DECLARATION

This thesis is my original work and has not been presented for a degree in any other University.

Signed ---------------------------------- 12/3/84

BEATRICE WANJIRU KING'ORI

This thesis has been submitted for examination with my approval as University Supervisor

Signed ---------------------------------- 12/3/84

PROFESSOR D. N. NGUGI

DEDICATION

To my parents

King'ori and Wagaki

&

To my daughters

Wanjiku and Nyambura

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ABSTRACT

A study on the effect of seed size and variety on growth, development and yield of potatoes (*S. tuberosum* L.) was carried out between 1981 and 1982 at the Field Station, University of Nairobi. Three seed sizes (35-45 mm - small; 45-55 mm - medium; 55-65mm - large) of three commonly grown potato varieties B53, Anett and Kerr's Pink were planted.

Seed size affected emergence. Thus, plants derived from the large seed tubers emerged earlier than plants derived from medium and small seed tubers. The plants from large seed tubers were bigger, more vigorous in growth and took a shorter time to completely cover the ground when compared to plants from medium and small seed tubers.

The number of stems per hill was highest in the plants derived from the large seed tubers and lowest in the small seed tubers. This was true for the three varieties.

Dry matter accumulation in the haulm continued to a maximum and then started declining as the crop matured. Tuber dry matter increased throughout the growing period. At the end of the growth period, B53 had the highest dry matter as is expected while Anett and Kerr's Pink had lower and comparable dry matter contents (percentage). This was true in both

seasons. In season I (short rains, 1981) which was notably dry and irrigation had to supplement the rainfall, the tubers had lower dry matter content as compared to season II (long rains, 1982) when rainfall was more or less adequate.

Total final tuber yield and ware grade yield were highest in Annet. B53 had the lowest tuber yield while Kerr's Pink had medium yield both in terms of total tuber yield and ware yield. Although plants from large seed tubers yielded more than plants from medium and small seed tubers, seed size effect was not significant. The variety effect was however significant (P = 0.05).

CHAPTER ONE

INTRODUCTION

1.1. Origin and the spread of potatoes

Botanical evidence points out that the origin of the cultivated potato (*Solanum tuberosum L.)* is in the Peru-Bolivian region (Hawkes, 1978). Potatoes were introduced in Southern Spain about 1570 (Salaman, 1937) from where they spread throughout Europe. Introduction into North America was from England in 1621 and into India and China in the late seventeenth century (Hawkes, 1978). The potatoes were introduced in West Indies and some parts of Africa by the late seventeenth century.

The potato was brought to Kenya from Europe in the ninteenth century most likely by the British East Africa Trading Company (Durr & Lorenzl, 1980). It was first grown by European settlers in the what was called "White Highlands". African farmers were only allowed to grow the crop after the World War I in the Rift Valley. Later production was extended to Kiambu, Nyeri and Murang'a in Central Province. The variety grown then was Kerr's Pink and was for domestic consumption only. Since its introduction in Kenya, the crop has expanded in terms of production and utilization as a food crop.

1.2. Nutritional and Economic Contribution of the potato

The potato is nutritionally important especially in the rural areas where it is grown and used as a major staple food. In urban areas too, the potato is also used as a staple food. In Kenya 7 - 10% of the total calory intake comes from potatoes. It is a good source of carbohydrates: proteins and fats are only a small proportion of the total solids (Table 1).

Table 1. Proximate Analysis of Potatoes (After Talburt, Schwimmer and Burr, 1975)

		Average %	Range %
Water		77.5	63.2-86.9
Total solids		22.5	13.1-36.8
Proteins		2.0	0.7-4.6
Fats		0.1	0.02-0.96
Carbohydrates:	Total	19.4	13.3-30.53
	crude fibre	0.6	0.17-3.48
Ash		1.0	0.44-1.90

As a result of the increasing importance of the agricultural sector in Kenya, the value of potatoes is also increasing. In 1975, potatoes accounted for 2% of the gross value marketed agricultural production which was about K£ 2.5 million (Anon. 1975). In 1981, potatoes accounted for only 1.1% of the gross value of marketed agricultural production which was about K£ 3.5 million. This shows an increase in the value of potatoes and the hectarage under potatoes has also increased. The potato industry employs about 3% of the agricultural labour force in Kenya (Durr and Lorenzl, 1980).

