analysis of macro nutrients and boron were cleaned and weighed after removing the roots. The samples were then dried in an electrical oven at 80°c for forty-eight hours. The dried samples were weighed and processed initially in macro and finally in micro grinder to have a fine powder. This was taken for chemical analysis.

Samples for the analysis of micro nutrients were thoroughly washed with distilled water and then by 0.3 N redistilled hydrochloric acid followed by another washing with distilled and redistilled water. The samples were air dried and then dried rapidly in an electrical oven at 80°c for forty-eight hours. These samples after drying were powdered in agate mortar and pestle. Metallic contamination was avoided during this process.

8. METHODS OF ANALYSIS

The methods of analysis followed were those recommended by the Association of official Agricultural Chemists (1955), Piper, (1966), Snell and Snell, (1951), Sandell, (1951), Jackson, (1958) and United State Department of Agriculture Hand Book No. 60 (1954).

(A) Soil Analysis

(1) Moisture percentage

Moisture content of the soil was determined by drying a weighed quantity of soil sample in an electrical oven at 105°c till constant weight and the loss in weight was calculated as moisture percentage (A.O.A.C. 1955).

(2) Soil Reaction

The pH of the soil was determined in 1:2.5 soil water suspension, using Beckman pH meter.

(3) Total salt content (E.C.)

The E.C. of the soil was determined in 1:2.5 soil water extract, using solubridge (Technival type), as described by Piper, (1966).

(4) Organic carbon

Organic carbon was determined by the wet digestion method of Walkley and Black (1935) as described by Piper, (1966).

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(5) Mineralisable Nitrogen (available N)

Available nitrogen in soil was determined by alkaline permanganate method as described by Subbaiah & Asija,(1956).

(6) Available phosphorus

Available phosphorus was estimated colorometrically by Olsen's method as described by Muhr *et al*., (1965).

(7) Available potassium

Potassium was determined by feeding the soil water extract directly to the flame photo meter after adjusting the instrument with suitable potassium standards.

(8) Cation exchange capacity of the soil

The C.E.C. was determined as per the method described by Jackson,(1967).

(9) Water solubles

1. Anions: Carbonate, bi-carbonate Chloride & Sulphates were determined in the soil water extract as described in U.S.D.A. Hand Book No. 60 (1954).

2. Cations: Calcium and Magnesium were analysed in the soil water extract as described in U.S.D.A. Hand Book No. 60 (1968).

(B) PLANT ANALYSIS

(1) Wet Digestion

Wet ashing method as described by Piper (1966) was followed for ashing the plant samples for determining both macro (except nitrogen), secondary and micro nutrients.

(2) Nitrogen

Nitrogen in plant tissue was estimated by the micro kjeldhal method outlined in A.O.A.C. (1955) and further modified in Technical Report Series No. 29 Laboratory Training Manual on the use of Isotopes and Radiation in soil plant relationship Research, International Atomic Energy Vienna (1964).

(3) Phosphorus

Phosphorus in plant sample was estimated by Vanado--molybdo-phosphoric yellow colour method in nitric acid medium as described by Jackson (1958). The intensity of the colour was read at 470 mu wave length, using a blue filter, on a Klett Summerson photo-electric colorimeter.

(4) Potassium

Potassium in plant sample was determined by direct feeding of the aliquot of the extract to the Langes' Flame photometer after adjusting the instrument with suitable potassium standards.

(4) Calcium and magnesium

Calcium and magnesium were determined by the Versenate method after precipitating and removing the interfering metals.

(5) Sulphur

Sulphur was determined gravimetrically as barium sulphate as described by Atkinson et al., (1958).

(6) Iron

Iron was determined following the ACNS method which works in strongly acid solution. The intensity of brick red colour was read at 480 mu wave length, using green filter on Klett Summerson Photo electric colorimeter.

(7) Manganese.

Manganese was determined by potassium periodate method, wherein the Mn^{++} was oxidised to MnO4, by potassium periodate fairly rapidly in hot acid solution. The intensity of the pink colour developed was read using a green filter (480 mu) on a Klett Summerson photo electric colorimeter.

(8) Zinc

Dithizone method which is suitable for colorimetric estimation was followed. The colour intensity of the grey layer of zinc dithizonate was read using the green filter (480 mu) on a Klett Summerson, Photo-electric colorimeter.

(9) Copper

Copper was determined directly by the carbamate method further modified by Cheng and Bray (1953). The intensity of the colour developed was read, using the blue filter (440 mu) on the Klett Summerson Photo-electric colorimeter.

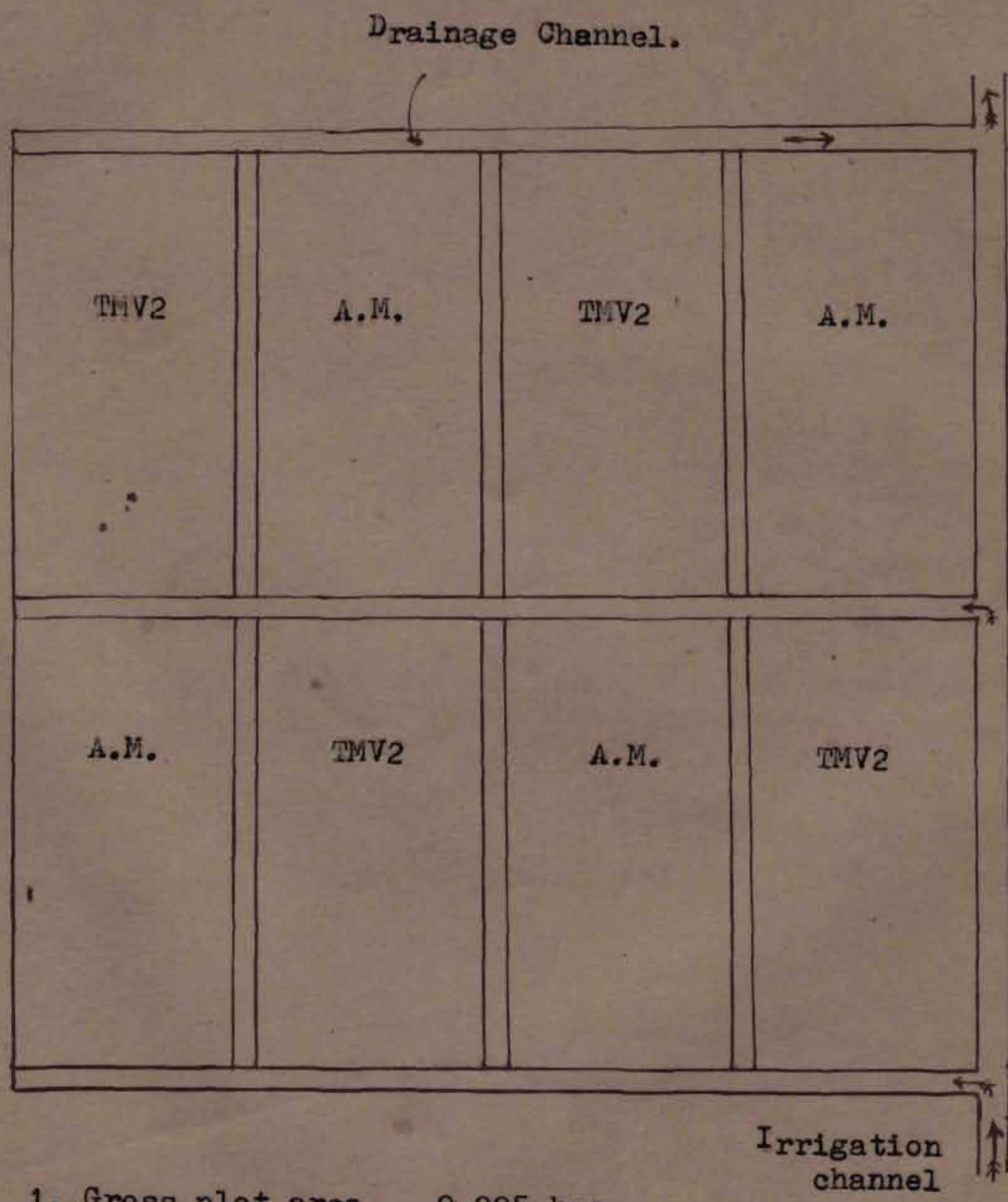
(10) Boron.

Carmine method as described by Hatcher and Wilcox (1950) was followed for the determination of boron in plant samples. The colour intensity developed was read, using the green filter combined with one fold of yellow paper (585 mu).

(11) Molybdenum

Molybdenum was determined following the KCNS method. The cherry red colour of Mo-CNS complex suitable for colorimetric work is extracted using the extractant mixture proposed by Johnson and Arkly (1954). The colour intensity was read using the blue filter on the Klett Summerson Photo-electric colorimeter.

FIG.1. FIELD PLAN OF LAYOUT FIELD NO. 135



1. Gross plot area. 0.005 hac.
2 Net plot area. 0.004 "
3. Date of sowing 22-1-1970
4. Date of harvest
   i) TMV2 20-5-1970
   ii) Asiriya Mwitunde(A.M.) 10-6-1970

IV RESULTS AND DISCUSSION

Uptake of nutrients by the groundnut plant in relation to its growth was studied in the present investigation. Two varieties namely TMV2 and Asiriya Mwitunde were chosen for the study. Whole plant samples collected during the different stages of growth of two varieties of groundnut crop were analysed for nitrogen, phosphorus, potassium, calcium magnesium, sulphur, iron, manganese, zinc, copper boron and molybdenum. Only the above ground portion of the plant was considered for the purpose of this study. After formation of pods the whole plant included the pods also. Vegetative (Stem + Leaves) and reproductive (Pods) parts collected at harvest and 20 days prior to harvest were analysed separately. The oven dry weights of the whole plant at different stages of growth and the pods at intermediate and final stages were recorded.

(1) DRY MATTER PRODUCTION

(A) Total dry matter production

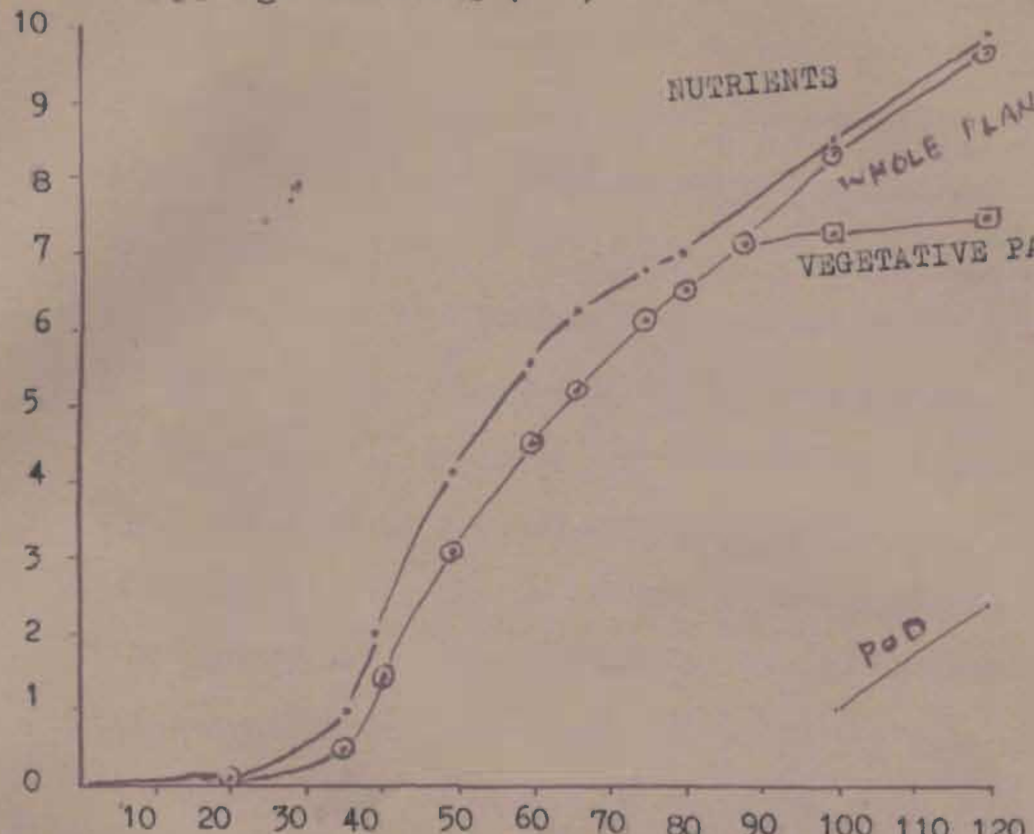
The data on total dry matter produced at various stages of growth of both the varieties, i.e., TMV2 and Asiriya Mwitunde are given in Table (1).

Table No. 1 DRY MATTER PRODUCTION AT DIFFERENT STAGES OF PLANT GROWTH

TMV2						ASIRIYA MWITUNDE					
Age in days.	Weight of 100 plants in gram (on oven dry basis)					Age in days.	Weight of 100 plants in gram (On oven dry basis)				
	Stem & leaves.	POD			Whole plant.		Stem & leaves.	POD			Whole plant.
		Shell.	Kernel.	Total.				Shell.	Kernel.	Total.	
1	2	3	4	5	6	1	2	3	4	5	6
20	11.5	-	-	-	11.5	20	31.3	-	-	-	31.3
35	100.2	-	-	-	100.2	40	400.2	-	-	-	400.2
40	250.3	-	-	-	250.3	50	1000.3	-	-	-	1000.3
50	530.4	-	-	-	530.4	60	1408.2	-	-	-	1408.2
60	780.2	-	-	-	780.2	66	1602.3	-	-	-	1602.3
66	900.3	-	-	-	900.3	75	1880.4	-	-	-	1880.4
75	1050.3	-	-	-	1050.3	80	2008.3	-	-	-	2008.3
80	1120.5	-	-	-	1120.5	88	2210.3	-	-	-	2210.4
88	1210.4	-	-	-	1210.4	100	2403.2	-	-	-	2403.2
100	1250.2	69.1	132.2	201.3	1451.5	120	2480.2	90.1	275.1	365.2	2845.4
120	1280.4	93.3	325.3	418.6	1699.0	140	2530.3	145.1	690.0	835.1	3365.4

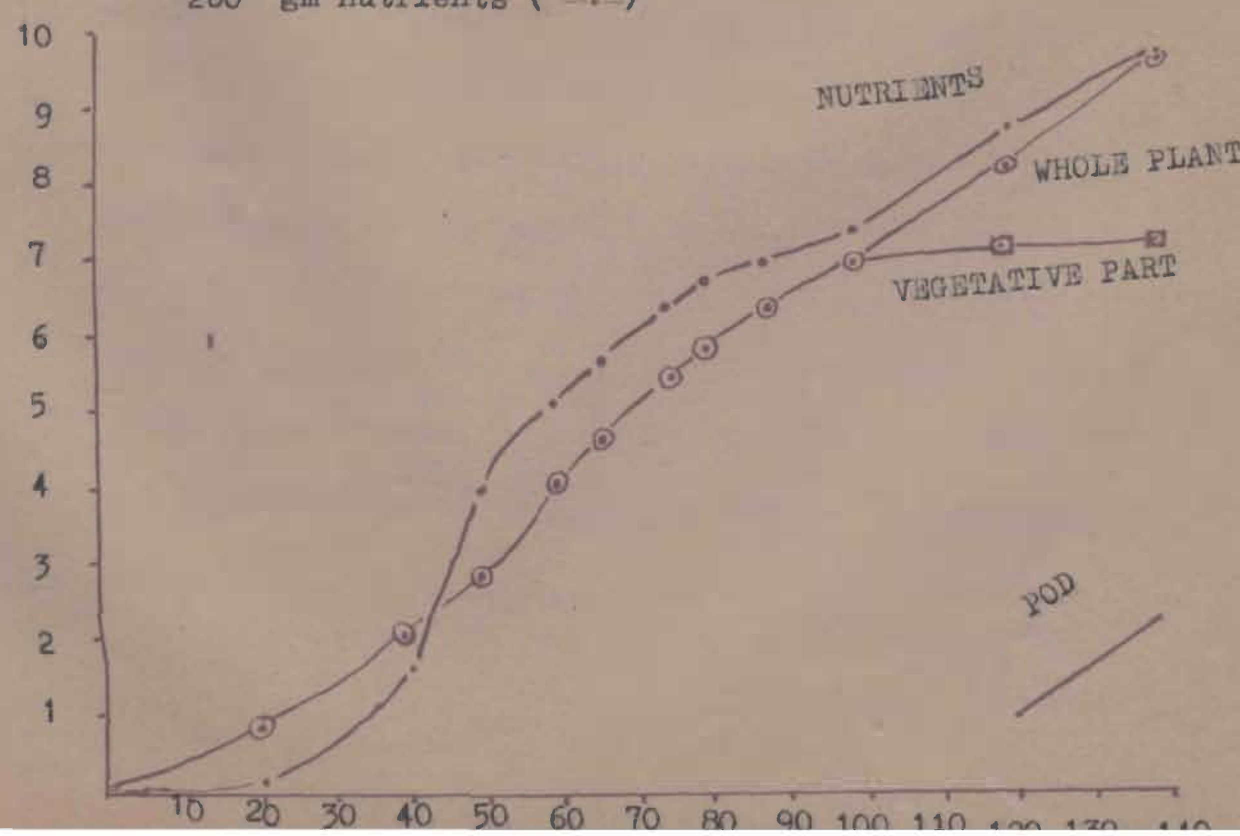
DRY MATTER PRODUCTION OF WHOLE PLANT, VEGETATIVE PARTS AND PODS AND ABSORPTION OF TOTAL NUTRIENTS (PUT TOGETHER) AT VARIOUS STAGES OF GROWTH (IN 100 PLANTS).

Y axis 1 cm =
170 gm dry matter (-⊙-) 1. TMV2
130 gm nutrients (-·-)



2. ASIRIYA MWITUNDE

Y axis 1 cm =
340 gm dry matter (-⊙-)
260 gm nutrients (-·-)



It is seen that total dry matter accumulation increased with increasing age of the crop in both the varieties of groundnut reaching the maximum at harvest.

The dry matter produced during the seedling phase, which represents the initial phase (c.f. Bouyer (1940-41) was very low in both the varieties (11.5 and 31.3 gm per 100 plants). This low dry matter production was in keeping with the phase where germinated seedlings at the first instance utilise plant food materials stored in the cotyledons and the development of roots and the vigour of the seedlings are such as not to contribute to high dry matt r production.

There was a steep rise in total dry matter production from the 20th day onwards till about the 88th day coinciding with the entire phase of intense vegetative growth and earlier part of the fruiting phase in both the varieties. It ranged between 100.2 gm to 1210.4 gm per 100 plants in the case of TMV2 and 400.2 gm to 2210.4 gm per 100 plants in the case of Asiriya Mwitunde. The increase in the total dry matter production after the 88th day was not significant in the case of TMV2. It was comparatively more in Asiriya Mwitunde in keeping with its overall greater production of dry matter.

The total dry matter production recorded a sudden increase during the period of pod formation and post tender pod formation in the case of TMV2. The total dry matter at the time of harvest was 1699.0 gm per 100 plants (7551.1 kg/hac.) in the case of TMV2 and 3365.4 gm/100 Plants (6648.04 kg/hac.) in Asiriya Mwitunde. The sudden increase (488.6 gm per 100 plants) in total dry matter production during the last 32 days of TMV2 was mainly due to production of pods. Similar was the case with Asiriya Mwitunde which produced 963.1 gm. per 100 plants during the last 40 days.

Though the total dry matter production in the case of Asiriya Mwitunde followed a pattern almost similar to that of TMV2, the increase in dry matter production during the phase of intense vegetative growth and part of the fruiting phase was spectacular and of a high order.

The total dry matter production was comparatively higher in the case of Asiriya Mwitunde at different stages of its growth and at the end also. At the time of harvest the total dry matter produced was 3365.4 gm per plants.

Dry matter production of vegetative portion (leaves + stem) was somewhat sigmoid in pattern in both the varieties. The pattern of total dry matter accumulation in both the varieties was almost similar.

(B) DRY MATTER OF POD

Dry matter production of pods were recorded at the 100th and the 120th day in TMV2 and 120th day and the 140th day in Asiriya Mwitunde. There was increase in dry matter production and maximum was recorded at harvest in both the varieties. TMV2 produced 418.6 gm. of dry pods per 100 plants whereas Asiriya Mwitunde produced nearly double (835.1 gm of dry pods per 100 plants) that of TMV2. The high total dry matter production and production of dry pods in the case of Asiriya Mwitunde was due to the very high yielding nature of variety compared to TMV2. Further it is a longer duration spreading variety. The total dry matter production of pods of at harvest was 2749.3 kg/hac. & 1649.59 kg/hac. by TMV2 and Asiriya Mwitunde respectively.

(2) NUTRIENT CONTENT (COMPOSITION)

Average percent content of various nutrient elements in the whole plant at different stages of growth, separately for vegetative (shoots) and reproductive (Pods) parts of the two varieties of groundnut is furnished in tables 2 to 13.

(a) MACRO NUTRIENTS

1. Nitrogen

It is seen that during the initial phase (20 days) the seedlings, being exclusively dependent on the nitrogen content of the seed and partly on the soil nitrogen recorded low nitrogen content (3.32 and 3.61 percent) in both the varieties. At the 35th and 40th day the whole plant nitrogen in TMV2 and Asiriya Mwitunde was maximum. This increase in nitrogen content may partly be due to the development of root system and partly due to absorption of symbiotic nitrogen formed in the root nodules which had developed by that time. From the 35th day onwards i.e., during the intense phase of vegetation (Bouyer, 1940-41), there was a gradual decrease in the whole plant nitrogen from 4.2 to 2.3 percent in TMV2 and 2.34 per-cent in

Table No. 2 PERCENT NITROGEN AT DIFFERENT STAGES OF PLANT GROWTH.

TMV2						ASIRIYA MATTUDDE					
Age in days.	Stem and leaves.	POD Shell.	POD Kernel.	POD Whole pod.	Whole plant.	Age in days.	Stem and leaves.	POD Shell.	POD Kernel.	POD Whole pod.	Whole plant.
1	2	3	4	5	6	1	2	3	4	5	6
20	3.32	-	-	-	3.32	20	3.61	-	-	-	3.61
35	4.20	-	-	-	4.20	40	4.20	-	-	-	4.20
40	4.10	-	-	-	4.10	50	3.69	-	-	-	3.69
50	3.85	-	-	-	3.85	60	3.00	-	-	-	3.00
60	3.30	-	-	-	3.30	66	2.81	-	-	-	2.81
66	2.93	-	-	-	2.93	75	2.60	-	-	-	2.60
75	2.57	-	-	-	2.57	80	2.46	-	-	-	2.46
80	2.42	-	-	-	2.42	88	2.38	-	-	-	2.38
88	2.30	-	-	-	2.30	100	2.34	-	-	-	2.34
100	2.20	0.5	5.6	3.84	2.42	120	2.25	0.60	5.70	4.44	2.53
120	2.00	0.4	5.5	4.36	2.58	140	2.10	0.50	5.60	4.71	2.74

Asiriya Mwitunde. After the 88th day, when the pods formed and started developing in the soil there was a slight increase in the whole plant nitorogen content till harvest in both the varieties. Absorption of nitrogen by the whole plant continued even after the cessation of the vegetative phase. Translocation of nitrogen from vegetative parts to reproductive parts was clearly seen from the descending trend in nitrogen content of vegetative parts (Stem + leaves) and increase in nitrogen content of pod in both the varieties.

The whole plant nitrogen content of Asiriya Mwitunde was comparatively higher than that of TMV2 at various stages of growth.

(2) Phosphorus.

The trend of percentage phosphorus content was more or less similar to that of nitrogen but very low in content when compared with nitrogen. Bouyer (1940-41) also reported low levels of phosphorus in groundnut.

The phosphorus content was 0.36 percent in TMV2 and 0.37 percent in Asiriya Mwintundo during

Table No. 3 PERCENT PHOSPHORUS AT DIFFERENT STAGES OF PLANT GROWTH.

TMV2						ASIRIYA MWITUNDE					
Age in days.	Stem and leaves.	POD			Whole plant.	Age in days.	Stem and leaves.	POD			Whole plant.
		Shell.	Kernel.	Whole pod.				Shell.	Kernel.	Whole pod.	
1	2	3	4	5	6	1	2	3	4	5	6
20	0.36	-	-	-	0.36	20	0.37	-	-	-	0.37
35	0.38	-	-	-	0.38	40	0.40	-	-	-	0.40
40	0.39	-	-	-	0.39	50	0.38	-	-	-	0.38
50	0.36	-	-	-	0.36	60	0.36	-	-	-	0.36
60	0.33	-	-	-	0.33	66	0.35	-	-	-	0.35
66	0.32	-	-	-	0.32	75	0.33	-	-	-	0.33
77	0.31	-	-	-	0.31	80	0.31	-	-	-	0.31
80	0.30	-	-	-	0.30	88	0.30	-	-	-	0.30
88	0.28	-	-	-	0.28	100	0.29	-	-	-	0.29
100	0.27	0.09	1.0	0.68	0.32	120	0.27	0.09	1.15	0.88	0.34
120	0.26	0.07	0.9	0.71	0.37	140	0.26	0.07	0.95	0.79	0.38

the seedling stage and reached a maximum of 0.39 percent in TMV2 and 0.4 percent in Asiriya Mwitunde at the 35th and 40th day respectively. Thereafter the percent content of the whole plant recorded a gradual fall upto 88th day and 100th day in the case of TMV2 and Asiriya Mwitunde respectively. After reaching a minimum the percentage of phosphorus increased and attained nearly the same level as it was at the 20th day in both the varieties.

The percentage phosphorus of the whole plant at different stages of growth was nearly the same in both the varieties under study.

The N:P ratio in respect of contents during the initial phase was 9.2 and touched the values 11.05 at the 35th day in the case of TMV2 and gradually decreased till harvest. A similar trend was observed in the case of Asiriya Mwitunde also (Highest ratio of 10.5 was recorded at 50th day).

(3) Potassium

The percentage potassium of the whole plant recorded the highest value (1.90 percent at 35th day and 1.98 percent at 40th day) in the case of

Table No. 4 PERCENT POTASSIUM AT DIFFERENT STAGES OF PLANT GROWTH.

TMV2						ASIRIYA MWITUNDE					
Age in days.	Stem and leaves.	POD			Whole plant.	Age in days.	Stem and leaves.	POD			Whole plant.
		Shell.	Kernel.	Whole pod.				Shell.	Kernel.	Whole pod.	
1	2	3	4	5	6	1	2	3	4	5	6
20	1.60	-	-	-	1.60	20	1.70	-	-	-	1.70
35	1.90	-	-	-	1.90	40	1.98	-	-	-	1.98
40	1.85	-	-	-	1.85	50	1.90	-	-	-	1.90
50	1.80	-	-	-	1.80	60	1.84	-	-	-	1.84
60	1.72	-	-	-	1.72	66	1.80	-	-	-	1.80
66	1.68	-	-	-	1.68	75	1.74	-	-	-	1.74
75	1.64	-	-	-	1.64	80	1.68	-	-	-	1.68
80	1.60	-	-	-	1.60	88	1.66	-	-	-	1.66
88	1.56	-	-	-	1.56	100	1.62	-	-	-	1.62
100	1.52	0.2	1.25	0.88	1.43	120	1.58	0.2	1.25	0.99	1.50
120	1.48	0.12	1.20	0.95	1.40	140	1.50	0.12	1.22	1.02	1.38

TMV2 and Asiriya Mwitunde respectively thereafter there was a gradual fall up to harvest. Lowest potassium content was recorded at harvest by both the varieties (1.4 and 1.38 percent). Such declining trend in potassium content was observed in soyabean by Togari et al (1955).

Though the potassium content in Asiriya Mwitundo was high during the initial and vegetative phases, but no appreciable differences were recorded at harvest. Potassium content in whole plant increased with the age of the crops in both the varieties. Asiriya Mwitunde pod recorded higher potassium value (0.99 and 1.02 per cent) when compared to TMV2 (0.88 and 0.95 percent). The N:K ratio was maximum (2.4) at 35th day in the case of TMV2 and 40th day in Asiriya Mwitunde (2.1).

(b) SECONDARY ELEMENTS.

(1) Calcium

The calcium content of the whole plant was (1.48 and 1.52 percent) at 20th day in TMV2 and Asiriya Mwitunde respectively. Highest calcium content was recorded at the 40th day in both the varieties. Thereafter it recorded a decreasing

Table No. 5 PERCENT CALCIUM AT DIFFERENT STAGES OF PLANT GROWTH.

TMV2						ASIRIYA MWITUNDE					
Age in days.	Stem and leaves.	POD Shell.	POD Kernel.	POD Whole pod.	Whole plant.	Age in days.	Stem and leaves.	POD Shell.	POD Kernel.	POD Whole pod.	Whole plant.
1	2	3	4	5	6	1	2	3	4	5	6
20	1.48	-	-	-	1.48	20	1.52	-	-	-	1.52
35	1.55	-	-	-	1.55	40	1.81	-	-	-	1.81
40	1.70	-	-	-	1.70	50	1.75	-	-	-	1.75
50	1.65	-	-	-	1.65	60	1.70	-	-	-	1.70
60	1.55	-	-	-	1.55	66	1.66	-	-	-	1.66
66	1.50	-	-	-	1.50	75	1.60	-	-	-	1.60
75	1.46	-	-	-	1.46	80	1.51	-	-	-	1.51
80	1.40	-	-	-	1.40	88	1.46	-	-	-	1.46
88	1.45	-	-	-	1.45	100	1.50	-	-	-	1.50
100	1.40	3.00	1.20	1.81	1.45	120	1.48	3.10	1.31	1.74	1.51
120	1.35	3.50	1.00	1.55	1.40	140	1.40	3.80	1.00	1.48	1.42

trend in the case of TMV2 till harvest except at 88th day when it was slightly more than 88th day. A similar trend was observed in the case of Asiriya Mwitunde also.

Asiriya Mwitunde recorded comparatively higher values of calcium content of whole plant when compared to TMV2 and this trend was kept up during all the stages of growth.

The whole pod calcium content showed a declining trend in both the varieties. TMV2 recorded higher whole pod calcium content than Asiriya Mwitunde.

The Ca:K ratio which governs the water balances in plants was 0.9 and 1.0 in TMV2 and Asiriya Mwintunde respectively.

(2) Magnesium

The Magnesium content in the whole plant during the initial stage (20th day) was 1.33 and 1.50 percent respectively. Maximum content was recorded at 40th day in both the varities (1.6 and 1.61 percent). From 40th day onwards there was a gradual fall in the magnesium content of the whole plant in both the varieties, but a slight increase at the 75th day in TMV2 and 80th day

Table No. 6 PERCENT MAGNESIUM AT DIFFERENT STAGES OF PLANT GROWTH.

TMV2						ASIRIYA MWITUNDE					
		POD						POD			
Age in days.	Stem and leaves.	Shell.	Kernel.	Whole pod.	Whole plant.	Age in days.	Stem and leaves.	Shell.	Kernel.	Whole pod.	Whole plant.
1	2	3	4	5	6	1	2	3	4	5	6
20	1.33	-	-	-	1.33	20	1.50	-	-	-	1.50
35	1.50	-	-	-	1.50	40	1.61	-	-	-	1.61
40	1.60	-	-	-	1.60	50	1.54	-	-	-	1.54
50	1.51	-	-	-	1.51	60	1.44	-	-	-	1.44
60	1.42	-	-	-	1.42	66	1.40	-	-	-	1.40
66	1.32	-	-	-	1.32	75	1.31	-	-	-	1.31
75	1.35	-	-	-	1.35	80	1.35	-	-	-	1.35
80	1.28	-	-	-	1.28	88	1.30	-	-	-	1.30
88	1.19	-	-	-	1.19	100	1.20	-	-	-	1.20
100	1.10	0.18	0.65	0.48	1.01	120	1.16	0.18	0.65	0.53	1.07
120	1.05	0.14	0.55	0.44	0.90	140	1.05	0.14	0.60	0.52	0.90

in Asiriya Kwitunde. Lowest values of 0.90 percent were recorded at harvest in both the varieties.

Asiriya Kwitunde recorded higher whole pod magnesium content when compared to TMV2.

(3) Sulphur

Among the secondary nutrients sulphur is required at lower levels. The sulphur content of the whole plant varied between 0.4 and 0.77 percent in TMV2 and 0.6 and 0.83 percent in Asiriya Kwitunde, reaching a peak value of 1.10 and 1.20 percent at 66th and 75th day respectively.

Asiriya Kwitunde recorded slightly higher sulphur content during the different stages of growth.

(c) MICRO NUTRIENTS.

(i) Iron.

There was a gradual fall in whole plant iron content from 40th day in the case of TMV2 and Asiriya Kwitunde which continued till harvest maximum values of 293 & 302 p.p.m. was recorded at 40th day and the lowest value of

Table No. 7 PERCENT SULPHUR AT DIFFERENT STAGES OF PLANT GROWTH.

TMV2						[illegible]					
Age in days.	Stem and leaves.	POD			Whole plant.	Age in days.	Stem and leaves.	POD			Whole plant
		Shell.	Kernel.	Whole pod.				Shell.	Kernel.	Whole pod.	
1	2	3	4	5	6	1	2	3	4	5	6
20	0.40	-	-	-	0.40	20	0.60	-	-	-	0.60
35	0.62	-	-	-	0.62	40	0.80	-	-	-	0.80
40	0.70	-	-	-	0.70	50	0.95	-	-	-	0.95
50	0.80	-	-	-	0.80	60	1.00	-	-	-	1.00
60	0.95	-	-	-	0.95	66	1.10	-	-	-	1.10
66	1.10	-	-	-	1.10	75	1.20	-	-	-	1.20
75	1.00	-	-	-	1.00	80	1.15	-	-	-	1.15
80	0.96	-	-	-	0.96	88	1.10	-	-	-	1.10
88	0.90	-	-	-	0.90	100	1.05	-	-	-	1.05
100	0.80	0.50	1.50	1.15	0.84	120	0.95	0.50	1.50	1.25	0.98
120	0.75	0.40	1.00	0.86	0.77	140	0.90	0.40	1.00	0.65	0.83

Table No. 8 IRON CONTENT AT DIFFERENT STAGES OF PLANT GROWTH.

In p.p.m.

TMV2						ASIRIYA MWITUNDE					
Age in days.	Stem and leaves. (ppm.)	POD Shell.	POD Kernel.	POD Whole pod.	Whole plant.	Age in days.	Stem and leaves. (in ppm)	POD Shell.	POD Kernel.	POD Whole pod.	Whole plant.
1	2	3	4	5	6	1	2	3	4	5	6
20	224	-	-	-	224	20	261	-	-	-	261
35	256	-	-	-	256	40	302	-	-	-	302
40	293	-	-	-	293	50	285	-	-	-	285
50	266	-	-	-	266	60	253	-	-	-	253
60	240	-	-	-	240	66	236	-	-	-	236
66	212	-	-	-	212	75	212	-	-	-	212
75	194	-	-	-	194	80	200	-	-	-	200
80	182	-	-	-	182	88	191	-	-	-	191
88	174	-	-	-	174	100	180	-	-	-	180
100	162	40	255	180	164	120	171	40	280	220	177
120	150	35	200	162	153	140	160	35	250	212	173

153 and 173 ppm respectively at harvest.

The whole plant iron content was slightly higher in the case of Asiriya Mwitunde at various stages of growth and even at harvest.

The whole pod iron also recorded a declining trend at harvest in both the varieties. Asiriya Mwitunde recorded slightly higher values (212 ppm) of iron in whole pod than TMV2 (162 ppm).

2. Manganese

The manganese content of whole plant ranged between 220 ppm and 178 ppm in TMV2 and 200 ppm and 160 ppm in Asiriya Mwitunde recording the highest values of 290 ppm and 280 ppm at 40th day and 50th day respectively. Thereafter there was a gradual decrease in whole plant manganese content which continued till harvest in both the varieties.

There were no appreciable differences in whole pod manganese content in both the varieties. The whole pod manganese also recorded a declining trend towards harvest.

3. Zinc

The whole plant zinc content ranged from

Table No. 9 MANGANESE CONTENT AT DIFFERENT STAGES OF PLANT GROWTH.

(In p.p.m.)

TMV2						ASIRIYA MWITUNDE					
Age in days.	Stem and leaves.	POD Shell.	POD Kernel.	POD Whole pod.	Whole plant.	Age in days.	Stem and leaves.	POD Shell.	POD Kernel.	POD Whole pod.	Whole plant.
1	2	3	4	5	6	1	2	3	4	5	6
20	220	-	-	-	220	20	200	-	-	-	200
35	230	-	-	-	230	40	250	-	-	-	250
40	290	-	-	-	290	50	280	-	-	-	280
50	280	-	-	-	280	60	250	-	-	-	250
60	260	-	-	-	260	66	240	-	-	-	240
66	250	-	-	-	250	75	220	-	-	-	220
75	230	-	-	-	230	80	210	-	-	-	210
80	220	-	-	-	220	88	200	-	-	-	200
88	210	-	-	-	210	100	185	-	-	-	185
100	190	220	260	246	197	120	160	200	260	245	170
120	170	180	210	203	178	140	150	160	200	193	160

Table No. 10 ZINC CONTENT AT DIFFERENT STAGES OF PLANT GROWTH.

(In p.p.m.)

TMV2						ASIRIYA MWITUNDE					
Age in days.	Stem and leaves.	POD			Whole plant	Age in days.	Stem and leaves.	POD			Whole plant.
		Shell.	Kernel.	Whole pod.				Shell.	Kernel.	Whole pod.	
1	2	3	4	5	6	1	2	3	4	5	6
20	20	-	-	-	20	20	18	-	-	-	18
35	22	-	-	-	22	40	20	-	-	-	20
40	26	-	-	-	26	50	23	-	-	-	23
50	24	-	-	-	24	60	22	-	-	-	22
60	23	-	-	-	23	66	20	-	-	-	20
66	21	-	-	-	21	75	18	-	-	-	18
75	19	-	-	-	19	80	17	-	-	-	17
80	18	-	-	-	18	88	16	-	-	-	16
88	18	-	-	-	18	100	15	-	-	-	15
100	17	25	30	28	18	120	14	20	28	26	15
120	16	18	26	26	18	140	13	18	25	24	15

20 ppm to 19 ppm in TMV2 and 18 ppm to 17 ppm in Asiriya Mwitunde recording the maximum value of 26 ppm and 23 ppm at 40th and 50th day respectively. After reaching a peak value the percentage zinc content of the whole plant showed decreasing trend till it attained the lowest values at harvest in both the varieties.

TMV2 recorded comparatively higher whole plant zinc content than Asiriya Mwitunde.

Zinc content of the pod was however slightly more than that in the pod of Asiriya Mwitunde.

4. Copper

Copper is required in smaller quantity than zinc. There was a gradual increase in whole plant copper content during the early part of the vegetative phase and attained the peak at 60th day in the case of TMV2 (20 ppm) and 66th day (18 ppm) in the case of Asiriya Mwitunde. Thereafter the whole plant copper recorded a descending trend which continued till harvest in both the varieties attaining the lowest values of 13 and 11 ppm respectively.

Though TMV2 recorded slightly higher whole

Table No. 11 COPPER CONTENT AT DIFFERENT STAGES OF PLANT GROWTH.

(In p.p.m.)

TMV2						ASIRIYA MWITUNDE					
Age in days.	Stem and leaves.	POD			Whole plant.	Age in days.	Stem and leaves.	POD			Whole plant.
		Shell.	Kernel.	Whole pod.				Shell.	Kernel.	Whole pod.	
1	2	3	4	5	6	1	2	3	4	5	6
20	18	-	-	-	18	20	15	-	-	-	15
35	14	-	-	-	14	40	10	-	-	-	10
40	15	-	-	-	15	50	11	-	-	-	11
50	18	-	-	-	18	60	13	-	-	-	13
60	20	-	-	-	20	66	18	-	-	-	18
66	19	-	-	-	19	75	16	-	-	-	16
75	18	-	-	-	18	80	15	-	-	-	15
80	17	-	-	-	17	88	14	-	-	-	14
88	16	-	-	-	16	100	13	-	-	-	13
100	14	15	25	21	15	120	11	15	25	22	12
120	13	11	15	13	13	140	10	15	15	14	11

plant copper content at different stages of its growth, copper content of the pod was nearly the same in both the varieties.

5. <u>Boron</u>

Boron content was lowest at 20th day in both the varieties (30 and 33 ppm). The whole plant boron content increased with increase in the age of the crop in both the varieties attaining the highest values of 44 ppm in TMV2 at 88th day and in Asiriya Mwitunde (46 ppm) at 100th day. The boron content of vegetative part can be considered to have maintained nearly the same level from 100th day onwards till harvest in both the varieties. The boron content of pod was 25 ppm in TMV2 and Asiriya Mwitunde at harvest.

6. <u>Molybdenum</u>

Molybdenum content in whole plant was highest during the initial stage (20th day) in both the varieties 19 and 22 ppm. From 20th day onwards there was a gradual decrease in whole plant molybdenum content till harvest in both the varieties, recording the lowest values of 7 and 10 ppm respectively.

Table No. 12 BORON CONTENT AT DIFFERENT STAGES OF PLANT GROWTH.

(In p.p.m.)

T.V2						A.H. [illegible]					
		POD						POD			
Age in days.	Stem and leaves.	Shell.	Kernel.	Whole pod.	Whole plant.	Age in days.	Stem and leaves.	Shell.	Kernel.	Whole pod.	Whole plant
1	2	3	4	5	6	1	2	3	4	5	6
20	30	-	-	-	30	20	33	-	-	-	33
35	32	-	-	-	32	40	35	-	-	-	35
40	38	-	-	-	38	50	40	-	-	-	40
50	39	-	-	-	39	60	41	-	-	-	41
60	40	-	-	-	40	66	42	-	-	-	42
66	41	-	-	-	41	75	43	-	-	-	43
75	42	-	-	-	42	80	44	-	-	-	44
80	43	-	-	-	43	88	45	-	-	-	45
88	44	-	-	-	44	100	46	-	-	-	46
100	45	25	30	28	42	120	45	30	33	32	43
120	44	25	25	25	40	140	45	25	25	25	39

Table No. 13 MOLYBDENUM CONTENT AT DIFFERENT STAGES OF PLANT GROWTH

(In p.p.m.)

TMV2						[illegible]					
Age in days.	Stem and leaves.	POD Shell.	POD Kernel.	POD Whole pod.	Whole plant.	Age in days.	Stem and leaves.	POD Shell.	POD Kernel.	POD Whole pod.	Whole plant.
1	2	3	4	5	6	1	2	3	4	5	6
20	19	-	-	-	19	20	22	-	-	-	22
35	18	-	-	-	18	40	20	-	-	-	20
40	17	-	-	-	17	50	18	-	-	-	18
50	15	-	-	-	15	60	15	-	-	-	15
60	12	-	-	-	12	66	14	-	-	-	14
66	11	-	-	-	11	75	13	-	-	-	13
75	9	-	-	-	9	80	12	-	-	-	12
80	11	-	-	-	11	88	13	-	-	-	13
88	11	-	-	-	11	100	12	-	-	-	12
100	10	6	19	11	8	120	11	6	20	16	11
120	9	6	11	9	7	140	9	6	11	10	10

Asiriya Mwitunde showed slightly higher whole plant molybdenum content when compared to TMV2 at all the stages of growth.

The molybdenum content of the pod also was slightly high in Asiriya Mwitundo.

3. NUTRIENT UPTAKE.

The uptake of various nutrient elements at different stages of growth separately for vegetative (shoots) and reproductive (pods) parts by the two varieties under study is furnished in Tables 14 to 25 and figures 2 to 8.

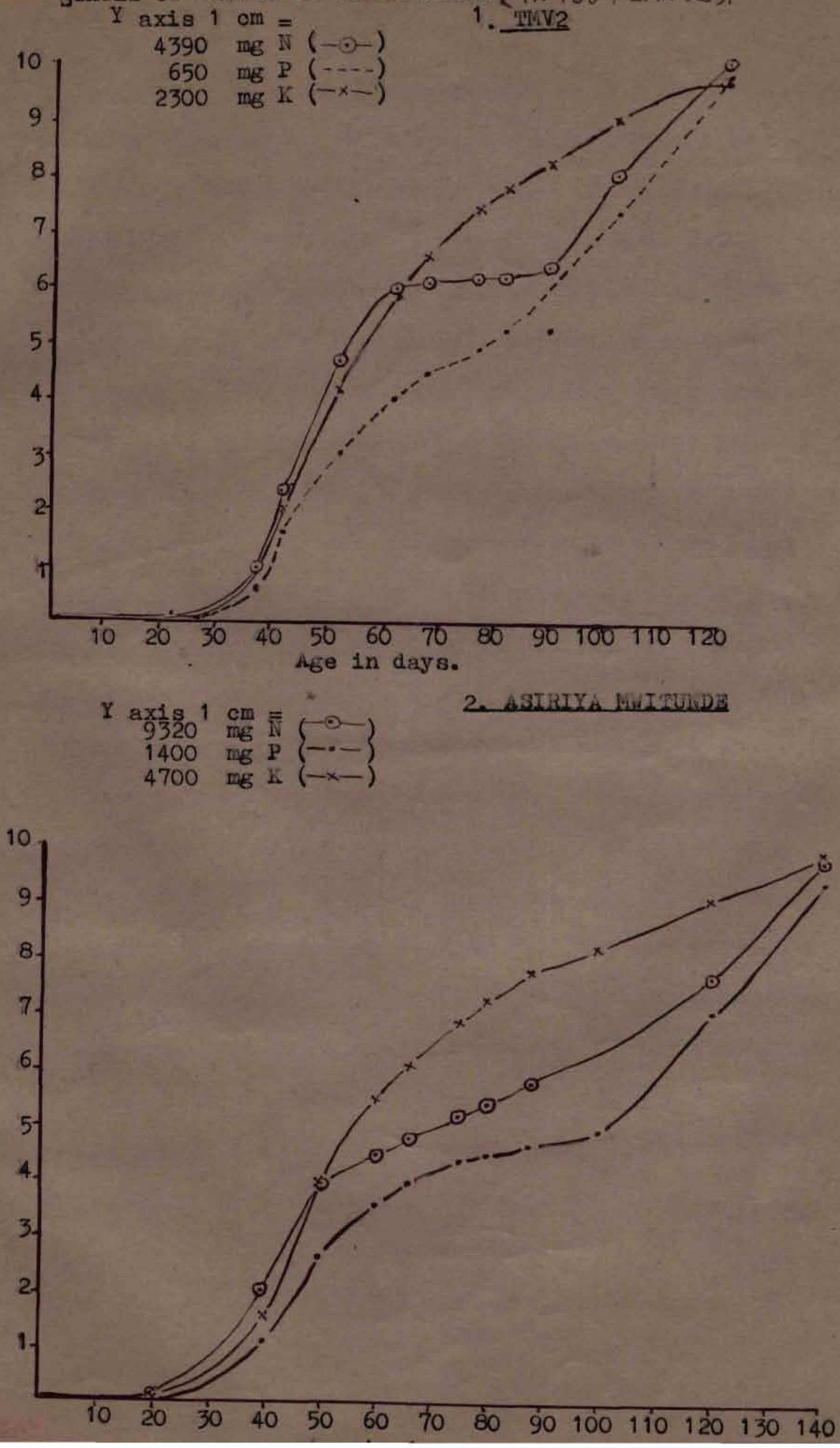
(a) MACRO NUTRIENTS.