Farmers grow potatoes mostly for home consumption and also income generation. Durr and Lorenzl (1980) found that about 70% of the total potato production is used for subsistence. Farmers also retain some of the crop to use as seed in the following season. Utilisation of the crop however, varies from place to place (Table 2).

Table 2. Utilization of Potato Crop as Percentage of Total Production (After Durr, G. & G. Lorenzl, 1980).

Area	% Sale	% Home Consumption	% Seed
Molo	39	36	25
Ol Kalou	32	41	25
Kinangop	27	48	25
Kiambu	14	54	32
Nyeri/Murang'a	18	54	27
Meru	60	19	21

1.3. Present Potato Production in Kenya

The potato is fairly widespread in the ecologically favourable areas. These include Molo, Mau Narok in the Nakuru District, Ol Kalou and Kinangop in Nyandarua district, Eastern slopes of the Aberdares in Kiambu, Murang'a and Nyeri districts and northern slopes of Mt. Kenya in Meru district. Here nearly all farmers grow potatoes.

Other favourable areas which grow potatoes only to a small extent are in Uasin Gishu, Trans Nzoia and Nandi districts. The Western and Nyanza provinces are also favourable but eating habits do not favour the growing of the crop.

In 1980, the area under potato cultivation was 55, 740 hectares (Anon. 1980; Table 3). Land under the potato crop varies in different regions. A survey conducted by Durr and Lorenzl (1980) showed that potatoes occupy 22% of the total farmland in Meru district while in other areas, potatoes occupy 2-11% of the total farmland. Production periods of the potato coincide with the rainfall seasons.

1.4. Problems in Potato Production

Price fluctuations caused by the seasonality in production discourage farmers from growing the crop. Production is abundant soon after harvest and lowest when the crop is not being grown. Prices are thus

Table 3. Potato Production and Value by Provinces 1977 - 1980

Year	CENTRAL Hectarage	CENTRAL Tonnes	CENTRAL Value K£	RIFT VALLEY Hectarage	RIFT VALLEY Tonnes	RIFT VALLEY Value K£	EASTERN Hectarage	EASTERN Tonnes	EASTERN Value K£
1977	26,882	92,579	6,697,412	67,136	92,915	3,613,361	7,599	46,284	863,836
1978	16,253	127,056	9,672,960	12,557	96,245	15,038,275	10,274	98,161	3,792,455
1979	20,443	174,289	7,734,086	8,636	78,367	11,755,050	10,800	104,160	3,709,300
1980	25,664	270,994	9,675,245	16,869	167,870	25,180,393	12,207	100,436	15,693,125

Sources: 1) Rift Valley Province Annual Reports: 1977, 1978, 1979, 1980.

2) Central Province, Annual Reports: 1977, 1978, 1979, 1980.

3) Eastern Province, Annual Reports: 1977, 1978, 1979, 1980.

lowest soon after harvest and highest when the crop is off-season. The peasant farmers may not be able to purchase seed for planting the following season when the prices are high.

Disease incidence also lowers the yield of the crop especially in the wet season when late blight *(Phytophthora infestans* L.*)* is prevalent. Advising the farmers on use of resistant varieties and effective use of fungicides is therefore important.

Lack of adequate good quality seed is another drawback to potato production. Farmers may use seed that is not free of disease. This gives rise to a diseased crop that yields very poorly. Farmers may not know the resistant varieties and they tend to use a wide range of seed sizes which may not give the expected high yields.

1.5. Objective of the study

The objective of this study is to find out the effect of using different seed sizes on the growth, development and yield of three potato varieties in Kenya.

Most farmers are mainly interested in high yields and especially the ware grade for sale and home consumption. Bearing in mind the fact that farmers use a wide range of seed sizes, it is therefore important to find out an appropriate recommendation of seed size to the farmers which give optimum yields.

The interaction of seed size and variety will be of interest considering that several varieties are planted by the farmers each year.

CHAPTER TWO

LITERATURE REVIEW

In order for the farmer to obtain optimum growth and high yields from a potato crop, many factors are involved. These include use of certified seed tubers of locally adapted varieties, good nutrient supply, use of appropriate plant population, good disease and weed control and also use of the right size of seed tubers. This review will look into the effect of seed size on various aspects of potato growth.