(1) Nitrogen.

The total uptake of nitrogen closely followed the trend of dry matter production. It increased with increase in the age of the plant in both the varieties attaining the highest values of 43872.7 and 92501.8 milligrams per 100 plants in TMV2 and Asiriya Mwitundo respectively at harvest. (195 and 183 kg N per hectare respectively at harvest). The total nitrogen uptake by Asiriya Mwitundo was more than twice that taken up by TMV2. This is attributable to higher dry matter production and

FIG. NO. 3

TOTAL UPTAKE OF MACRO NUTRIENDS (N,P, & K) AT DIFFERENT STAGES OF GROWTH OF WHOLE PLANT (IN 100 PLANTS).

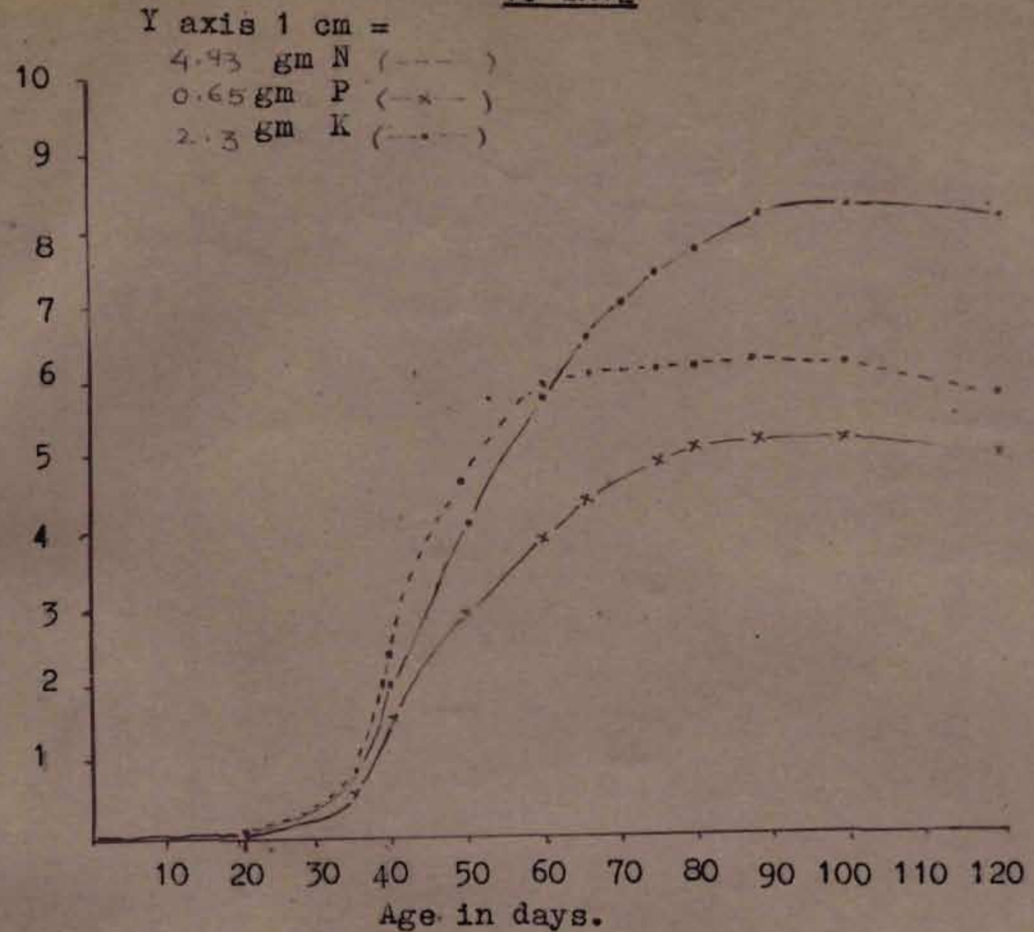


partly to higher nitrogen content of the whole plant in Asiriya Mwitunde. A sudden increase in total nitrogen uptake was recorded within a period of 25 days from 4.208 gm per 100 plants at 35th day to 25.746 gm per 100 plants at 68th day which corresponds with the phase of intense vegetative growth in the case of TMV2. Thereafter the increase in total nitrogen uptake was not spectacular till 83th day. There was a considerable nitrogen uptake till the time of harvest, coinciding with the later part of the fruiting phase. In the [illegible] siriya Mwitunde the total nitrogen uptake [illegible] siderably higher than that of TMV2 at diff[illegible] of growth. The patt rn of nitrogen uptake was nearly similar to that of TMV2. There was a considerable increase in nitrogen with increase in the age of the crop till 60th day, coinciding with the phase of intense vegetative growth. Thereafter the increase was not spectacular till 100th day. There was a considerable uptake of nitrogen till [illegible] harvests coinciding with the later part of the fruiting stage as in the case of TMV2. The ~~[illegible]~~ nitrogen uptake by Asiriya Mwitunde was more than double that of by

FIG. NO. 4

UPTAKE OF MACRO NUTRIENTS (N, P & K) BY VEGETATIVE PARTS AT VARIOUS STAGES OF GROWTH (IN 100 PLANTS).

1. TMV2



2. ASIRIYA MWITUNDE

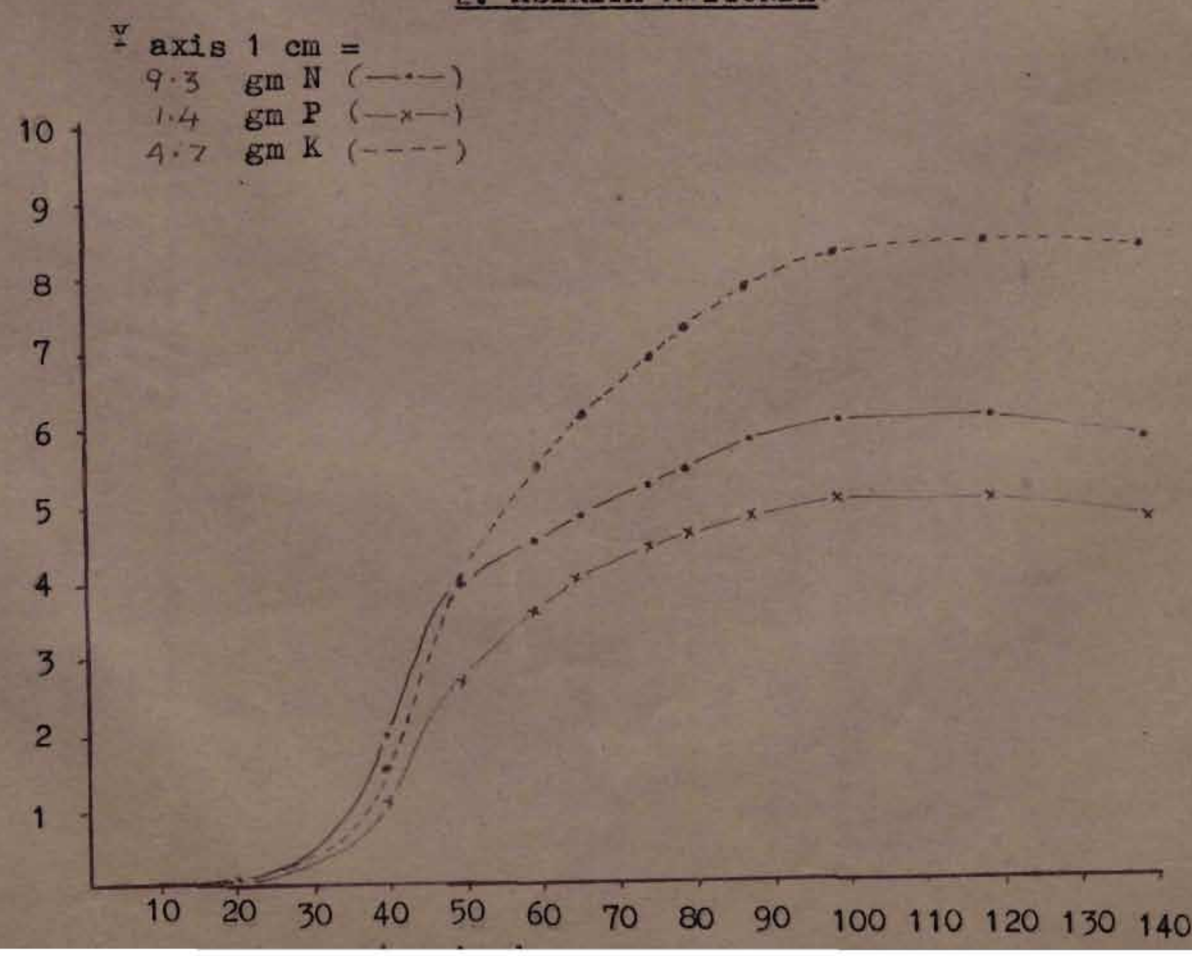


Table No. 14

UPTAKE OF NITROGEN AT VARIOUS STAGES OF PLANT GROWTH

T.V2						ASIRIYA MWITUNDE					
Age in days.	GRAMS IN 100 PLANTS.					Age in days.	GRAMS IN 100 PLANTS.				
	Stem & leaves.	POD			Whole plant.		Stem & leaves.	POD			Whole plant.
		Shell.	Kernel.	Total.				Shell.	Kernel.	Total.	
1	2	3	4	5	6	1	2	3	4	5	6
20	0.38	-	-	-	0.38	20	1.13	-	-	-	1.13
35	4.21	-	-	-	4.21	40	16.81	-	-	-	16.81
40	10.26	-	-	-	10.26	50	36.91	-	-	-	36.91
50	20.42	-	-	-	20.42	60	42.25	-	-	-	42.25
60	25.75	-	-	-	25.75	66	45.02	-	-	-	45.02
66	26.38	-	-	-	26.38	75	48.89	-	-	-	48.89
75	26.99	-	-	-	26.99	80	50.63	-	-	-	50.63
80	27.12	-	-	-	27.12	88	52.61	-	-	-	52.61
88	27.84	-	-	-	27.84	100	56.21	-	-	-	56.21
100	27.51	0.35	7.40	7.75	35.26	120	55.80	0.54	15.68	16.22	72.02
120	25.61	0.37	17.89	18.26	43.87	140	53.14	0.72	38.64	39.36	92.50

Table No. 14 (a) UPTAKE OF NITROGEN AT DIFFERENT STAGES OF PLANT GROWTH BY TMV2 AND ASIRIYA MUITUNDE (Kg/hac)

Age in days.	TMV2			Age in days.	ASIRIYA MUITUNDE.		
	Stem + leaves.	Pods.	Whole plant.		Stem + Leaves.	Pods.	Whole plant
20	1.69	-	1.69	20	2.23	-	2.23
35	18.71	-	18.71	40	33.00	-	33.00
40	45.60	-	45.60	50	72.91	-	72.91
50	90.76	-	90.76	60	83.46	-	83.46
60	114.44	-	114.44	66	88.93	-	88.93
66	117.24	-	117.24	75	86.57	-	86.57
75	119.96	-	119.96	80	100.01	-	100.01
80	120.53	-	120.53	88	104.02	-	104.02
88	123.73	-	123.73	100	111.04	-	111.04
100	122.27	34.44	156.71	120	110.22	32.04	142.26
120	113.82	81.15	194.97	140	104.97	77.75	182.72

TMV2. Translocation of nitrogen from vegetative parts to reproductive parts is clearly seen by the decreasing trend and nitrogen uptake by vegetative part after 88th day in TMV2 and 100th day in Asiriya Mwitunde.

(2) Phosphorus

The total phosphorus uptake by the whole plant followed the trend of nitrogen uptake in both the varieties in that it increased with increase in the age of the crop till harvest. There was a rapid increase in phosphorus uptake from 20th to 35th day in TMV2 and 20th to 40th day in Asiriya Mwitunde and continued during the intense vegetative phase and fruiting phase till 68th day in the case of TMV2 and 75th day in Asiriya Mwitunde. The total uptake during this period was 2.57 gm per 100 plants in TMV2 and 6.24 gm per 100 plants in Asiriya Mwitunde. The uptake of phosphorus continued even during the fruiting phase in smaller quantities in the first part of the phase and in considerable quantities in the later part. As in the case of nitrogen, the trend of uptake of phosphorus in both the varieties indicates that phosphorus is required for vegetative growth and pod formation. The whole plant phosphorus

Table No. 15 UPTAKE OF PHOSPHORUS AT VARIOUS STAGE OF PLANT GROWTH

TMV2						ASIRIYA [illegible]					
Age in days.	GRAMS IN 100 PLANTS.					Age in days.	GRAMS IN 100 PLANTS.				
	Stem & leaves.	POD			Whole plant.		Stem & leaves.	POD			Whole plant.
		Shell.	Kernel.	Total.				Shell.	Kernel.	Total	
1	2	3	4	5	6	1	2	3	4	5	6
20	0.04	-	-	-	0.04	20	0.11	-	-	-	0.11
35	0.38	-	-	-	0.38	40	1.60	-	-	-	1.60
40	0.97	-	-	-	0.97	50	3.80	-	-	-	3.80
50	1.91	-	-	-	1.91	60	5.07	-	-	-	5.07
60	2.57	-	-	-	2.57	66	5.61	-	-	-	5.61
66	2.88	-	-	-	2.88	75	6.21	-	-	-	6.21
75	3.15	-	-	-	3.15	80	6.38	-	-	-	6.38
80	3.36	-	-	-	3.36	88	6.63	-	-	-	6.63
88	3.39	-	-	-	3.39	100	6.97	-	-	-	6.97
100	3.37	0.06	1.32	1.38	4.75	120	6.70	0.08	3.16	3.24	9.94
120	3.33	0.06	2.93	2.99	6.32	140	6.58	0.10	6.55	6.65	13.23

Table No. 15 (a) UPTAKE OF PHOSPHORUS AT DIFFERENT STAGES OF PLANT GROWTH BY EMV2 AND ASIRIYA MWITUNDE (Kg/hac).

Age in days.	EMV2			Age in days.	ASIRIYA MWITUNDE		
	Stem + leaves.	Pods.	Whole plant.		Stem + leaves.	Pods.	Whole plant
20	0.18	-	0.18	20	0.22	-	0.22
35	1.69	-	1.69	40	3.16	-	3.16
40	4.31	-	4.31	50	7.51	-	7.51
50	8.49	-	8.49	60	9.91	-	9.91
60	11.42	-	11.42	66	11.08	-	11.08
66	12.80	-	12.80	75	12.27	-	12.27
75	14.00	-	14.00	80	12.60	-	12.60
80	14.93	-	14.93	88	13.10	-	13.10
88	15.07	-	15.07	100	13.77	-	13.77
100	14.98	6.13	21.11	120	13.23	6.40	19.63
120	14.80	13.29	28.09	140	13.00	13.13	26.13

uptake was considerably higher in Asiriya Mwitundo than that in TMV2 at all the stages of growth. While it was 6.32 gm per 100 plants in the case of TMV2 it was 13.23 gm per 100 plants in case of Asiriya Mwitundo which is nearly double (28 and 26 kg per hectare respectively at harvest).

Phosphorus uptake by Asiriya Mwitundo pod (6.65 gm/100)plants was also greater than that (2.99 gm per 100 plants) by TMV2.

The data show the greater efficiency of Asiriya Mwitundo in absorbing phosporus as in the case of nitrogen. As a result of this the total dry matter as also pod production were higher in Asiriya Mwitundo, indicating the high yielding nature of Asiriya Mwitundo.

The phosphorus uptake by vegetative portion (leave + stem) was somewhat sigmoid in pattern in both the varieties as in the case of nitrogen.

(3) Potassium

Total uptake of potassium also closely followed the pattern of dry matter production in

Table No. 16 UPTAKE OF POTASSIUM AT VARIOUS STAGE OF PLANT GROWTH

KHV2						[illegible]					
Age in days.	GRAMS IN 100 PLANTS. Stem & Leaves.	Pod Shell.	Pod Kernel.	Pod Total.	Whole plant.	Age in days.	GRAMS IN 100 PLANTS. Stem & leaves.	Pod Shell.	Pod Kernel.	Pod Total.	Whole plant.
1	2	3	4	5	6	1	2	3	4	5	6
20	0.18	-	-	-	0.18	20	0.53	-	-	-	0.53
35	1.90	-	-	-	1.90	40	7.92	-	-	-	7.92
40	4.63	-	-	-	4.63	50	19.00	-	-	-	19.00
50	9.55	-	-	-	9.55	60	25.91	-	-	-	25.91
60	13.42	-	-	-	13.42	66	28.84	-	-	-	28.84
66	15.12	-	-	-	15.12	75	32.72	-	-	-	32.72
75	17.22	-	-	-	17.22	80	34.58	-	-	-	34.58
80	17.93	-	-	-	17.93	88	36.69	-	-	-	36.69
88	18.88	-	-	-	18.88	100	38.92	-	-	-	38.92
100	19.00	0.14	1.65	1.79	20.79	120	39.19	0.18	3.43	3.61	42.80
120	18.95	0.11	3.90	4.01	22.96	140	37.95	0.17	8.42	8.59	46.54

Table No. 16(a) UPTAKE OF POTASSIUM AT DIFFERENT STAGES OF PLANT GROWTH BY TMV2 AND ASIRIYA MWITUNDE (Kg/Hac)

Age in days.	TMV2			Age in days.	ASIRIYA MWITUNDE		
	Stem + Leaves.	Pods.	Whole plant.		Stem + Leaves.	Pods.	Whole Plant.
20	0.80	-	0.80	20	1.05	-	1.05
35	8.44	-	8.44	40	15.84	-	15.84
40	16.13	-	16.13	50	37.53	-	37.53
50	42.24	-	42.24	60	51.18	-	51.18
60	59.64	-	59.64	66	56.97	-	56.97
66	67.20	-	67.20	75	64.63	-	64.63
75	76.53	-	76.53	80	68.31	-	68.31
80	79.64	-	79.64	88	73.47	-	73.47
88	83.91	-	83.91	100	76.98	-	76.98
100	84.44	7.96	92.40	120	77.41	7.13	84.54
120	84.22	17.82	102.04	140	74.96	16.97	91.93

both the varieties in that it increased with increase in the age of the crop. Uptake of potassium was low during the initial phase 0.18 and 0.53 gm per 100 plants) (20th day) and increased rapidly during the vegetative phase in both the varieties. The total uptake by the whole plant during this phase ranged between 1.903 and 13.42 gm per 100 plants and 7.92 and 25.91 gm per 100 plants in the case of TMV2 and Asiriya Mwitunde respectively, the vegetative period covering 60 days. However the potassium absorption continued even after the phase of intense vegetative growth.

Potassium uptake by whole plant as well as pod was higher in Asiriya Mwitunde than that in TMV2 during the different stages of growth. It was more than double the absorption by TMV2. While the total uptake by TMV2 was 22.96 gm per 100 plants it was 46.54 mg per 100 plants by Asiriya Mwitunde. (102 and 92 kg K per hectare respectively at harvest)

The potassium uptake curves by the vegetative parts of the two varieties were somewhat sigmoid in pattern.

(b) SECONDARY NUTRIENTS.

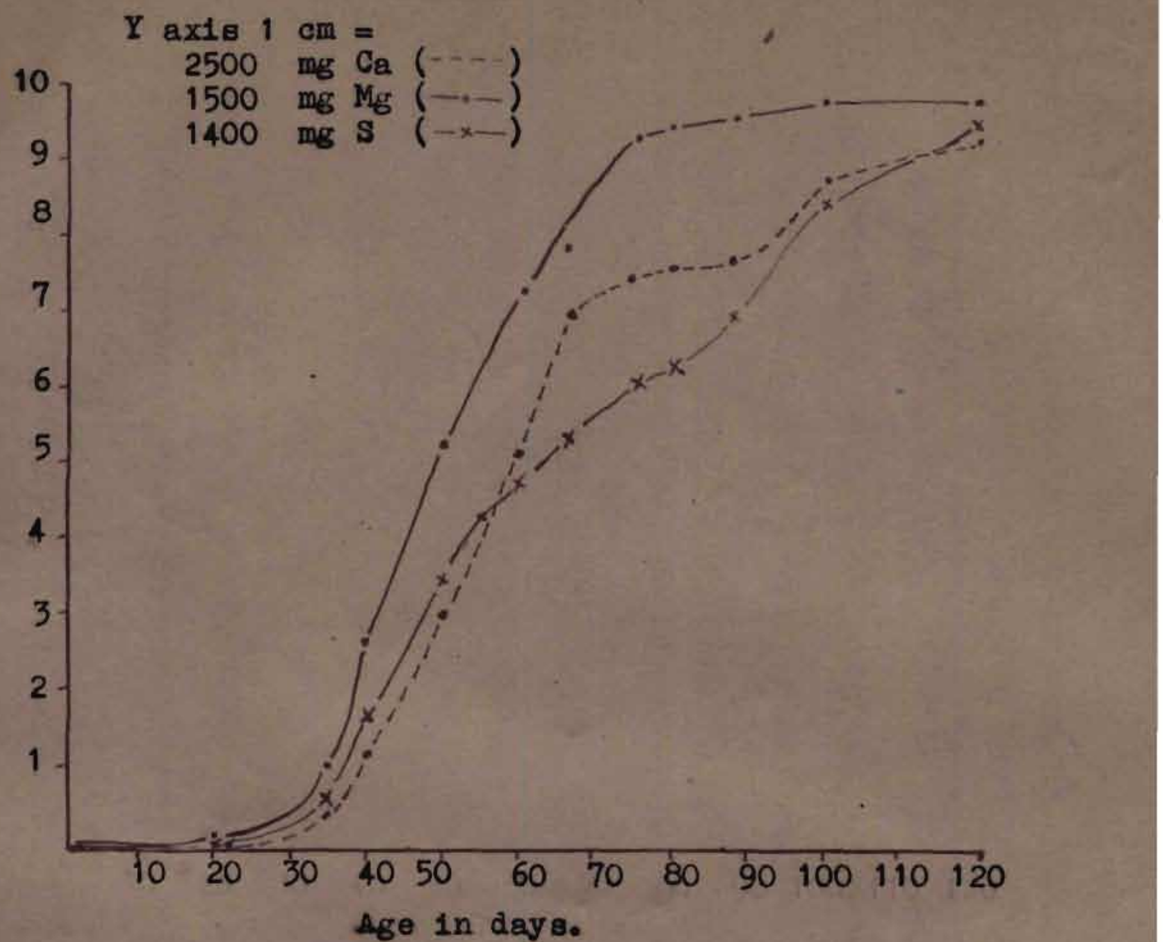
(1) Calcium

Uptake of calcium by the whole plant followed a pattern almost similar to that of potassium in both the varieties. Calcium absorption was low (0.17 and 0.47 gm per 100 plants) in both the varieties at 20th day; but there was a rapid increase upto 60th day in the case of TMV2 and the increasing trend continued thereafter till 88th day with a further spurt in calcium uptake, thereafter till harvest. This is probably due to the high calcium requirement at the time of pod formation. A similar trend was observed in the case of Asiriya Mwitunde. There was rapid increase in the uptake of whole plant calcium from 20th day onwards till the initiation of pod formation. As in the case of TMV2 there was a second spurt in the uptake of calcium of a greater magnitude during the last 40 days coinciding with pod formation hardening etc.

Asiriya Mwitunde recorded higher uptake of calcium during the initial phase

FIG. NO 5.
TOTAL UPTAKE OF SECONDARY NUTRIENTS (Ca, Mg & S)
AT VARIOUS STAGES OF GROWTH OF WHOLE PLANT (IN 100 PLANTS)

1. TMV2



2. ASIRIYA MWITUNDE.

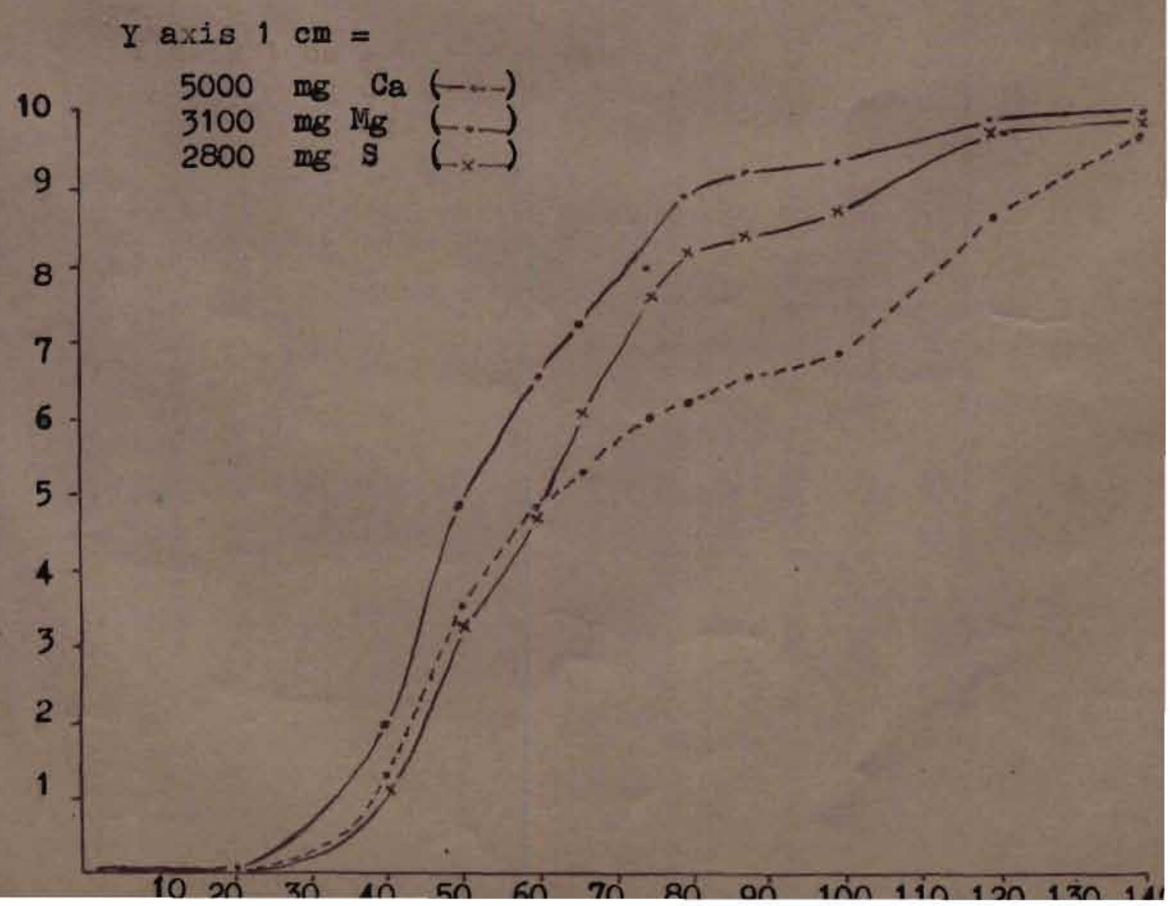


Table No. 17 UPTAKE OF CALCIUM AT VARIOUS STAGES OF PLANT GROWTH

[illegible]						[illegible]					
Age in days.	GRAMS IN 100 PLANTS.					Age in days.	GRAMS IN 100 PLANTS.				
	Stem & leaves.	POD			Whole plant.		Stem & leaves.	POD			Whole plant.
		Shell.	Kernel.	Total.				Shell.	Kernel.	Total	
1	2	3	4	5	6	1	2	3	4	5	6
20	0.17	-	-	-	0.17	20	0.47	-	-	-	0.47
35	1.55	-	-	-	1.55	40	6.40	-	-	-	6.40
40	4.25	-	-	-	4.25	50	17.50	-	-	-	17.50
50	8.75	-	-	-	8.75	60	23.94	-	-	-	23.94
60	12.09	-	-	-	12.09	66	26.60	-	-	-	26.60
66	13.50	-	-	-	13.50	75	30.08	-	-	-	30.08
75	15.33	-	-	-	15.33	80	31.08	-	-	-	31.08
80	15.69	-	-	-	15.69	88	32.27	-	-	-	32.27
88	17.65	-	-	-	17.65	100	33.87	-	-	-	33.87
100	17.50	2.07	1.59	3.66	21.16	120	36.71	2.79	3.58	6.37	43.08
120	17.28	3.27	3.25	6.52	23.80	140	35.42	5.51	6.90	12.41	47.83

Table No. 17(a) UPTAKE OF CALCIUM AT DIFFERENT STAGES OF PLANT GROWTH BY TMV2 & AMIRIYA MAITUNDE (Kg/hac)

Age in days.	TMV2			Age in days.	AMIRIYA MAITUNDE.		
	Stem + Leaves.	Pods.	Whole Plant.		Stem + Leaves.	Pods.	Whole plant.
20	0.76	-	0.76	20	0.93	-	0.93
35	6.89	-	6.89	40	12.64	-	12.64
40	18.89	-	18.89	50	34.57	-	34.57
50	38.89	-	38.89	60	47.29	-	47.29
60	53.73	-	53.73	66	52.54	-	52.54
66	60.00	-	60.00	75	59.42	-	59.42
75	68.13	-	68.13	80	61.39	-	61.39
80	69.73	-	69.73	88	63.74	-	63.74
88	68.44	-	68.44	100	66.90	-	66.90
100	77.78	16.26	94.04	120	72.51	12.58	85.09
120	76.80	28.98	105.78	140	69.97	24.51	94.48

(20th day) and this trend was kept up during the vegetative phase at harvest when compared to TMV2.

Asiriya Mwitunde pod recorded higher uptake (47.838 gm per 100 plants) than TMV2 (23.80 gm per 100 plants). TMV2 and Asiriya Mwitunde absorbed 106 and 95 kg per hectare at the time of harvest respectively.

The uptake curves of vegetative parts were somewhat sigmoid in pattern in both the varieties.

(2) Magnesium.

Uptake of magnesium was low in both the varieties (0.17 and 0.47 gm per 100 plants) during the initial phase (20th day). There was a rapid increase during the period roughly coinciding with the vegetative and early fruiting phase (upto 75th day) in the case of TMV2 (170.2 to 14179.1 mg per 100 plants) and thereafter uptake of magnesium was not significant; indicating that unlike calcium, magnesium is not important in pod formation. Amost similar trend was observed in the case of Asiriya Mwitunde.

Table No. 18 UPTAKE OF MAGNESIUM AT VARIOUS STAGES OF PLANT GROWTH

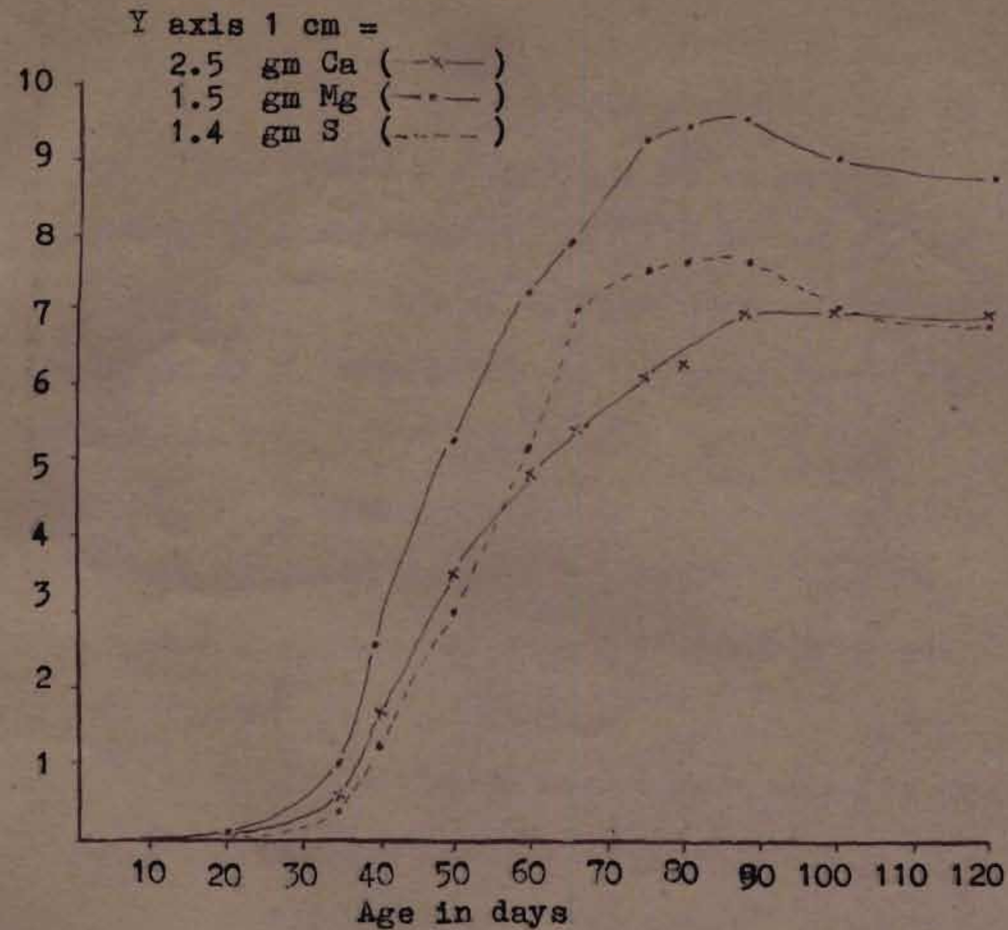
TMV2						ASIRIYA MWITUNDE					
Age in days.	GRAMS IN 100 PLANTS					Age in days.	GRAMS IN 100 PLANTS				
	Stem & leaves.	POD			Whole plant.		Stem & leaves.	POD			Whole plant.
		Shell.	Kernel.	Total.				Shell.	Kernel.	Total.	
1	2	3	4	5	6	1	2	3	4	5	6
20	0.15	-	-	-	0.15	20	0.47	-	-	-	0.47
35	1.50	-	-	-	1.50	40	6.44	-	-	-	6.44
40	4.00	-	-	-	4.00	50	15.40	-	-	-	15.40
50	8.00	-	-	-	8.00	60	20.28	-	-	-	20.28
60	11.08	-	-	-	11.08	66	22.43	-	-	-	22.43
66	11.88	-	-	-	11.88	75	24.63	-	-	-	24.63
75	14.18	-	-	-	14.18	80	27.79	-	-	-	27.79
80	14.34	-	-	-	14.34	88	28.73	-	-	-	28.73
88	14.40	-	-	-	14.40	100	28.83	-	-	-	28.83
100	13.75	0.12	0.86	0.98	14.73	120	28.77	0.16	1.79	1.95	30.72
120	13.44	0.13	1.79	1.92	15.36	140	26.57	0.20	4.14	4.34	31.00

Table No. 18(a) UPTAKE OF MAGNESIUM AT DIFFERENT STAGES OF PLANT GROWTH BY TMV2 AND ASIRIYA MWITUNDE (Kg/hac)

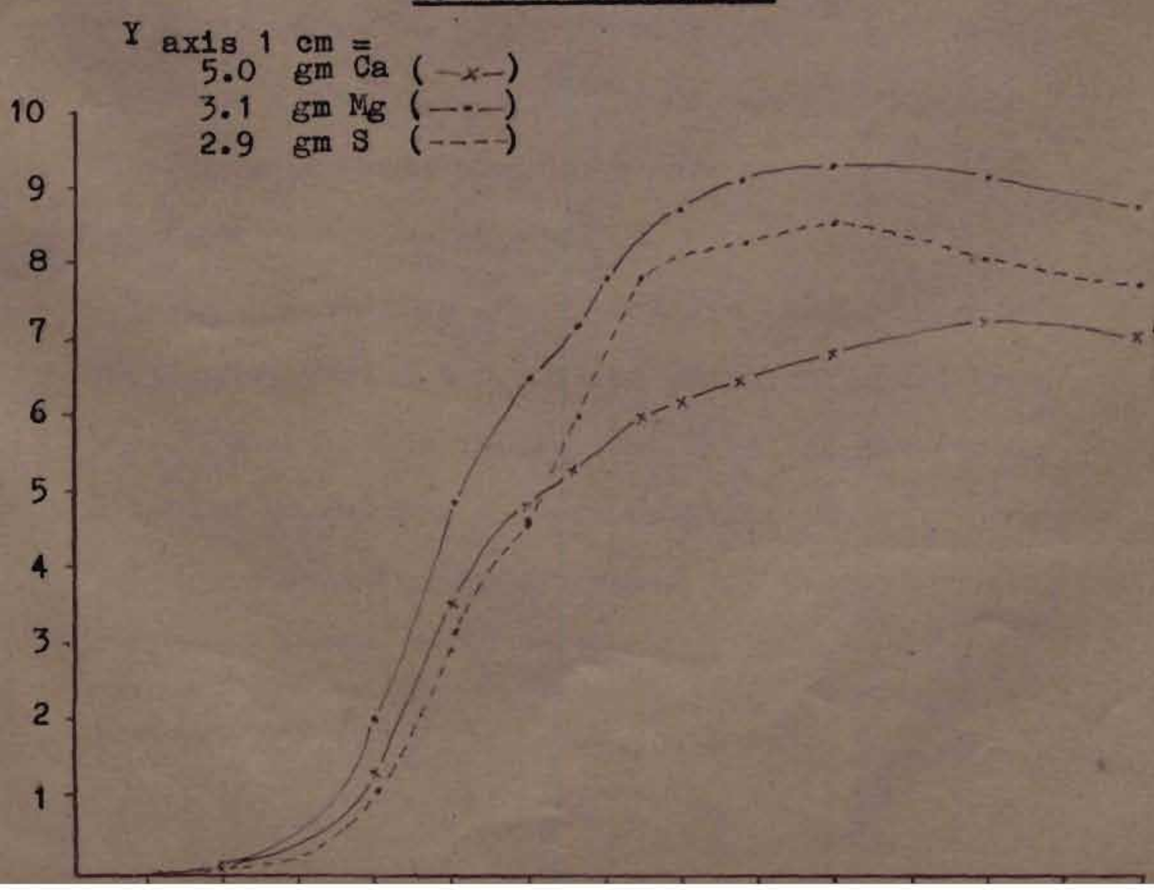
Age in days.	TMV2 Stem + Leaves.	TMV2 Pods.	TMV2 Whole plant.	Age in days.	ASIRIYA MWITUNDE Stem + Leaves.	ASIRIYA MWITUNDE Pods.	ASIRIYA MWITUNDE Whole Plant
20	0.67	-	0.67	20	0.93	-	0.93
35	6.67	-	6.67	40	12.72	-	12.72
40	17.78	-	17.78	50	30.42	-	30.42
50	35.56	-	35.56	60	40.06	-	40.06
60	49.27	-	49.27	66	44.31	-	44.31
66	52.80	-	52.80	75	48.65	-	48.65
75	63.02	-	63.02	80	54.89	-	54.89
80	63.73	-	63.73	88	56.75	-	56.75
88	64.00	-	64.00	100	56.95	-	56.95
100	61.11	4.36	65.47	120	56.83	3.85	60.68
120	59.73	8.53	68.26	140	52.48	8.57	61.05

FIG. NO. 6
UPTAKE OF SECONDARY NUTRIENTS (Ca, Mg, & S) BY VEGETATIVE PARTS AT VARIOUS STAGES OF GROWTH (IN 100 PLANTS)

1. TMV2



2. ASIRIYA MWITUNDE



Asiriya Mwitunde absorbed slightly more than double the quantity (31.0 gm per 100 plants) absorbed by TMV2 (15.36 gm per 100 plants) at the time of harvest. However per hectare uptake of Mg were 65 and 61 kg respectively at harvest.

Asiriya Mwitunde pod recorded higher uptake of magnesium (4343.1 mg per 100 plants) when compared with TMV2 (1919.8 mg per 100 plants).

The uptake curves were nearly sigmoid in both the varieties.

(3) Sulphur

Among the secondary nutrients, sulphur was absorbed by the plant in relatively lower level. Among the 2 varieties under study, the absorption of sulphur by whole plant was more in Asiriya Mwitunde.

Sulphur absorption was low (0.06 gm per 100 plants) during the initial phase, followed by a rapid absorption in the case of TMV2 and continued till post vegetative and pre-fruiting phases reaching a value of 9.90 gm per 100 plants by

Table No. 19 UPTAKE OF SULPHUR AT DIFFERENT STAGES OF PLANT GROWTH.

TMV2						ASIRIYA MWITUNDE					
	GRAMS IN 100 PLANTS						GRAMS IN 100 PLANTS				
		POD						POD			
Age in days.	Stem & leaves.	Shell.	Kernel.	Total.	Whole plant.	Age in days.	Stem & leaves.	Shell.	Kernel.	Total.	Whole plant.
1	2	3	4	5	6	1	2	3	4	5	6
20	0.05	-	-	-	0.05	20	0.19	-	-	-	0.19
35	0.62	-	-	-	0.62	40	3.20	-	-	-	3.20
40	1.75	-	-	-	1.75	50	9.50	-	-	-	9.50
50	4.24	-	-	-	4.24	60	14.08	-	-	-	14.08
60	7.41	-	-	-	7.41	66	17.62	-	-	-	17.62
66	9.90	-	-	-	9.90	75	22.56	-	-	-	22.56
75	10.50	-	-	-	10.50	80	23.67	-	-	-	23.67
80	10.76	-	-	-	10.76	88	24.31	-	-	-	24.31
88	10.69	-	-	-	10.69	100	25.22	-	-	-	25.22
100	10.00	0.35	1.98	2.33	12.33	120	23.56	0.45	4.13	4.58	28.14
120	9.60	0.37	3.25	3.62	13.22	140	22.77	0.58	4.90	5.48	28.22

Table No. 19(a) UPTAKE OF SULPHUR AT DIFFERENT STAGES OF PLANT GROWTH BY TMV2 AND ASIRIYA MWITUNDE (kg/hac)

Age in days.	TMV2			Age in days.	ASIRIYA MWITUNDE.		
	Stem + Leaves.	Pods.	Whole plant.		Stem + Leaves.	Pods.	Whole plant.
20	0.22	-	0.22	20	0.38	-	0.38
35	2.78	-	2.78	40	6.32	-	6.32
40	7.78	-	7.78	50	18.77	-	18.77
50	18.84	-	18.84	60	27.81	-	27.81
60	32.93	-	32.93	66	34.81	-	34.81
66	44.00	-	44.00	75	44.56	-	44.56
75	46.67	-	46.67	80	46.76	-	46.76
80	47.82	-	47.82	88	48.02	-	48.02
88	48.40	-	48.40	100	49.82	-	49.82
100	44.44	10.36	54.80	120	46.54	9.05	55.58
120	42.67	16.09	58.76	140	44.98	10.82	55.80

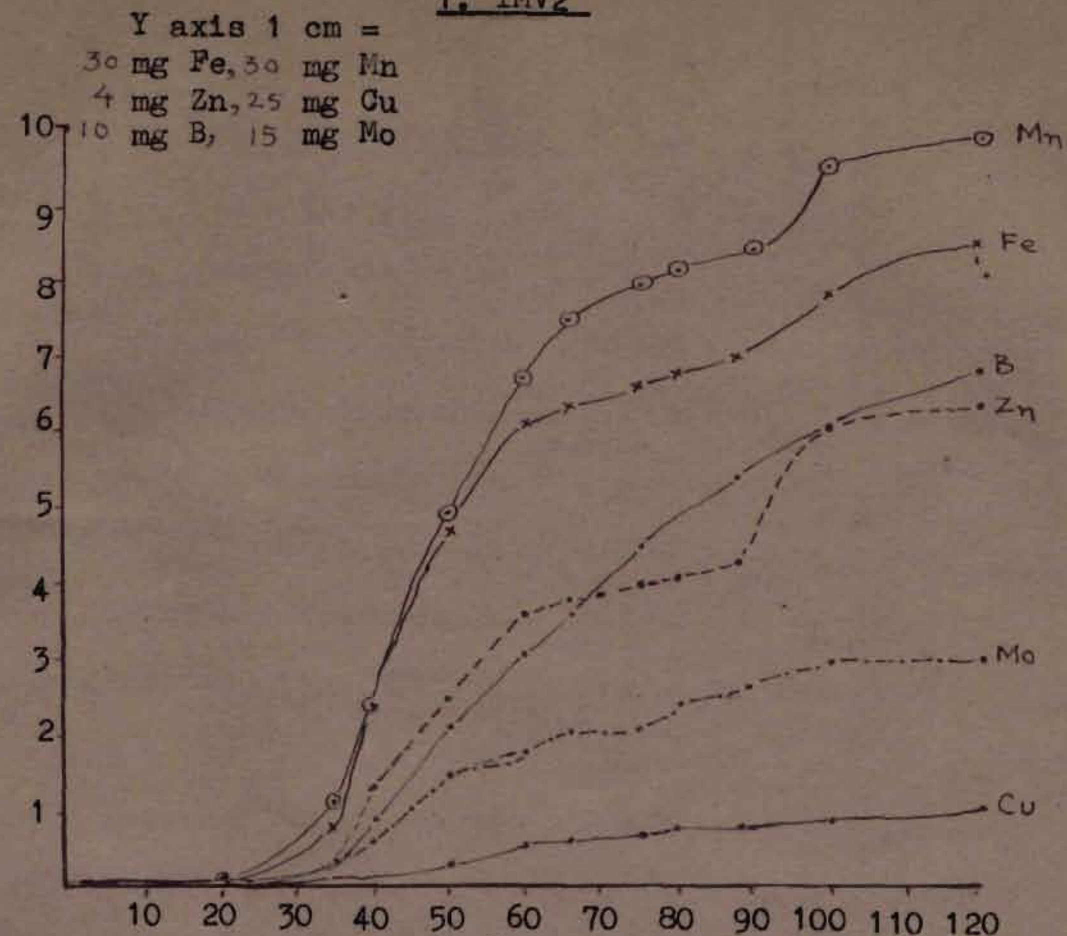
66th day. Thereafter the uptake remained nearly the same till 88th day followed by a further increase during the pod formation stage recording a total whole plant uptake of 13.22 gm sulphur per 100 plants at harvest. A similar trend was observed in the case of Aciriya Kwitundo. The initial absorption was low(0.19 gm per 100 plants) followed by a rapid increase after 20th day till 75th day. The increase thereafter was only small till 100th day, followed by a second spurt in sulphur uptake during the pod formation stage. Uptake of sulphur during fruiting phase in both the varieties may be due to its requirements by developing pods.

Both the reproductive and vegetative parts of Aciriya Kwitundo recorded higher uptake of sulphur (whole plant uptake 28.22 gm per 100 plants) than EWV2 (whole plant uptake 13.22 gm per 100 plants) EWV2 and Aciriya Kwitundo absorbed a total of 59 and 56 kg of S per hectare at harvest.

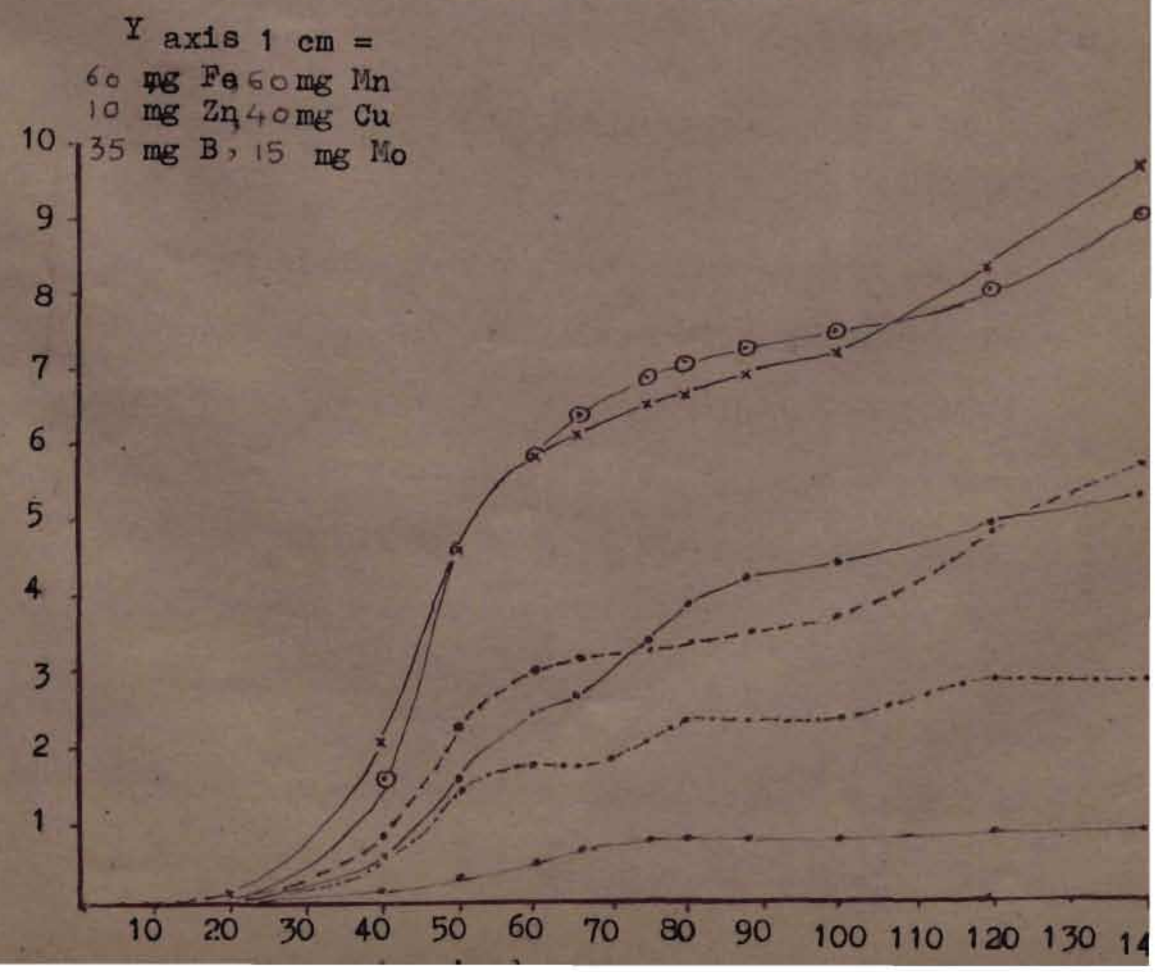
The uptake curves may be considered to be somewhat sigmoid in both the varieties.

TOTAL UPTAKE OF MICRO NUTRIENT (Fe, Mn, Zn, Cu, B & Mo) AT VARIOUS STAGES OF GROWTH OF WHOLE PLANT (IN 100 PLANTS)

1. TMV2



2. ASIRIYA MWITUNDE

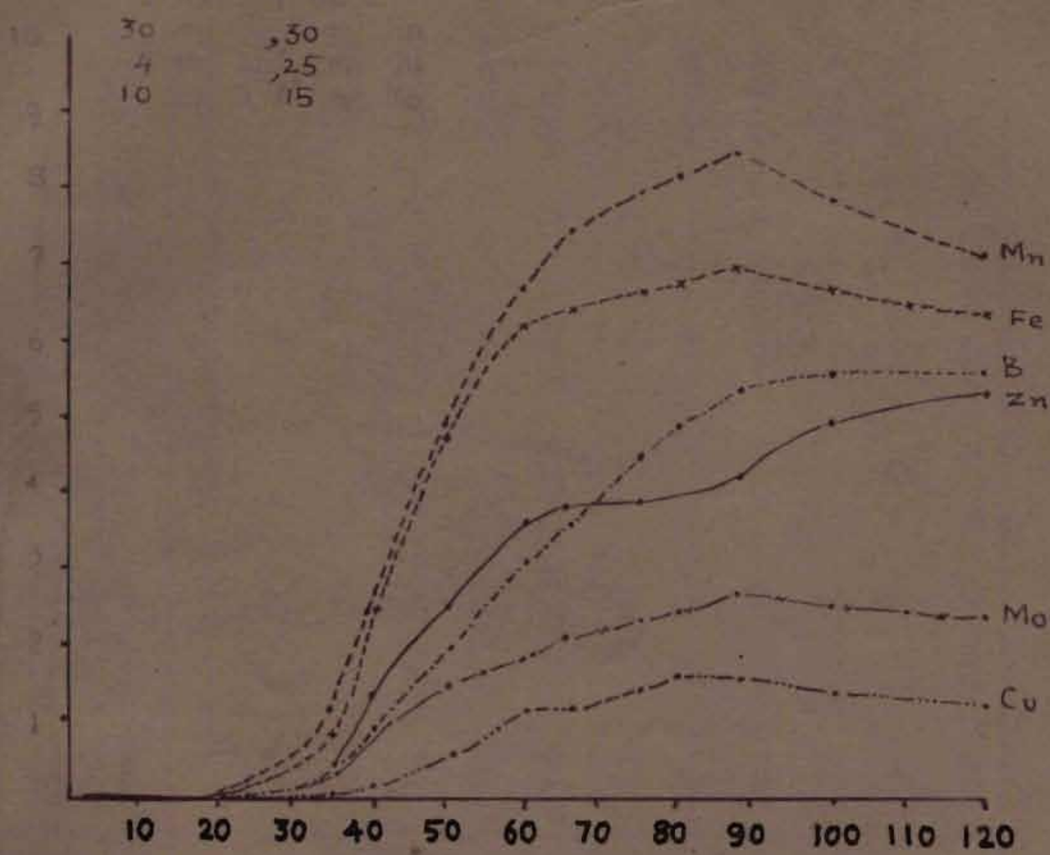


(c) <u>MICRO NUTRIENTS</u>

(1) <u>Iron</u>

As in the case of macro and secondary nutrients, uptake of iron also increased with increase in the age of the crop till harvest in both the varieties. The uptake during the first 20 days i.e. initial phase was very small in both the varieties. Increase in uptake started after 20th day in both the varieties and continued at almost a regulated way till harvest. Major portion of uptake was completed during the phase of intense vegetative growth. The uptake of iron by Asiriya Mwitunde whole plant and pod was more than 2 times that of TMV2, whole plants and pod. While TMV2 absorbed 260.18 mg per 100 plants, Asiriya Mwitunde absorbed 582.43 mg per 100 plants. Uptake by vegetative parts decreased aft attaining the highest value at 88th day in TMV2 and 100th day in Asiriya Mwitunde indicating translocation into the pod. TMV2 and Asiriya Mwitunde absorbed 1.15 and 1.50 kg of iron per hectare respectively at the time of harvest. The whole plant uptake curves are somewhat sigmoid.

UPTAKE OF MICRONUTRIENTS (Fe, Mn, Zn, Cu, B & Mo) BY VEGETATIVE PARTS AT VARIOUS STAGES OF GROWTH (IN 100 PLANT



2. ASIRIYA MWITUNDE

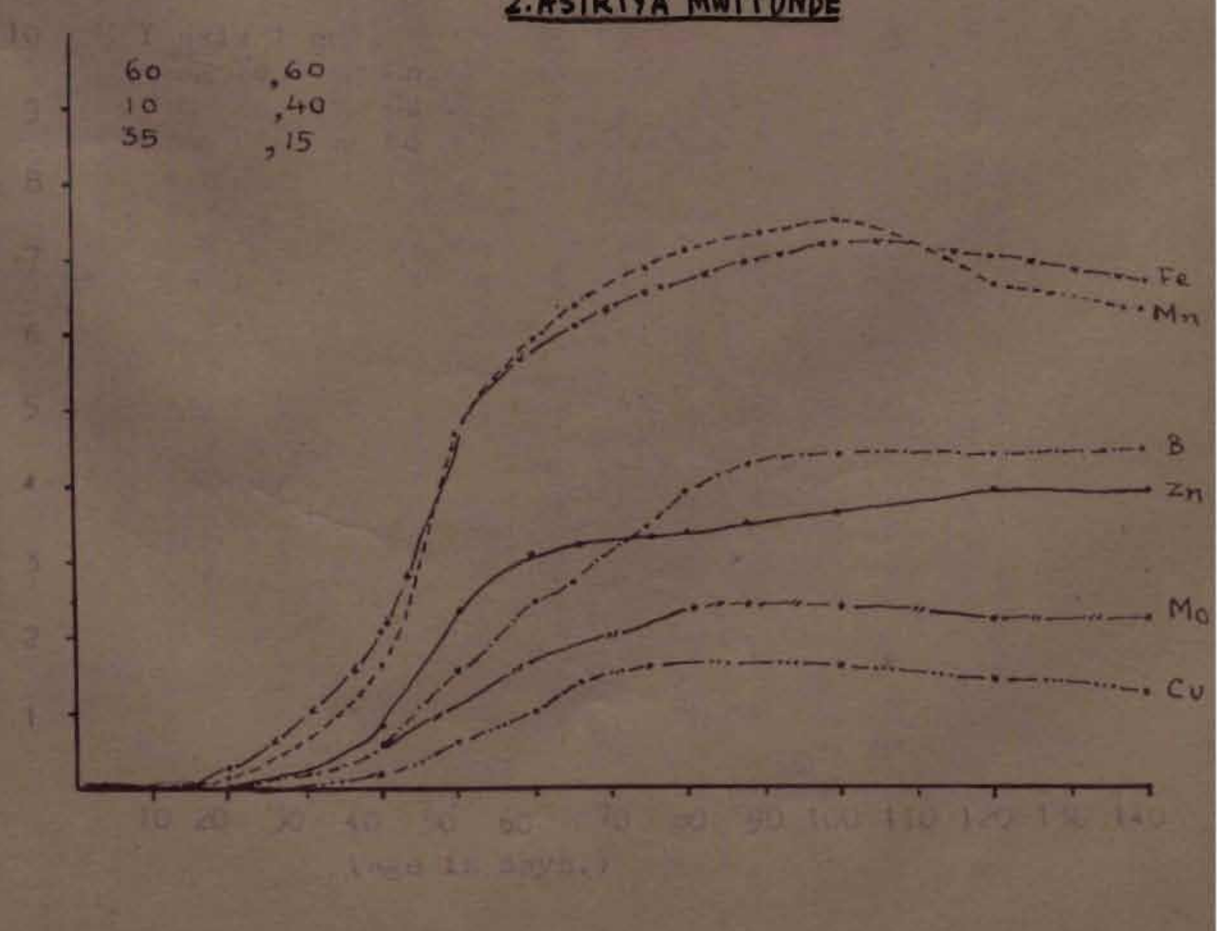


Table No. 20 UPTAKE OF IRON AT DIFFERENT STAGES OF PLANT GROWTH.

TMV2					
Age in days.	MILLIGRAMS IN 100 PLANTS.				
	Stem & leaves.	POD			Whole plant.
		Shell.	Kernel.	Total.	
1	2	3	4	5	6
20	2.50	-	-	-	2.50
35	25.65	-	-	-	25.65
40	73.34	-	-	-	73.34
50	141.90	-	-	-	141.90
60	187.25	-	-	-	187.25
66	190.86	-	-	-	190.86
75	199.56	-	-	-	199.56
80	203.93	-	-	-	203.93
88	210.61	-	-	-	210.61
100	202.53	2.76	33.49	36.25	238.78
120	192.06	3.26	65.66	68.12	260.18

ASIRIYA MWITUNDE					
Age in days.	MILLIGRAMS IN 100 PLANTS.				
	Stem & leaves.	POD			Whole plant.
		Shell.	Kernel.	Total.	
1	2	3	4	5	6
20	8.17	-	-	-	8.17
40	120.86	-	-	-	120.86
50	285.08	-	-	-	285.08
60	356.27	-	-	-	356.27
66	368.53	-	-	-	368.53
75	398.64	-	-	-	398.64
80	401.60	-	-	-	401.60
88	422.19	-	-	-	422.19
100	432.58	-	-	-	432.58
120	424.11	3.60	77.03	80.63	504.74
140	404.85	5.08	172.50	177.58	582.43

Table No. 20(a) UPTAKE OF IRON AT DIFFERENT STAGES OF PLANT GROWTH BY TMV2 AND ASIRIYA MWITUNDE(gm/hac).

Age in days.	TMV2			Age in days.	ASIRIYA MWITUNDE.		
	Stem + Leaves.	Pods.	Whole plant.		Stem + Leaves.	Pods.	Whole plant
20	11.11	-	11.11	20	16.14	-	16.14
35	114.00	-	114.00	40	238.74	-	238.74
40	325.95	-	325.95	50	563.12	-	563.12
50	630.67	-	630.67	60	703.75	-	703.75
60	832.22	-	832.22	66	727.96	-	727.96
66	848.27	-	848.27	75	787.44	-	787.44
75	886.93	-	886.93	80	793.29	-	793.29
80	906.35	-	906.35	88	833.96	-	833.96
88	936.04	-	936.04	100	854.48	-	854.48
100	900.13	161.11	1061.24	120	837.75	159.27	997.02
120	853.60	302.76	1156.36	140	799.61	350.78	1150.39

(2) Manganese.

The uptake of manganese was low (2.53 and 6.26 mg per 100 plants) during the initial stage of 20 days. Thereafter there was a rapid increase in whole plant manganese uptake in both the varieties and continued upto 75th day in both. The total absorption ranged between 2.53 to 241.57 mg per 100 plants and 6.26 to 413.68 mg per 100 plants respectively. Thereafter the increase continued at a slow space till 88th day in TMV2 and 100th day in Asiriya Mwitunde and again a rapid increase was recorded at 100th and 120th day respectively and continued till harvest. At harvest the whole plants uptake of manganese was 302.77 and 540.76 mg per 100 plants in TMV2 and Asiriya Mwitundo respectively. (1.34 and 1.07 kg per hectare respectively)

Just as in the case of iron, the uptake of manganese by the vegetative parts reached a maximum at 88th day in TMV2 and 100th day in Asiriya Mwitunde and thereafter recorded a decline. The uptake curve of whole plant of TMV2 was somewhat sigmoid in nature.

Asiriya Mwitunde recorded higher uptake values than TMV2 in all the stages of growth

Tablo No. 21 UPTAKE OF MANGANESE AT DIFFERENT STAGES OF PLANT GROWTH.

TMV2						ASIRIYA MWITUNDE					
Age in days.	MILLIGRAMS IN 100 PLANTS.					Age in days.	MILLIGRAMS IN 100 PLANTS				
	Stem & leaves.	POD			Whole plant.		Stem & leaves.	POD			Whole plant
		Shell.	Kernel.	Total.				Shell.	Kernel.	Total.	
1	2	3	4	5	6	1	2	3	4	5	6
20	2.53	-	-	-	2.53	20	6.26	-	-	-	6.26
35	23.04	-	-	-	23.04	40	100.05	-	-	-	100.05
40	72.59	-	-	-	72.59	50	280.08	-	-	-	280.08
50	148.51	-	-	-	148.51	60	352.03	-	-	-	352.03
60	202.85	-	-	-	202.85	66	384.55	-	-	-	384.55
66	225.07	-	-	-	225.07	75	413.69	-	-	-	413.69
75	241.57	-	-	-	241.57	80	420.73	-	-	-	420.73
80	246.51	-	-	-	246.51	88	442.08	-	-	-	442.08
88.	254.18	-	-	-	254.18	100	444.59	-	-	-	444.59
100.	237.54	15.2	34.37	49.57	287.11	120	396.83	18.02	71.53	89.55	486.38
120	217.67	16.79	68.31	85.10	302.77	140	379.54	23.22	138.00	168.22	540.76

Table No. 21 (a) UPTAKE OF MANGANESE AT DIFFERENT STAGES OF PLANT GROWTH BY TMV2 AND ASIRIYA MWITUNDE (gm/hac)

Age in days.	TMV2 Stem + Leaves.	TMV2 Pods.	TMV2 Whole Plant.	Age in days.	ASIRIYA MWITUNDE Stem + Leaves.	ASIRIYA MWITUNDE Pods.	ASIRIYA MWITUNDE Whole Plant.
20	11.24	-	11.24	20	12.37	-	12.37
35	102.40	-	102.40	40	197.65	-	197.63
40	322.62	-	322.62	50	553.26	-	553.26
50	660.04	-	660.04	60	695.37	-	695.37
60	901.55	-	901.55	66	759.51	-	759.51
66	1000.31	-	1000.31	75	816.17	-	816.17
75	1073.64	-	1073.64	80	831.08	-	831.08
80	1095.60	-	1095.60	88	873.25	-	873.25
88	1129.69	-	1129.69	100	878.21	-	878.21
100	1055.73	220.31	1276.04	120	783.87	176.89	960.76
120	967.42	378.22	1345.64	140	749.71	332.29	1082.00

and this superiority was also noted in the case of pods.

(3) Zinc

Zinc was absorbed in very small amounts in both the varieties. The values were low during the initial phase 0.2 and 0.5 mg per 100 plants in TMV2 and Asiriya Mwitundo respectively; but the uptake rapidly increased thereafter recording highest value of 26.9 and 44.2 mg per 100 plants at 100th and 120th day respectively. As in the case of iron and manganese the uptake of zinc by the vegetative parts after reaching the highest values at 88th and 100th day in TMV2 and Asiriya Mwitundo, fell down indicating trans-location into the pod. Absorption of zinc was comparatively more in Asiriya Mwitundo than TMV2 during all stages of growth. Similarly the uptake values were higher in the case of pod also. The total uptake of zinc by TMV2 and Asiriya Mwitundo at the time of harvest was 137 and 104 grams per hectare respectively.

The uptake curves were somewhat sigmoid in the case of whole plant.

(4) Copper

Copper was taken up by the plant even in

Table No. 22 UPTAKE OF ZINC AT DIFFERENT STAGES OF PLANT GROWTH.

TMV2						AMBIYA MWITUNDE					
	MILLIGRAMS IN 100 PLANTS.						MILLIGRAM I. 100 PLANTS				
Age in days.	Stem & leaves.	POD Shell.	POD Kernel.	POD Total.	Whole plant.	Age in days.	Stem & leaves.	POD Shell.	POD Kernel.	POD Total.	Whole plant.
1	2	3	4	5	6	1	2	3	4	5	6
20	0.23	-	-	-	0.23	20	0.55	-	-	-	0.55
35	2.20	-	-	-	2.20	40	8.00	-	-	-	8.00
40	6.51	-	-	-	6.51	50	23.00	-	-	-	23.00
50	12.73	-	-	-	12.73	60	30.98	-	-	-	30.98
60	17.94	-	-	-	17.94	66	32.05	-	-	-	32.05
66	18.91	-	-	-	18.91	75	33.85	-	-	-	33.85
75	19.95	-	-	-	19.95	80	34.14	-	-	-	34.14
80	20.17	-	-	-	20.17	88	35.37	-	-	-	35.37
88	21.79	-	-	-	21.79	100	36.63	-	-	-	36.63
100	21.20	1.73	3.97	5.70	26.20	120	34.70	1.80	7.70	9.50	44.20
120	20.48	1.86	8.45	10.31	30.79	140	32.89	2.61	17.25	19.86	52.75

Table No. 22(a) UPTAKE OF ZINC AT DIFFERENT STAGES OF PLANT GROWTH BY TMV2 AND ASIRIYA MWITUNDE (gm/hae).

Age in days.	TMV2			Age in days.	ASIRIYA MWITUNDE		
	Stem + leaves.	Pods.	Whole plant.		Stem + leaves.	Pods.	Whole plant
20	1.02	-	1.02	20	1.09	-	1.09
35	9.78	-	9.78	40	15.80	-	15.80
40	28.93	-	28.93	50	45.43	-	45.43
50	56.48	-	56.48	60	61.20	-	61.20
60	79.78	-	79.78	66	63.31	-	63.31
66	84.04	-	84.04	75	66.86	-	66.86
75	88.67	-	88.67	80	67.44	-	67.44
80	89.64	-	89.64	88	69.87	-	69.87
88	96.84	-	96.84	100	72.37	-	72.37
100	94.22	25.33	117.55	120	68.54	18.77	87.31
120	91.02	45.82	136.84	140	64.97	39.23	104.20

Table No. 23 UPTAKE OF COPPER AT DIFFERENT STAGES OF PLANT GROWTH

TMV2						AMERIKA [illegible]					
Age in days.	MILLIGRAMS IN 100 PLANTS.					Age in days.	MILLIGRAMS IN 100 PLANTS				
	Stem & leaves.	POD			Whole plant.		Stem & leaves.	POD			Whole plant.
		Shell.	Kernel.	Total.				Shell.	Kernel.	Total.	
1	2	3	4	5	6	1	2	3	4	5	6
20	0.20	-	-	-	0.20	20	0.46	-	-	-	0.46
35	1.40	-	-	-	1.40	40	4.00	-	-	-	4.00
40	3.70	-	-	-	3.70	50	11.00	-	-	-	11.00
50	9.00	-	-	-	9.00	60	18.30	-	-	-	18.30
60	16.00	-	-	-	16.00	66	28.80	-	-	-	28.80
66	17.00	-	-	-	17.00	75	30.00	-	-	-	30.00
75	18.90	-	-	-	18.90	80	30.10	-	-	-	30.10
80	19.00	-	-	-	19.00	88	30.90	-	-	-	30.90
88	19.40	-	-	-	19.40	100	31.20	-	-	-	31.20
100	17.50	1.00	3.30	4.30	21.80	120	27.20	1.30	6.80	8.10	35.30
120	16.60	1.00	4.80	5.80	22.40	140	25.30	2.10	10.30	12.40	37.70

Table No. 23(a) UPTAKE OF COPPER AT DIFFERENT STAGES OF PLANT GROWTH BY T.V2 AND ASIRIYA MAITUNDE(gm/hac)

Age in days.	T.V2			Age in days.	ASIRIYA MAITUNDE		
	Stem + leaves.	Pods.	Whole Plant.		Stem + leaves.	Pods.	Whole plant
20	0.89	-	0.89	20	0.91	-	0.91
35	6.22	-	6.22	40	7.90	-	7.90
40	16.44	-	16.44	50	21.73	-	21.73
50	40.00	-	40.00	60	36.15	-	36.15
60	71.11	-	71.11	66	56.89	-	56.89
66	75.56	-	75.56	75	59.26	-	59.26
75	84.00	-	84.00	80	59.46	-	59.46
80	84.44	-	84.44	88	61.04	-	61.04
88	86.22	-	86.22	100	61.82	-	61.82
100	77.78	19.11	96.89	120	53.73	16.00	69.73
120	73.78	25.78	99.56	140	49.98	24.49	74.47

smaller amounts than zinc by both the varieties. Uptake of copper was about one half of zinc in TMV2 and two thirds in Asiriya Mwitunde.

Copper absorption was low during the initial phase (first twenty days) in both the. varieties (0.2 and 0.46 mg per 100 plants) Thereafter there was a rapid increase in copper uptake upto 60th day (o.2 to 16.0 mg per 100 plants) in TMV2 and upto 66th day (0.46 to 28.8 mg per 100 plants) in Asiriya Mwitunde, the period coinciding with the phase of intense vegetative growth. Thereafter the increase in copper uptake by whole plant was comparatively lower till harvest in both the varieties. The whole plant copper uptake increased with increase in the age of the crop in both the varieties. The total copper uptake by Asiriya Mwitunde was about 1½ time higher than that by TMV2. The uptake of copper by Asiriya Mwitunde was comparatively higher at various stages of its growth. Similarly Asiriya Mwitunde pod absorbed copper twice that absorbed by the pod of TMV2 The whole plant uptake of copper was somewhat sigmoid in nature in both the varieties. The total uptake of copper at the time of harvest was 22.40

and 37.70 grams per hectare respectively by TMV2 and Asiriya Mwitunde.

(5) Molybdenum:

Uptake of molybdenum was half of that of copper in TMV2 and only slightly less in Asiriya Mwitunde, indicating that Asiriya Mwitunde required molybdenum in greater quantities (more than 2½ times) than that required by TMV2. Whole plant uptake of molybdenum increased with increase in the age of the crop in both the varieties. During the initial phase the uptake of molybdenum in both the varieties was low (0.2 and 0.7 mg per 100 plants) There was rapid increase in the uptake of molybdenum after 20 days in both the varieties and continued till harvest. Major portion of the uptake occured during the phase of intense vegetative growth in both the varieties. At harvest the whole plant uptake of molybdenum was 15.5 and 33.7 mg per 100 plants in TMV2 and Asiriya Mwitunde respectively (68.9 and 66.6 grams per hectare respectively). The uptake of Asiriya Mwitunde pod was (8.4 mg per 100 plants) was double that of TMV2.

The uptake of molybdenum by the vegetative

Table No. 24 UPTAKE OF MOLYBDENUM AT DIFFERENT STAGES OF PLANT GROWTH

TMV2					
Age in days.	MILLIGRAMS IN 100 PLANTS.				
	Stem & leaves.	POD			Whole plant.
		Shell.	Kernel.	Total.	
1	2	3	4	5	6
20	0.2	-	-	-	0.2
35	1.5	-	-	-	1.5
40	4.2	-	-	-	4.2
50	7.9	-	-	-	7.9
60	9.4	-	-	-	9.4
66	9.9	-	-	-	9.9
75	10.5	-	-	-	10.5
80	12.3	-	-	-	12.3
88	13.3	-	-	-	13.3
100	12.5	0.4	1.9	2.3	14.8
120	11.5	0.5	3.5	4.0	15.5

A [illegible]					
Age in days.	MILLIGRAMS IN 100 PLANTS				
	Stem & leaves.	POD			Whole plant.
		Shell.	Kernel.	Total.	
1	2	3	4	5	6
20	0.7	-	-	-	0.7
40	8.0	-	-	-	8.0
50	18.0	-	-	-	18.0
60	21.1	-	-	-	21.1
66	21.8	-	-	-	21.8
75	24.4	-	-	-	24.4
80	27.7	-	-	-	27.7
88	28.7	-	-	-	28.7
100	28.8	-	-	-	28.8
120	27.3	0.5	5.5	6.0	33.3
140	25.3	0.8	7.6	8.4	33.7

Table No. 25(a) UPTAKE OF MOLYBDENUM AT DIFFERENT STAGES OF PLANT GROWTH BY TMV2 AND ASIRIYA MWITUNDE (gm/hac)

Age in days.	TMV2 Stem + leaves.	TMV2 Pods.	TMV2 Whole plant.	Age in days.	ASIRIYA MWITUNDE Stem + leaves.	ASIRIYA MWITUNDE Pods.	ASIRIYA MWITUNDE Whole plant.
20	0.89	-	0.89	20	1.38	-	1.38
35	6.67	-	6.67	40	15.80	-	15.80
40	18.67	-	18.67	50	35.56	-	35.56
50	35.11	-	35.11	60	41.68	-	41.68
60	41.78	-	41.78	66	43.06	-	43.06
66	44.00	-	44.00	75	48.20	-	48.20
75	46.67	-	46.67	80	54.72	-	54.72
80	54.67	-	54.67	88	56.69	-	56.69
88	59.11	-	59.11	100	56.89	-	56.89
100	55.56	10.22	65.78	120	53.93	11.85	65.78
120	51.11	17.78	68.89	140	49.98	16.59	66.57

Table No. 25 UPTAKE OF BORON AT DIFFERENT STAGES OF PLANT GROWTH

TMV2						[illegible]					
Age in days.	Milligrams in 100 plants.					Age in days.	Milligrams in 100 plants				
	Stem & leaves.	Pod			Whole plant.		Stem & leaves.	Pod			Whole plant
		Shell.	Kernel.	Total.				Shell.	Kernel.	Total.	
1	2	3	4	5	6	1	2	3	4	5	6
20	0.34	-	-	-	0;34	20	1.03	-	-	-	1.03
35	3.20	-	-	-	3.20	40	14.00	-	-	-	14.00
40	9.51	-	-	-	9.51	50	40.00	-	-	-	40.00
50	20.15	-	-	-	20.15	60	57.74	-	-	-	57.74
60	31.21	-	-	-	31.21	66	67.20	-	-	-	67.20
66	36.91	-	-	-	36.91	75	86.36	-	-	-	86.36
75	45.16	-	-	-	45.16	80	97.26	-	-	-	97.26
80	49.30	-	-	-	49.30	88	108.10	-	-	-	108.10
88	54.47	-	-	-	54.47	100	110.50	-	-	-	110.50
100	56.26	1.71	3.97	5.68	61.94	120	111.61	2.70	9.08	11.78	123.39
120	56.36	2.33	8.13	10.46	66.82	140	111.33	3.63	17.20	20.83	132.16

Table No. 24(a) UPTAKE OF BORON AT [illegible] STAGES OF PLANT GROWTH BY [illegible]V2 AND [illegible] (gm/hac)

Age in days.	[illegible]V2 Stem + leaves.	Pods.	Whole plant.	Age in days.	[illegible] Stem + leaves.	Pods.	Whole plant.
20	1.51	-	1.51	20	2.03	-	2.03
35	14.22	-	14.22	40	27.65	-	27.65
40	42.27	-	42.27	50	79.01	-	79.01
50	89.56	-	89.56	60	114.05	-	114.05
60	138.70	-	138.70	66	132.74	-	132.74
66	164.04	-	164.04	75	170.59	-	170.59
75	200.71	-	200.71	80	192.12	-	192.12
80	219.11	-	219.11	88	213.53	-	213.53
88	242.09	-	242.09	100	218.27	-	218.27
100	250.04	25.24	275.28	120	229.35	23.27	252.60
120	250.49	46.48	296.97	140	219.91	41.14	261.05

parts reached a maximum at 88th day and 100th day in TMV2 and Asiriya Mwitunde respectively and declined thereafter indicating its translocation in to the pod The whole plant molybdenum uptake curves were somewhat sigmoid in nature as were the case with other nutrients.

(6) Boron.

Like all other nutrients the whole plant uptake of boron increased with increase in the age of the crop in both the varieties. The values were low at the initial stage of their growth (0.34 and 1.03 mg per 100 plants). After that there was a rapid increase in boron uptake and the increase continued right upto the harvest. Uptake of boron continued beyond the vegetative phase to a considerable extent Whole plant uptake by TMV2 was 66.8 mg per 100 plants, it was double (132.16 mg per 100 plants) in Asiriya Mwitunde. Similar was the trend in respect of pods of the two varieties (10.46 mg per 100 plants in TMV2 pod and 20.83 mg per 100 plants in Asiriya Mwitunde pod) TMV2 and Asiriya Mwitunde absorbed 296.9 and 261 grams per hectare respectively at the time of harvest. The uptake curves of the whole plants were somewhat sigmoid in nature as was the case in all other nutrients.

4. RATE OF TOTAL DRY MATTER PRODUCTION AND ABSORPTION OF VARIOUS NUTRIENTS

1. Rate of dry matter production:

Rate of total dry matter production and absorption of various nutrient elements at different stages of crop growth by TMV2 and Asiriya Mwitunde are presented in table 26 and 27 and graphically represented in figures 9 to 11.

It can be seen from the figures, that TMV2 had two peaks of rate of production of dry matter one at the 40th day and the other at the 100th day occuring during the phase of intense vegetative growth and the other during the pod formation phase respectively. However, the rate of total dry matter production at the 2nd peak was comparatively lower than the rates during the period of intense vegetative growth till the 66th day. The highest rate of dry matter production recorded at the first peak was 30 gm per day per 100 plants. In the case of Asiriya Mwitunde only one peak of rate of dry matter production was observed at the 50th day (60 gm per day per 100 plants) which may also be considered to fall during the phase of intense vegetative growth. The rate of dry matter

Table No. 26 RATES OF DRY MATTER PRODUCTION AND ABSORPTION OF NUTRIENTS AT VARIOUS STAGES OF GROWTH OF WHOLE PLANT (TMV2)

Age in days.	Rate of production of dry matter in 100 plants in gm.	RATE OF ABSORPTION IN MILLIGRAM IN 100 PLANTS BY TMV2											
		N	P	k	Ca	Mg	S	Fe	Mn	Zn	Cu	B	Mo
20	0.60	19.1	2.1	9.2	8.5	9.6	28.3	0.1	0.10	0.01	0.01	0.01	0.01
35	5.91	225.1	22.6	114.6	92.2	90.0	38.3	1.54	2.10	0.13	0.08	0.19	0.08
40	30.00	1210.8	119.2	545.3	540.4	500.3	226.1	9.53	7.91	0.86	0.46	1.26	0.54
50	28.00	1015.8	93.3	491.6	449.6	400.4	249.1	6.85	7.59	0.62	0.53	1.06	0.32
60	25.00	532.6	66.5	387.2	334.1	307.1	316.8	4.53	5.43	0.52	0.07	1.10	0.25
66	20.00	105.3	51.0	284.3	235.1	134.1	415.2	0.60	3.70	0.16	0.16	0.95	0.08
75	16.70	68.2	30.0	222.2	203.3	255.0	66.7	0.96	1.80	0.11	0.21	0.91	0.06
80	14.0	54.7	21.0	140.6	70.5	32.6	50.7	0.87	0.98	0.04	0.02	0.82	0.36
88	11.2	90.4	3.4	119.2	245.4	7.6	17.1	0.83	0.95	0.20	0.04	0.64	0.12
100	20.09	618.1	114.2	159.3	292.5	27.6	119.7	2.33	2.74	0.36	0.20	0.62	0.12
120	12.38	430.8	78.0	108.5	132.5	31.4	44.9	1.07	0.78	0.22	0.03	0.24	0.03

Table No. 27 RATES OF DRY MATTER PRODUCTION AND ABSORPTION OF NUTRIENTS AT VARIOUS STAGES OF GROWTH OF WHOLE PLANT(ASIRIYA WAITULDE)

Age in days.	Rate of production of dry matter in 100 plants in gm.	RATE OF ABSORPTION IN MILLIGRAM IN 100 PLANTS BY ASARIYA AMITUNDA.											
		N	P	K	Ca	Mg	S	Fe	Mn	Zn	Cu	B	Mo
20	1.5	85.5	5.7	26.6	23.7	23.4	9.3	0.4	0.31	0.27	0.02	0.05	0.03
40	18.0	783.9	74.2	369.5	296.3	298.6	150.6	5.6	4.68	0.37	0.17	0.62	0.36
50	60.0	2010.3	220.0	1108.1	1110.2	896.1	630.1	16.4	18.0	1.5	0.7	2.6	1.0
60	40.0	533.5	126.8	690.5	643.4	487.3	457.9	7.1	7.19	0.79	0.73	1.77	0.31
66	33.3	463.1	89.7	488.3	443.1	359.0	590.5	2.04	5.42	0.17	1.75	1.57	0.11
75	31.1	429.5	66.3	430.8	387.5	244.8	548.8	3.3	3.23	0.2	0.13	2.12	0.26
80	24.0	343.7	35.0	372.1	198.7	630.7	221.1	0.6	1.4	0.05	0.02	2.18	0.66
88	22.2	246.4	31.2	264.1	148.9	119.6	80.5	2.5	0.17	0.15	0.1	1.35	0.12
100	16.6	300.4	27.9	185.3	131.3	7.7	75.8	0.86	0.21	0.1	0.02	0.2	0.01
120	22.1	790.6	148.7	194.4	460.1	94.6	145.7	3.6	2.08	0.37	0.2	0.64	0.22
140	26.0	770.7	149.2	187.1	243.0	9.5	56.6	3.8	2.71	0.42	0.12	0.43	0.02

production decreased thereafter reaching a value of 16.6 gm per day/100 plants at the 100th day. Subsequently it recorded a slight increase till harvest (26.0 gm per day/100 plants).

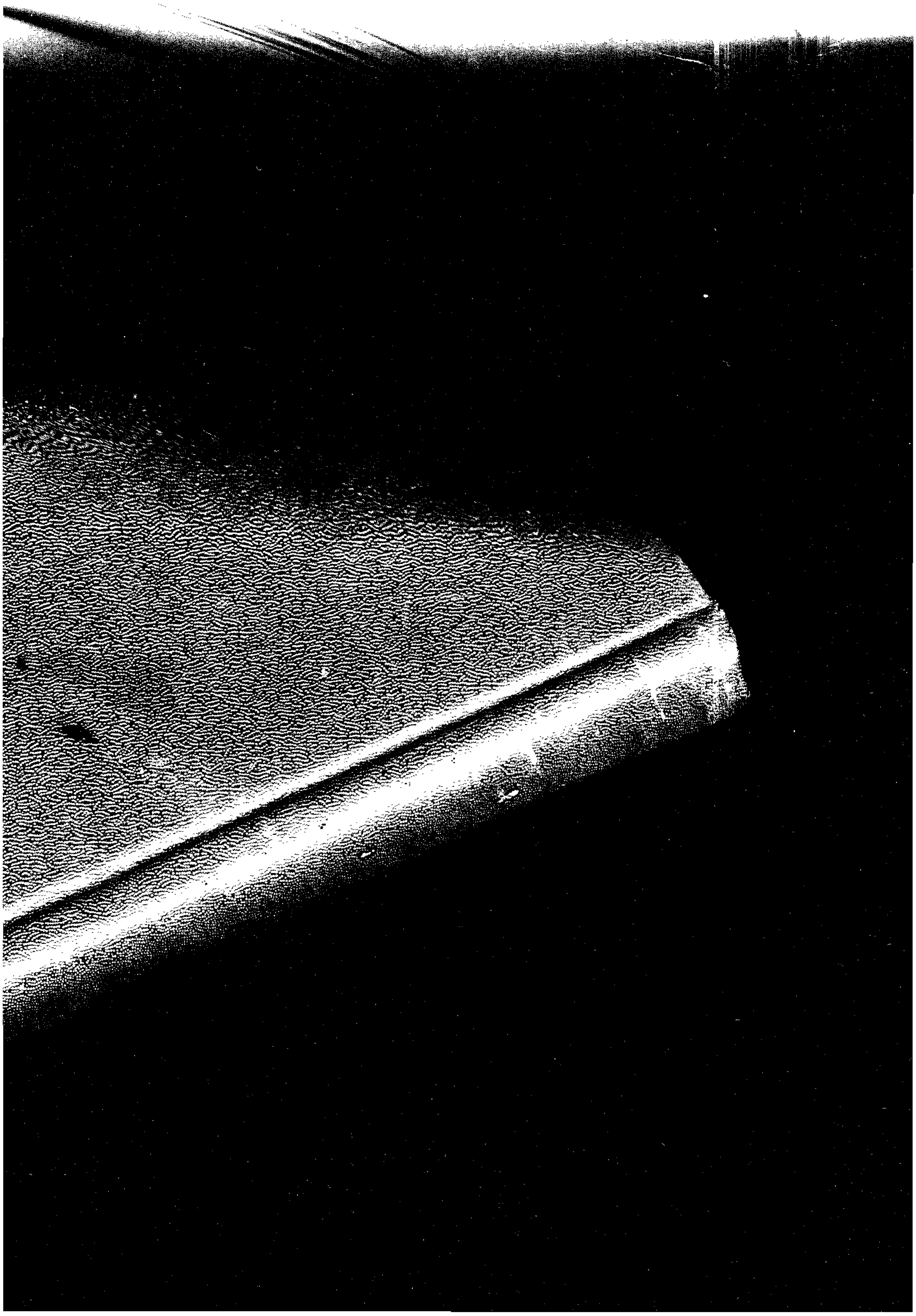
ii) Rate of absorption of nutrient elements:

(A) Rate of absorption of macro nutrients

i) Nitrogen

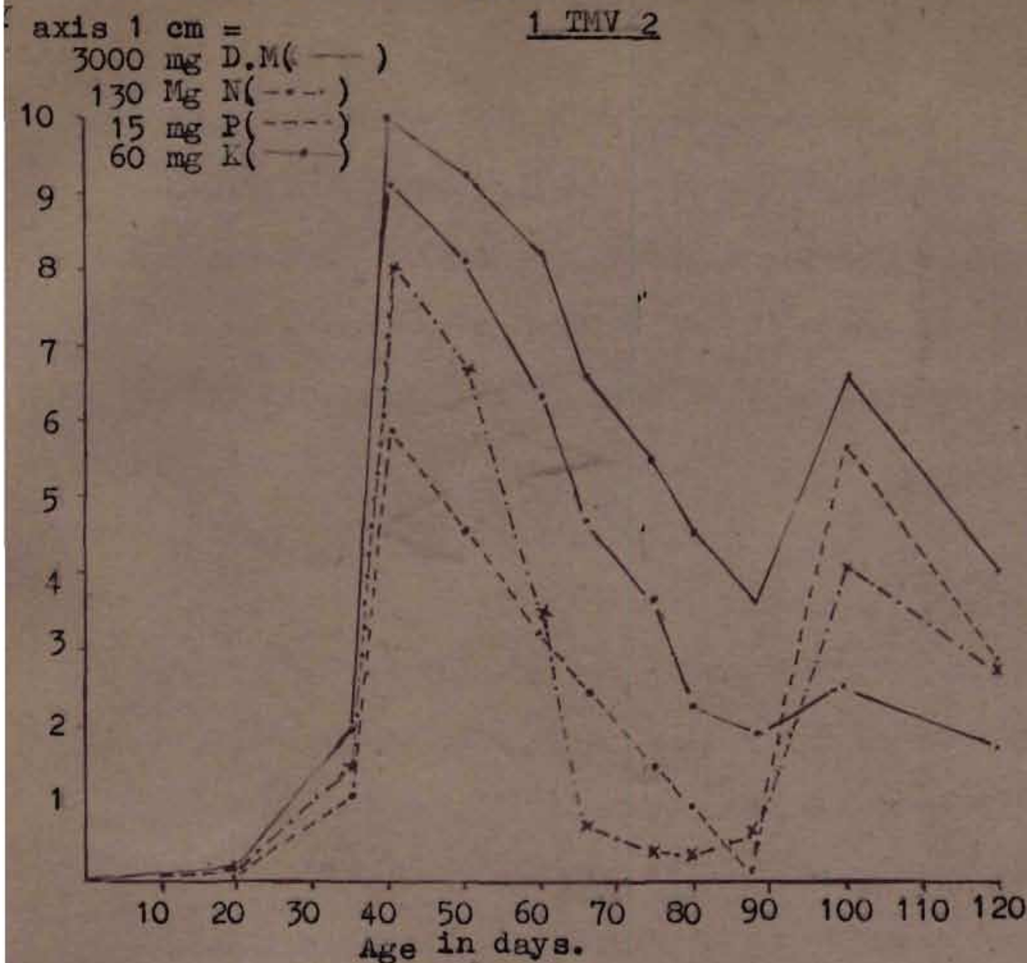
The rate of nitrogen absorption by ENV2 registered two peaks, one at the 40th day (1210.8 mg per day per 100 plants) corresponding with the first peak of rate of dry matter production and the other at the 100th day (618.1 mg per day/100 plants) coinciding again with the second peak of rate of dry matter production. This indicates that the rate of absorption of nitrogen is alemost similar in pattern to that of dry matter production not only at the two peaks but also at the various stages of the crop growth.

The rate of absorption of nitrogen by Asiriya Mwitunde may also be considered to have two peaks, one at the 50th day (2010.3 mg per day per 100 plants) corresponding with the peak of rate of dry matter production and the other at the 120th day

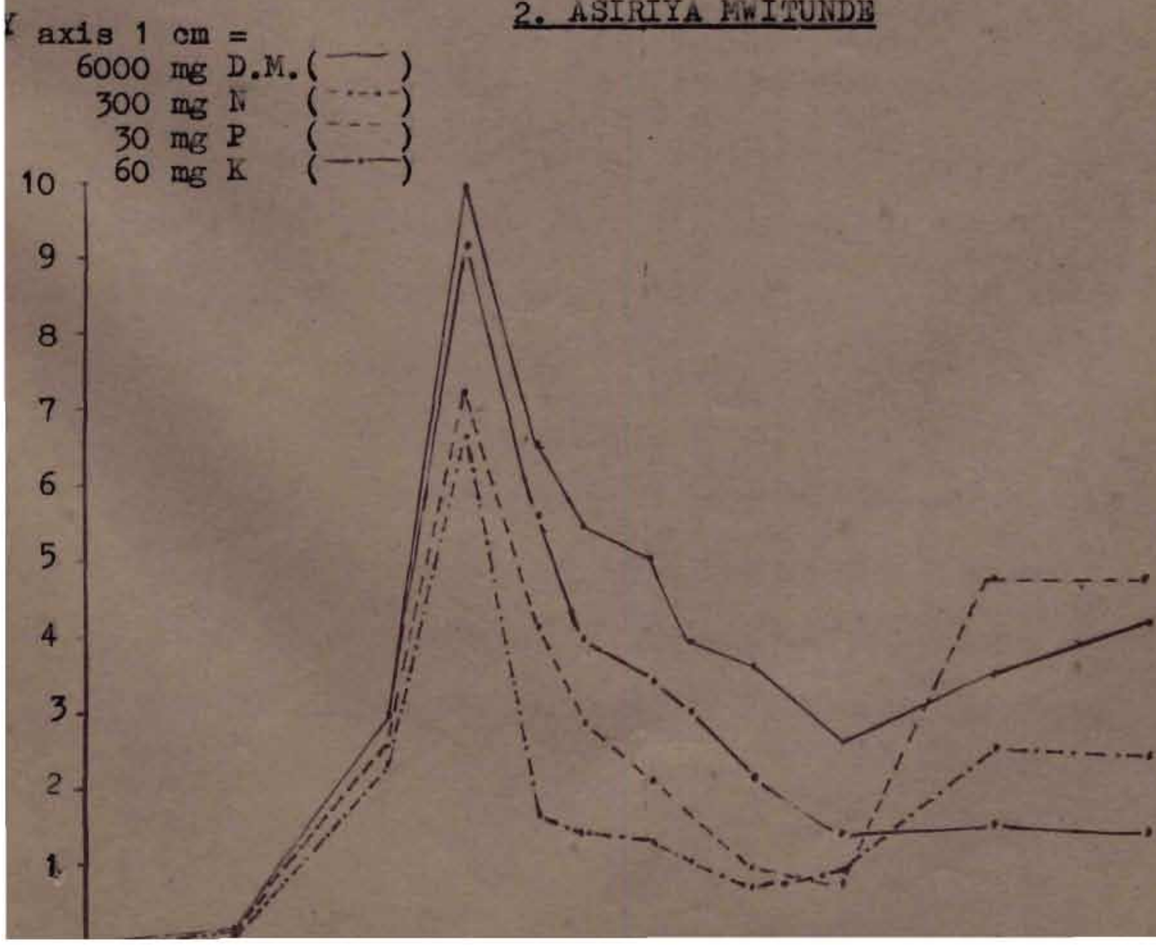


RATES OF DRY MATTER PRODUCTION AND ABSORPTION OF MACRO NUTRIENTS (N. P & K) AT VARIOUS STAGES OF GROWTH OF WHOLE PLANT (IN 100 PLANTS).

1 TMV 2



2. ASIRIYA MWITUNDE



(790.6 mg per day/100 plants), which is however not very prominent and may be ignored. But for this slight variation, the rate of absorption of nitrogen by Asiriya Mwitunde can be considered nearly similar to that of dry matter production.

(2) Phosphorus

The rate of phosphorus absorption by TMV2 had two peaks, one at the 40th day (119.2 mg per day per 100 plants) and the other at the 100th day (114.2 mg per day/100 plants), the pattern being just similar to the rate of dry matter production and nitrogen absorption.

Just like the rate of nitrogen absorption, the rate of phosphorus absorption by Asiriya Mwitunde had two peaks, one at the 50th day (220.0 mg per day per 100 plants) and the other at 120th day (148.7 mg per day per 100 plants) which was not prominent.

(3) Potassium

The rate of potassium absorption registered two peaks in TMV2, one at the 40th day (545.3 mg per day/100 plants) and the other at the 100th day (159.3 mg per day/100 plants.).

However the second peak was not prominent.

Asiriya Mwitunde may be considered to have had just one peak rate of absorption of potassium at 50th day (1108.1 mg per day per 100 plants) coinciding with the peaks rate of dry matter production, and absorption of nitrogen and phosphorus. There was an in-significant (not prominent) peak at the 120th day.

(B) Secondary nutrients

1. Calcium

The rate of absorption of calcium by TMV2 was just similar to that of potassium in that it had a prominent peak at the 40th day (540.4 mg per day/100 plants) and another peak at the 100th day (292.5 mg per day per 100 plants) which was not prominent, and hence for all practical purposes the rate of calcium absorption by TMV2 may be considered to be having only one peak.

Unlike the rate of dry matter production and rates of absorption of nitrogen, phosphorus and potassium, the rate of absorption of calcium by Asiriya Mwitunde exhibited one predominant peak at the 50th day (1110 mg per day/100 plants) corresponding to the peaks rate of dry matter production, However the second peak was not prominent.

Asiriya Mwitunde may be considered to have had just one peak rate of absorption of potassium at 50th day (1108.1 mg per day per 100 plants) coinciding with the peaks rate of dry matter production, and absorption of nitrogen and phosphorus. There was an in-significant (not prominent) peak at the 120th day.

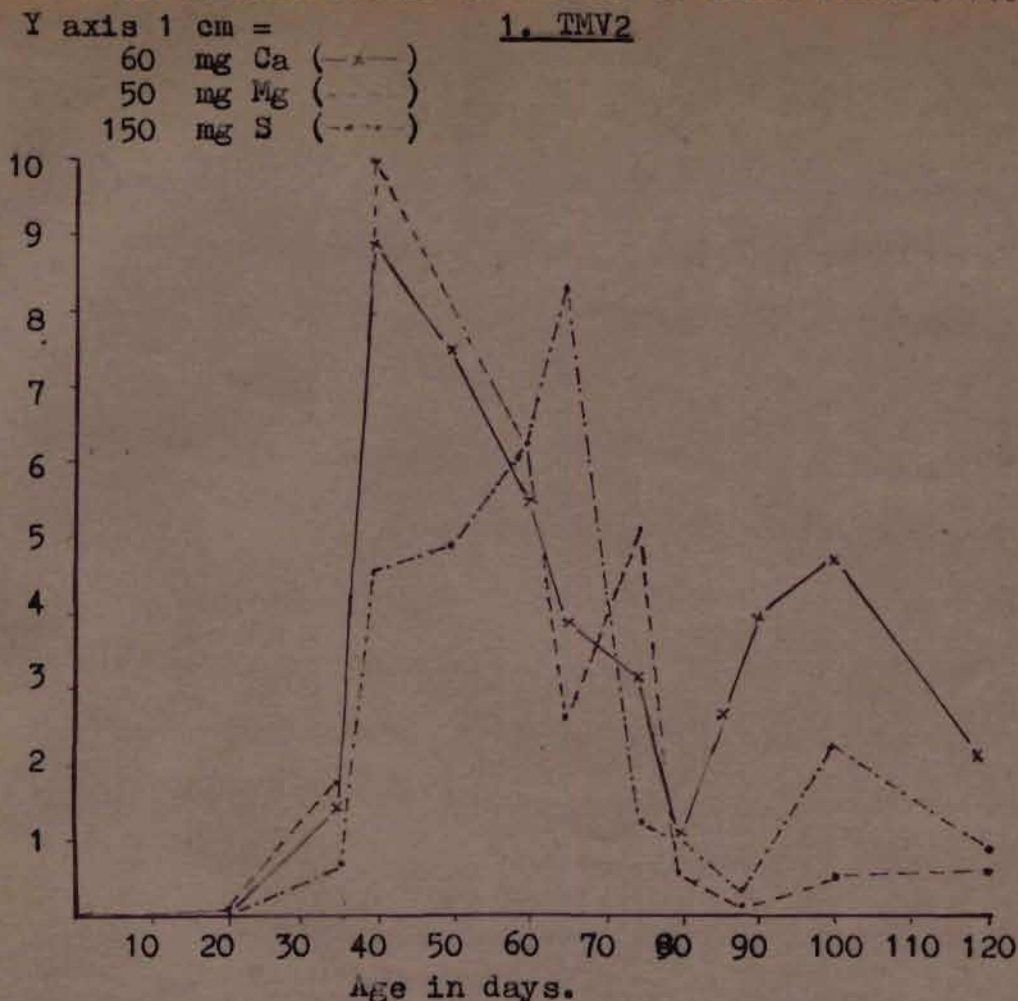
(B) Secondary nutrients

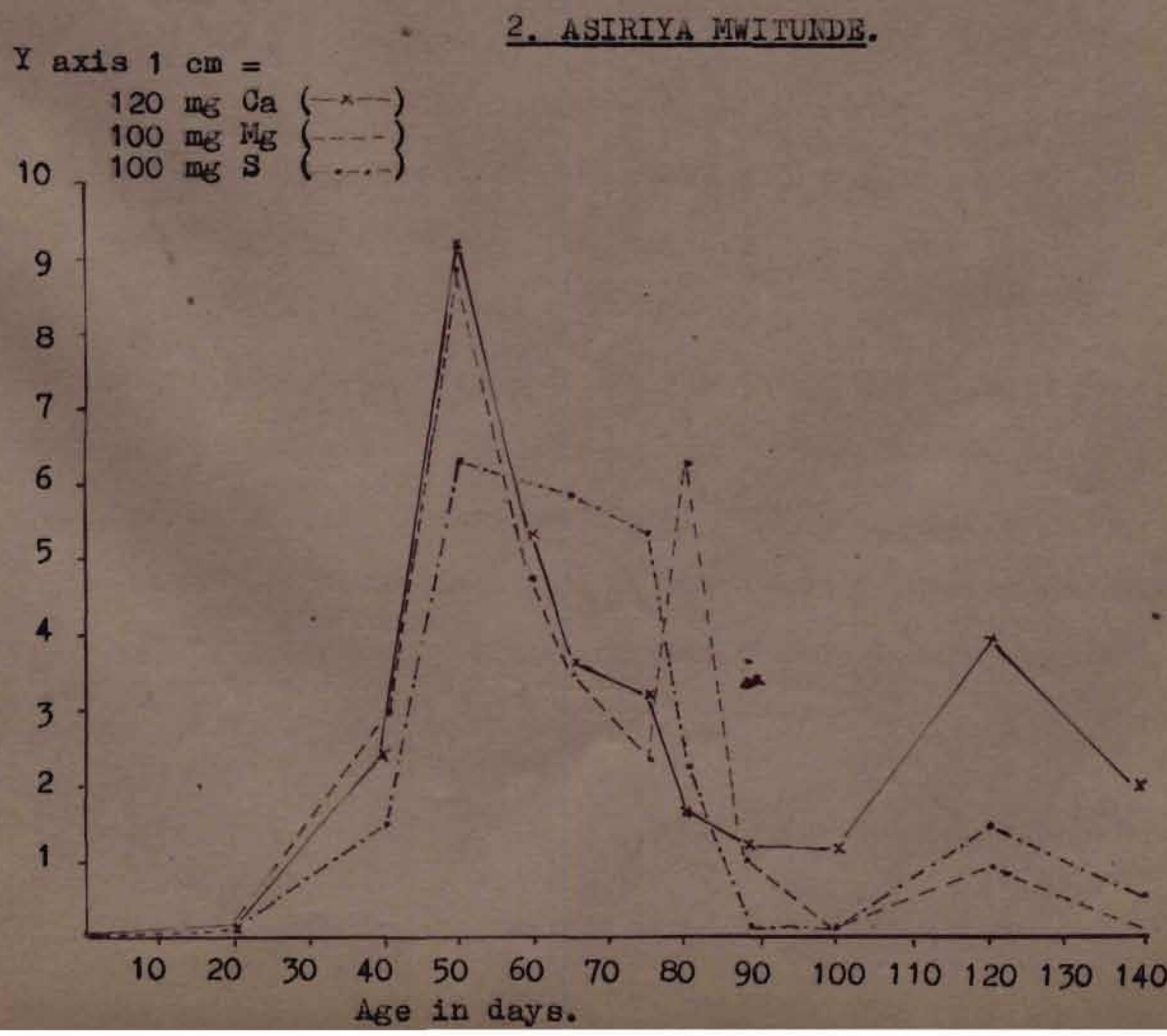
1. Calcium

The rate of absorption of calcium by TMV2 was just similar to that of potassium in that it had a prominent peak at the 40th day (540.4 mg per day/100 plants) and another peak at the 100th day (292.5 mg per day per 100 plants) which was not prominent, and hence for all practical purposes the rate of calcium absorption by TMV2 may be considered to be having only one peak.

Unlike the rate of dry matter production and rates of absorption of nitrogen, phosphorus and potassium, the rate of absorption of calcium by Asiriya Mwitunde exhibited one predominent peak at the 50th day (1110 mg per day/100 plants) corresponding to the peaks rate of dry matter production,

AT VARIOUS STAGES OF GROWTH OF WHOLE PLANT (IN 100 PLANTS).





and rate of absorption of nitrogen, phosphorus, and potassium and a second peak less prominent than the first at the 120th day (460.1 mg per day/ 100 plants).

2. Magnesium

TMV2 recorded a prominent peak of rate of absorption of magnesium at 40th day (500.3 mg per day per 100 plants) corresponding with the peaks in respect of dry matter accumulation and absorption of nitrogen, phosphorus, potassium and calcium. There were two insignificant peaks at the 75th day (255.0 mg per day/100 plants) and 100th day (2706 mg per day per 100 plants) which may as well as be ignored.

Unlike TMV2, Asiriya Mwitunde had 3 peaks of rate of absorption of magnesium occuring at the 50th day (896.1 mg per day per 100 plants), 80th day (630.7 mg per day per 100 plants) and 120th day (94.6 mg per day per 100 plants). The first two peaks were very prominent and the third less prominent indicated that magnesium requirements of Asiriya Mwitunde was considerable at the time of intense vegetative growth, flower formation and pod formation respectively. Thus the rate of absorption of magnesium slightly differed with the rate of dry matter production and absorption of nitrogen, phosphorus, potassium and calcium.

(3) Sulphur

TMV2 registered a prominent peak of rate of absorption of sulphur at 66th day (415.2 mg per day per 100 plants) during the phase of intense vegetative growth. There was a second peak at 100th day (119.7 mg per day per 100 plants) coinciding with the 2nd peaks of rate of production of dry matter and rate of absorption of nitrogen and phosphorus. The second peak was comparatively less prominent than the first one.

Unlike TMV2, Asiriya Mwintunde, had three peaks of rate of absorption of sulphur, occurring at 50th day (630.1 mg per day per 100 plants), 66th day (590.5 mg per day per 100 plants) and 120th day 145.7 mg per day per 100 plants), occurring during the intense vegetative phase, later part of the vegetative and initial peak of flowering phases and pod formation phase respectively.

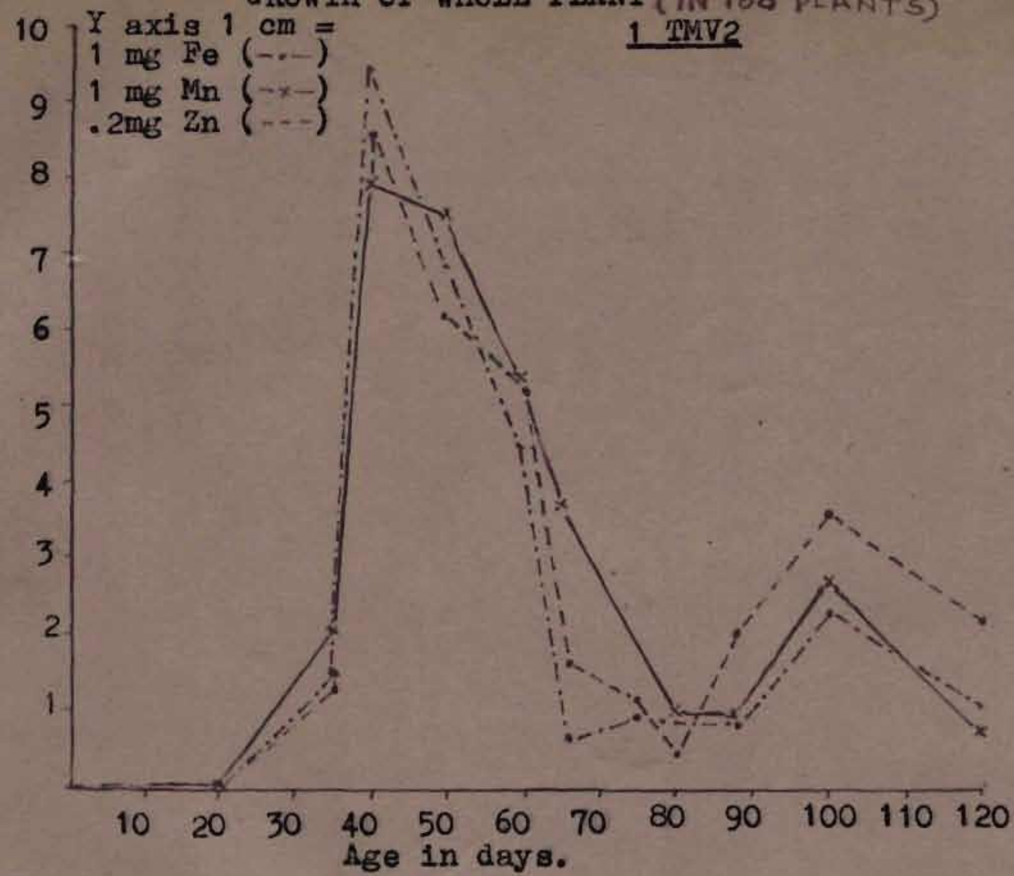
(c) Micro nutrients.

(i) Iron: The rate of iron absorption by TMV2 recorded a prominent peak at the 40th

FIG. NO. 11

RATE OF ABSORPTION OF MICRO NUTRIENTS (Fe, Mn, Zn, Cu, B & Mo) AT VARIOUS STAGES OF GROWTH OF WHOLE PLANT (IN 100 PLANTS)

1 TMV2



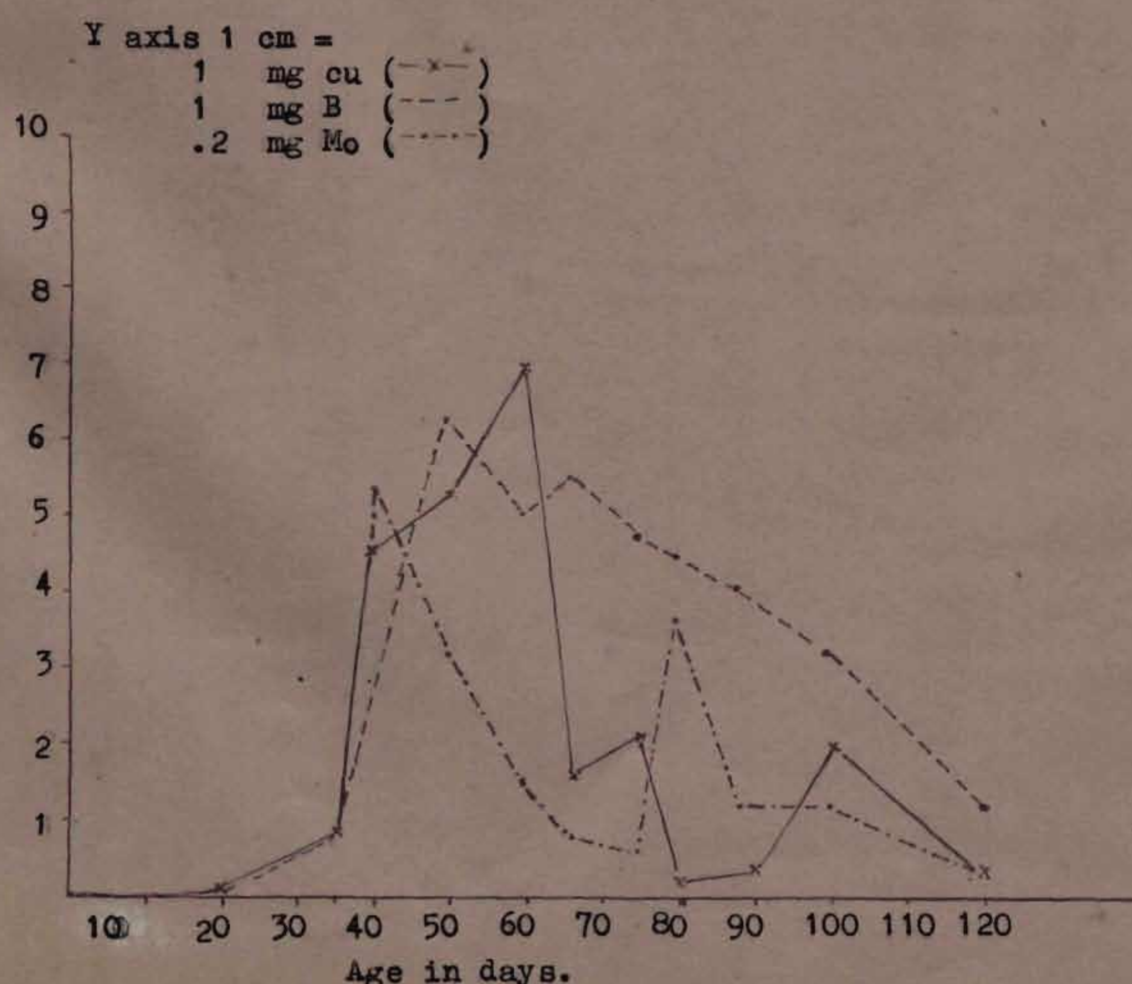
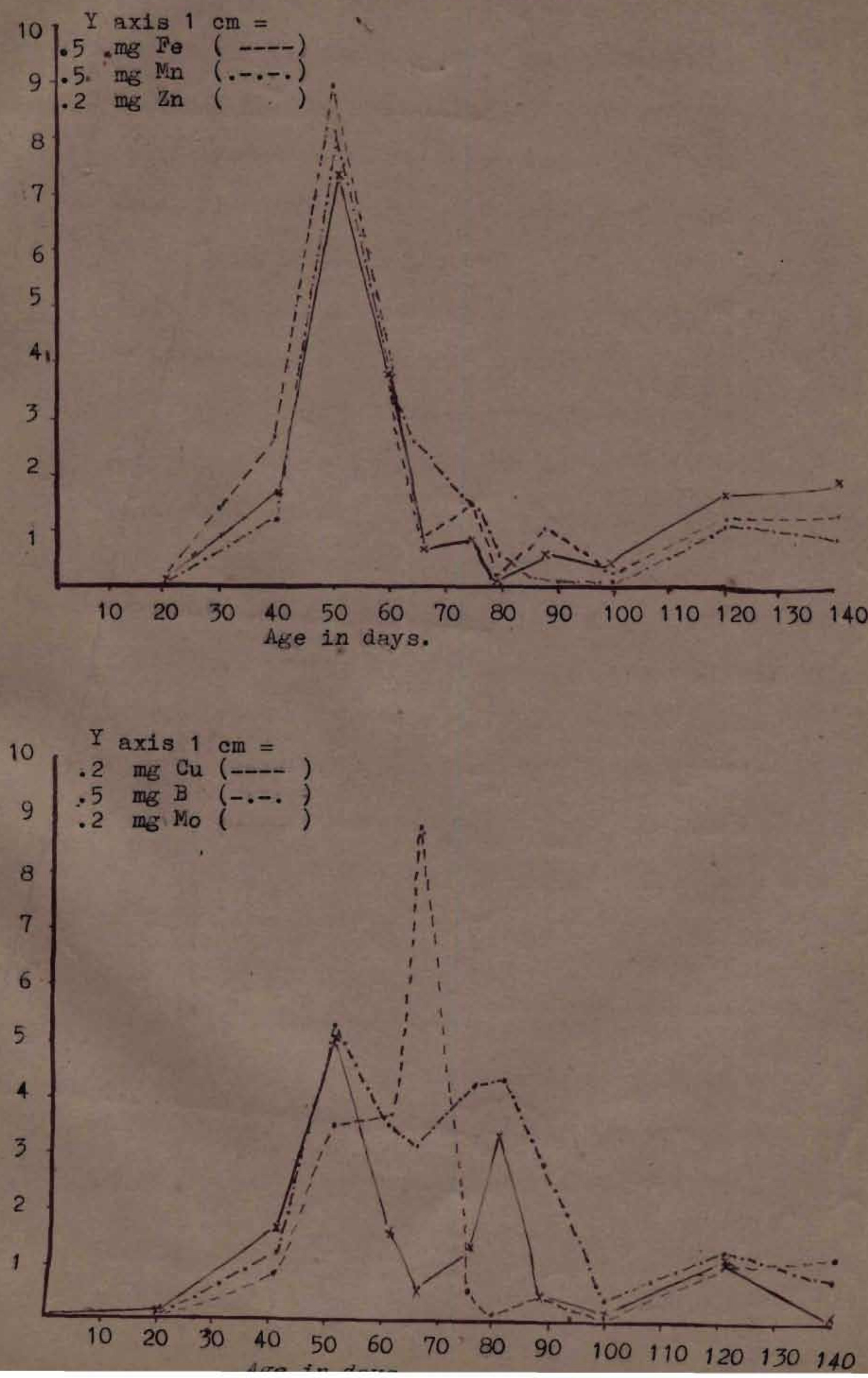


FIG. NO. 11 (B)
RATE OF ABSORPTION OF MICRO NUTRIENTS (Fe, Mn, Zu. Cu, B & Mo) AT VARIOUS STAGES OF GROWTH OF WHOLE PLANT (IN 100 PLANTS)

2 ASIRIYA MWITUNDE



day (9.5 mg per day per 100 plants) corresponding to the peaks of rate of dry matter accumulation and absorption of nitrogen, phosphorus, potassium, calcium and magnesium. it also recorded a second insignificant peak at 100th day (2.3 mg per day per 100 plants) similar to the 2nd peak of the rate of absorption of potassium and calcium.

Unlike TMV2, Asiriya Mwitunde had only one prominent peak at the 50th day (16.4 mg per day per 100 plants) The rate of absorption of iron decreased thereafter reaching a value of 0.86 mg per day/100 plants at the 100th day. Subsequently it recorded a slight increase till harvest (3.8 mg per day/100 plants). It can be inferred from the rate of absorption that requirements of iron are not with in the earlier stages of crop growth most probably during the phase of intense vegetative growth.

(2) Manganese

The rate of absorption of manganese by TMV2 closely followed the trend of rate of absorption of iron in that it recorded the first prominent peak at the 40th day (7.9 mg per day/

100 plants) and 100th day (2.74 mg per day /100 plants).

Unlike TMV2, Asiriya Mwi-tunde recorded only one peak of rate of manganese absorption at the 50th day (18 mg per day/100 plants). Thereafter the rate of manganese absorption decreased reaching a value of 0.17 mg per day/100 plants at 88th day. Subsequently it recorded a slight increase till harvest (2.71 mg per day/100 plants). The trend of manganese absorption by Asiriya Mwitunde may be considered to be similar to that of iron absorption.

(3) Zinc TMV2 recorded only one prominent peak of the rate of absorption of zinc at the 40th day (0.86 mg per day/100 plants) corresponding to the peaks of rate of dry matters accumulation and rates of absorption of nitrogen, phosphorus potassium, calcium, magnesium iron and manganese. A similar trend was observed in the case of Asiriya Mwintunde but with slightly higher values. There were however two less prominent peaks which may as well be ignored. The peak rate of absorption was

registered at the 50th day (1.50 mg per day/ 100 plants).

(4) Copper

TMV2 recorded the first prominent peak rate of absorption of copper at 60th day followed by two more peaks at the 75th and 100th day. The peak at 75th day was the least prominent. The trend of rate of absorption of copper differed with that of rates of accumulation of dry matter and absorption of nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, and manganese except the least peak occurred at the 100th day as in the case of the second peaks of rate of accumulation of dry matter and absorption of nitrogen, phosphorus mangesium,&sulphur. A similar trend was observed in Asiriya Mwitunde. The peaks were registered at 66th (1.75 mg per day/100 plants), 88th day (0.1 mg per day/100 plants) and 120th day (0.2 mg per day/100 plants). Only the first peak was prominent and the later were less prominent.

(5) Boron

The rate of absorption of boron by TMV2 recorded the first peak at 40th day

(1.26 mg per day per 100 plants). There was an other less significant peak at 60th day (1.1 mg per day/100 plants). Asiriya Mwitunde registered 2 prominent peaks at 40th day (2.6 mg per day/100 plants) and 80th day (2.18 mg per day/100 plants). There was however a less prominent or rather insignificant peak at 120th day (0.64 mg per day per 100 plants).

(6) <u>Molybdenum</u>

TMV2 registered a prominent peak of rate of absorption of molybdenum at 40th day (0.54 mg per day/100 plants) corresponding to the peaks of rate of accumulation of dry matter and rates of absorption of nitrogen, phosphorous, potassium calcium, magnesium, iron, manganese and zinc. There was another less prominent peak at 80th day (0.36 mg per day/100 plants) which may be ignored. A similar trend was observed in Asiriya Mwitunde also. It recorded three peaks at 50th day (1.0 mg per day /100 plants), 88th day (0.66 mg per day/100 plants) and 120th day (0.22 mg per day/100 plants.)

(D) <u>Absorption of total nutrient elements</u>.

The absorption of total nutrients

viz., macro, secondary and micro nutrients put together at different stages of growth is presented in Tables (28 & 29). Whole plant absorption of all the nutrients put together increased gradually from 35th day till harvest and from 40th day till harvest in TMV2 and Asiriya Mwitunde respectively. The increase in whole plant absorption of all the nutrients from 20th day to 30th day in TMV2 and 20th day to 40th day in Asiriya Mwitunde was 10 times and 15 times that at 20th day respectively. Thereafter the increase was gradual and attaining the highest values at harvest. The whole plant absorption of all the nutrients at harvest by Asiriya Mwitunde (260358 mg per 100 plants) was twice that absorbed by TMV2 (126254 mg per 100 plants). The rate of absorption was similar to that of dry matter production, and nitrogen absorption and the curve is sigmoid in nature in both the varieties.

Data on rate of absorption of all the nutrients put together are furnished in Table 28 & 29. It can be seen from the Tables that the rate of absorption of all the nutrient elements by TMV2 closely followed the trend similar to that

Table No. 28

ABSORPTION OF TOTAL NUTRIENT ELEMENTS (PUT TOGETHER) AT VARIOUS STAGES OF GROWTH OF WHOLE PLANT (TMV2)

Age in days	MILLIGRAMS IN 100 PLANTS Absorption of nutrient elements(put together) *	Rate of absorption of nutrient elements (put together)*
20	982.2	49.1
35	10236.5	619.9
40	26050.7	3162.9
50	53221.4	2717.1
60	72788.9	1956.7
66	80176.0	1231.3
75	87920.3	860.4
80	89744.7	364.8
88	93632.4	486.0
100	109684.3	1337.6
120	126254.0	828.5

* Figure arrived by summing up of the uptake values of individualnutrient element viz., N, P, K, Ca, Mg, S, Fe, Zn, Mn, Cu, B, & Mo.

Table No. 29

ABSORPTION OF TOTAL NUTRIENT ELEMENTS (PUT TOGETHER) AT VARIOUS STAGES OF GROWTH OF WHOLE PLANT (ASIRIYA-MWITUNDE)

Age in days	MILLIGRAMS IN 100 PLANTS	
	Absorption of nutrient elements(put together) *	Rate of absorption of nutrient elements(put-together)*
20	2925.1	146.2
40	42636.7	2647.4
50	103751.9	6111.5
60	132359.9	2860.8
66	147032.7	2445.5
75	166086.0	2116.0
80	175143.5	1811.4
88	182320.1	890.1
100	191105.4	732.1
120	227936.2	1841.5
140	260358.9	1621.1

* Figure arrived by summing up of the uptake values of individual nutrient element viz., N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu, B, & Mo.

of dry matter production, absorption of nitrogen phosphorus, potassium, copper and iron in that it also registered two peaks of rate of absorption of nutrients, one at the 40th day (3162.9 mg per day per 100 plants) corresponding to the intense phase of vegetative growth and the other at the 100th day (1337.6 mg per day per 100 plants) coinciding with the pod formation phase in TMV2. Asiriya Mwitunde also recorded two peaks of rate of absorption of total nutrients, one at 50th day (6111.5 mg per day/100 plants) and the other at 120th day (1841.5 mg per day/100 plants) similar to those of dry matter production and absorption of nitrogen, phosphorus, calcium, iron and manganese. The data further indicate that the nutrients are required only when the plants put on growth.

5. DISTRIBUTION OF DRY MATTER PRODUCTION & VARIOUS NUTRIENT ELEMENTS IN VEGETATIVE AND REPRODUCTIVE PARTS.

The distribution of dry matter and nutrient elements between the vegetative (stem + leaves) and reproductive (pods) parts at harvest is furnished in Table 30. The data indicate that the distribution

TABLE 30

DISTRIBUTION OF DRY MATTER AND NUTRIENT ELEMENTS BETWEEN VEGETATIVE (STEM + LEAVES) AND REPRODUCTIVE (POD) - PARTS AT HARVEST - (ON PERCENT BASIS)

ITEM.	TMV2		A.M.	
	Vegetatative parts.	Reproductive parts.	Vegetative parts.	Reproductive parts.
1. Dry Matter	75	25	75	25
2. Nitrogen	58	42	57	43
3. Phosphorus	53	47	50	50
4. Calcium	83	17	81	19
5. Calcium	73	27	74	26
6. Magnesium	87	13	86	14
7. Sulphur	73	27	81	19
8. Iron	74	26	69	31
9. Manganese	72	48	70	30
10. Zinc	68	32	66	34
11. Copper	74	26	67	33
12. Boron	82	18	84	16
13. Molybdenum	69	31	75	25
Total nutrient	70	30	70	30

TABLE NO. 31

TOTAL QUANTITIES OF NUTRIENTS ABSORBED

Sl No.	Nutrient absorbed		TKV2	Asiriya Mwitunde
1.	Nitrogen	(Kilogram per hectare)	195	183
2.	Phosphorus	-do-	28	26
3.	Potassium	-do-	102	92
4.	Calcium	-do-	106	95
5.	Magnesium	-do-	69	61
6.	Sulphur	-do-	59	56
7.	Iron	-do-	1.2	1.2
8.	Manganese	-do-	1.4	1.1
9.	Zinc	(Gram per hectare)	137	104
10.	Copper	-do-	100	75
11.	Boron	-do-	297	261
12.	Molybdenum	-do-	69	67
13.	Dry matter	(Kilogram per hectare)	2749	1650

of dry matter in vegetative and reproductive parts was 75% and 25% respectively in both the varieties. TMV2 and Asiriya Mwitunde did not differ much in respect of distribution of nitrogen, phosphorus, potassium, calcium, magnesium, manganese, zinc and boron between vegetative and reproductive parts. Distribution of nitrogen and phosphorus between vegetative and reproductive parts was either 50 : 50 or the percentage is slightly more in the vegetative parts (57 to 58 percent nitrogen in vegetative parts and 42 to 43 per cent in reproductive parts, 50 to 53 percent phosphorus in vegetative parts and 47 to 50 percent in reproductive parts) The major portion of potasium, calcium, magnesium, sulphur, iron, manganese, zinc, copper, boron and molybdenum (81 to 83 percent, 73 to 74 percent, 86 to 87 percent, 73 to 81 percent, 69 to 74 percent, 70 to 72 percent, 66 to 68 percent, 67 to 74 percent, 82 to 84 percent and 69 to 75 percent respectively) remained in the vegetative portion of the plant body. When uptake of total nutrients is considered major portion (70%) of the total nutrients absorbed by the whole plant remained in the vegetative portion of the plant body.

V. SUMMARY AND CONCLUSIONS

Studies on the uptake of macro (nitrogen, phosphorus and potassium), secondary (calcium magnesium and sulphur) and micro (iron, manganese, zinc, copper, boron and molybdenum) nutrients have been made with two high yielding varieties of groundnut TMV2 (bunch type) and Asiriya Mwitunde (semi-spreading type) having a duration of 120 and 140 days respectively, with a common level of fertilizers (N 30, P_2O_5 60 and K_2O 30 kg) and spacing of 15 X 15 cm and 22.5 X 22.5 cm respectively.

Growth, as measured by dry matter production was recorded in both the varieties at different stages of plant growth. There was gradual increase in the dry matter production with the increase in the age of the crop. The dry matter production exhibited sigmoid curves in both the varieties. The rate of dry matter production was higher during the phases of intense vegetative growth at 40th & 50th day and during the pod formation at 100th and 120th day in TMV2 and Asiriya Mwitunde respectively. The total dry matter production by TMV2 and Asiriya Mwitunde was 1860.4 kg and 1649.6 kg per hectare respectively.

It was observed that the whole plant nitrogen and potassium content was highest at the 35th and 40th day in TMV2 and Asiriya Mwitunde respectively, thereafter it followed a declining trend which continued till harvest. A slight increase in nitrogen content was recorded at 100th day and 120th day respectively. The whole plant phosphorus, calcium, magnesium iron, manganese and zinc content registered the highest values at 40th and 50th day in TMV2 and Asiriya Mwitunde respectively. Sulphur and copper content was highest at the 66th and 75th day and 60th and 66th day respectively in both the varieties. Molybdenum content of the whole plant was highest at the 20th day and decreased subsequently with increase in the age of the crop, while in the case of boron it increased with the increase in the age of the crop from the begining to the end.

Uptake of various nutrients increased with increase in the age of the crop and the uptake curves were sigmoid in nature for all the nutrients studied.

There were two prominent peaks of absorption in respect of nitrogen and phosphorus at the 40th and 100 day in TMV2 and 50th and 120th day in Asiriya Mwitunde. The two varieties slightly differed in potassium uptake. There were two peaks of potassium absorption in TMV2 at 40th and 100th day while there was one prominent peak at 50th day in Asiriya Mwitunde. The second peak at 120th day being insignificant, calcium magnesium, iron, manganese and molybdenum recorded only one prominent peak at 40th and 50th day in TMV2 and Asiriya Mwitunde respectively. Corresponding to the first peak of dry matter accumulation. The second peak at 100th and 120th day was less prominent and insignificant. Magnesium and sulphur recorded three peaks of absorption in Asiriya Mwitunde. There was only one prominent peak at 40th day and 50th day in zinc in both the varieties respectively. Copper recorded two distinct peaks at the 60th and 100th day in TMV2 and 66th and 120th day in Asiriya Mwitunde. Boron recorded only one prominent peak at the

60th day with one less prominent peak while there were two distinct peaks in Asiriya Mwitunde at 66th and 80th day.

Absorption of total nutrient put together increased gradually and attained the highest value at harvest. The curve was sigmoid in nature. The rate of absorption closely followed the trend of dry matter production. It recorded two distinct peaks, one at 40th day in TMV2 and 50th day in Asiriya Mwitunde and the other at 100 day in TMV2 and 120 day in Asiriya Mwitunde. Accumulation of dry matter and distribution of various nutrients between the vegetative and reproductive parts at harvest were as follows. The ratio of dry matter accumulation between the vegetative parts and reproductive parts was 3:1. Distribution of nitrogen and phosphrous was nearly 50 : 50 between the reproductive and vegetative parts. In both the varieties the distribution of other nutrients ranged from 65 to 80 percent in vegetative parts, and 20 to 35 percent in reproductive parts. Distribution of all the nutrients put together between the two parts was 70 percent and 30 percent respectively and resembled the pattern of accumulation of dry matter between the two plant parts.

Since TMV2 is a short duration variety maximum dry matter production and absorption of nutrients and their rates occured about 20-25 days earlier than that in Asiriya Mwitunde which is a medium duration variety coming to harvest about 20 days later.

Though dry matter production and absorption of various nutrients when considered on per plant basis were more in Asiriya Mwitunde than in TMV2 there were no significant differences between the two varieties when considered on hectare basis. This was due to differences in plant population. Since Asiriya Mwitunde is a semi spreading variety the spacing adopted was 22.5 X 22.5 centimeter whereas it was 15 X 15 centimeters in TMV2. What was gained by the higher yield potential of Asiriya Mwitunde was compensated by the greater plant population of TMV2 in a hectare.

The uptake and rate of absorption of nutrients at various stages of growth clearly indicated that there are two crucial periods occurring during 35 to 40 days and 88 to 100 days in TMV2 and 40 to 50 days and 100 to 120 days in Asiriya Mwitunde. The first period however is more important. During this period rate of peak growth and absorption of nutrients are very high. Hence any fertilizer scheduling should take in to consideration the high initial demand for nutrient in the initial period of growth of groundnut crop. Since there was considerable uptake of nitrogen as also other elements during the second period, it is desirable to split up nitrogen in two doses, one at the time of sowing and the second just before flowering. Splitting is much more desirable in sandy soils where leaching losses will be considerable.

In the present investigation except nitrogen, phosphorus and potassium and farm yard manure at 30, 60, 30 and 2750 kg per hectare respectively, no other nutrient element was supplied from outside. Part of the micronutrient requirements of the crop must have been met from the farm yard manure since no deficiency symptoms were observed, it is concluded that application of about two, two and half tons of farm yard manure would be desirable. Since groundnut is a leguminous crop, it fixes considerable quantities of nitrogen and major part of nitrogen requirement of the crop must have been met with from this source.

Based on the results of the present investigation the following recommendations are made:

1. Depending upon the soil conditions and irrigation facilities available either MHV2 or Asiriya Mwitunde may be chosen.

2. A dose of 30 to 45 kg nitrogen, 60 kg P_2O_5 and 30 kg K_2O along with a basal application of 2750 kg of farm yard manure per hectare is tried.

3. Spliting of nitrogen seems to be desirable but needs confirmation by further field experimentation. The other nutrients may be applied at the time of sowing.

4. Under the conditions obtainable at Agricultural Research Institute Rajendranagar there is no immediate need for applying micro-nutrient elements. However it is desirable to apply bulky organic manure.

ECONOMICS

At harvest, after removing the pods the weights of the pods and haulms were recorded separately. The yield data in respect of pods and haulms are presented in table 32. The economics of growing the two high yielding varieties, TMV2 and Asiriya Mwitunde, were worked out and presented in Table 33. The cultivation expenses and the fertilizer levels used were the same in both the varieties. However the cost of TMV2 seed sown was more than that of Asiriya Mwitunde seed sown due to difference in seed rate. Though Asiriya Mwitunde recorded a higher yield (1044 gm. per 100 plants) more than double than TMV2 (510 gm per 100 plants) no appreciable differences were observed in pod yield on hectare basis (2266.6 kg in TMV2 and 2062.2 kg in Asiriya Mwintunde). This is mainly due to the wide spacing adopted in this variety which resulted in a lower population per hectare (197532) than TMV2 (444444).

TABLE NO. 32

YIELD DATA RECORDED AT HARVEST

	TMV2	ASIRIYA MWITUNDE
1. Yield of Pod		
(a) For 100 plants (in gm)	510.00	1044.0
(b) Per hectare (kg per hac.)	2266.6	2062.2
2. Yield of haulm		
(a) For 100 plants (in gm)	8372.0	16705.0
(b) Per hectare (in quintal)	37.2	33.2

TABLE No. 33

RELATIVE RETURN FROM TMV2 AND ASIRIYA MWITUNDE PER HECTARE

Item	TMV2 Rs.	ASIRIYA MWITUNDE Rs.
1. Expenditure		
1. Cost of seeds	404=00	264=00
2. Cost of manures and fertilizers.	366=00	366=00
3. Cultivation expenses.	472=00	472=00
Total	1242=00	1102=00
II. Receipt.		
1. By the sale of pods.	3965=50	3608=50
2. By the sale haulm	111=00	99=00
III. Net returns		
1. In each variety	2834=50 (A)	2605=50 (B)
2. Among the variety A (-) B	229=00	

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APPENDICES

APPENDICES

APPENDIX. I

RESULTS OF SOIL ANALYSIS

PARTICULARS.	Results of soil analysis before sowing. Profile sample		Results of soil analysis after 6 harvest	
	Profile sample		TMV2 plot	Asiriya Mwitunda plot.
Depth of sample	0-6"	6-12"	0-6"	0-6"
1. pH (1:2.5 soil water extract).	7.9	7.3	7.2	7.8
2. Electrical conductivity. (m.mhos @ 25° c.)	0.108	0.105	0.124	0.113
3. Organic carbon(%)	0.47	0.41	0.68	0.62
4. Nitrogen (%)	0.04	0.03	0.06	0.06
5. Water soluble salts:-(in p.p.m)				
i) Carbonate	-	-	-	-
ii) Bicarbonate	232.3	145.2	217.8	174.3
iii) Chloride	48.7	55.7	40.7	50.7
iv) Sulphate	-	-	-	-
v) Calcium	69.3	55.3	54.6	54.6
vi) Magnesium	4.2	17.7	3.3	3.2
6. Available nutrients (kg/hac.)				
i) N	150	140	100	90
ii) P_2O_5	63	84	23	25
iii) K_2O	375	225	125	105

7. Soil textural classification - Sandy loam

APPENDIX II.

METERIOLOGICAL DATA RECORDED AT AGRICULTURAL RESEARCH INSTITUTE RAJENDRANAGAR DURING THE PERIOD NOVEMBER 1969 TO AUGUST 1970

PARTICULARS.	NOV. 69.	DEC. 69.	JAN. 70.	FEB. 70.	MAR. 70.	APR. 70.	MAY. 70.	JUN. 70.	JUL. 70.	AUG: 70.
1. Mean maximum temperature in °c.	28.4	26.1	28.7	32.5	35.49	37.3	38.4	31.8	31.2	28.3
2. Mean minimum temperature in °c.	17.7	13.2	14.0	15.8	21.25	21.3	22.3	22.5	22.7	22.1
3. Highest maximum temperature in °c.	32.2	28.2	31.1	35.7	38.7	40.6	41.8	33.8	34.2	32.6
4. Highest minimum temperature in °c.	20.8	19.9	19.4	20.9	26.6	24.3	25.0	24.7	23.8	24.2
5. Lowest maximum temperature in °c.	22.5	25.2	26.8	29.9	28.8	33.7	31.7	29.0	26.1	23.7
6. Lowest minimum temperature °c.	14.1	6.8	8.5	13.2	14.6	17.5	14.9	21.3	20.9	20.7
7. Average humidity at 7 hours (%)	90.6	96.4	92.0	82.3	63.3	71.2	64.1	85.9	88.5	91.4
8. Average humidity at 14 hours (%)	550	51.2	39.0	31.8	22.7	25.6	30.7	60.4	66.1	75.4
9. Rainfall during the month (mm)	37.4	13.2	3.8	-	19.6	22.6	41.2	170.0	67.3	390.2
10. Rainy days during the month.	4	1	1	-	1	7	5	13	6	15
11. Rainfall since 1-6-69 (m.m.)	587.3	600.5	604.3	604.3	623.9	646.5	686.7	170.0	237.3	627.5
12. Rainy days since 1-6-69.	40	41	43	45	46	53	58	13	19	34
13. Hours of bright sun shine during the month.	218.5	241.3	287.8	303.8	-	-	-	-	-	112.9