2.1. <u>Effect of Seed Size in Potatoes</u>

Much work on the effects of seed size in potatoes has been carried out in temperate countries while very little has been done in Africa. Seed potatoes can be classified as large, medium and small either on the basis of riddle size or tuber weight. In the present work the sizes were based on riddle size. Seed size in potatoes has been found to influence sprout growth, plant emergence and subsequent growth in the field and final yield and grading.

2.1.1. <u>Effect of Seed Size on Sprout Growth</u>

Sprouting of potato seed tubers is important in advancing the growth cycle of the plant. If seed tubers are well sprouted and planting is done timely in the season, then each phase of the growth cycle, that is emergence, growth and senescence of foliage and initiation, bulking and maturity of tubers occurs earlier (Toosey, 1963).

Wakankar (1944) working in India, used seed pieces of Darjeeling-red potatoes weighing 10g, 20g and 40g and found that the number of sprouts increased with increase in seed tuber size. His data showed that yield, total number of tubers per hill and individual tuber size was governed by the number of sprouts produced rather than the amount of food stored.

Similarly, Morris (1966) working in England on the effects of tuber size, sprout number and temperature on sprout growth during storage (seed sizes used were 200 ± 2.2g; 102 ± 1.6g and 53 ± 0.8g) found that mean sprout length was a function of tuber size. The mean dry weight of the sprouts per tuber increased with seed tuber size. He concluded that the rapidity of plant emergence; number of main stems and branches, the onset of tuber initiation, the rate of tuber bulking, the number and size distribution of tubers are all affected by the number and size of sprouts on the mother tuber at the time of planting.

Wurr (1978) in his study on potato sprout growth found that as the initial tuber weight increased, the total sprout length also increased.

Seed tuber sizes used were 30-40mm and 40-45mm of the varieties Desiree, Majestic, Pentland. Crown and King Edward.

All the above reports concur that an increase in number of sprouts in turn determine emergence, number of stems, tuber initiation, number and size of tubers and the final yield. Sprouts derive their energy and nutrients for growth from the mother tuber. Large seed tubers have more food reserves and therefore give rise to more sprouts compared to small seed tubers.

2.1.2. Effect of Seed Size on Plant Development

Working in Norway with the varieties Kerr's Pink and Arran Consul (seed sizes used ranged from 12.5 to 150g), Roer (1957) found that sprouts from largest seed tubers emerged more rapidly and their shoots showed more vigour than those from small seed tubers.

Elbe (1957) in West Germany found that date of emergence was dependent on tuber size. Large tubers produced shoots five to eight days before the small tubers. He conducted the trials for eight years with varieties Ackergsegen and Olympia using four sizes < 3.4 cm (undersize), 3.4 - 5cm (small) 5-7 cm (large) and > 7cm (oversize).

Reestman (1953) stated that the use of small seed tubers 25-28 mm is considered to be economically justified but in practice it is inferior to large seed tubers. This conclusion was based on the slow development during earlier stages of growth and the supposition that plants from small seed tubers are at the beginning affected more by adverse conditions. All these reports show that large seed tubers give rise to larger plants that are more vigorous than plants from small seed tubers.

Large seed tubers have more reserve material and this can result in higher relative growth rates than in small seeds tubers during the pre-emergence and early post-emergence periods. Large seed tubers give rise to larger plants than do small seed tubers in the establishment phase though the difference in plant size is relatively smaller than in seed size (Taha, 1961). After establishment, seed tuber size has no direct effect on the relative growth rate and behaviour of plants from large or small seed tubers depends on the intensity of inter-plant competition to which they are subjected; if low as with widely spaced plants, the initial advantage of plants from large seed tubers may be maintained for longer (Black, 1957). Under more intense conditions of competition, the earlier onset of inter-plant competion in large seed tuber plants causes a decrease in relative growth rate compared to small seed tuber plants.

The fact that large seed tubers give rise to large plants when compared to small seed tubers, also means that the photosynthetic apparatus can therefore trap more radiation than the small seed plants. Throughout the period of emergence, the plant is dependent on the carbohydrate reserve in the mother tuber. After emergence, leaf expansion is rapid and the plant becomes autotrophic. Transfer of reserves from the mother tuber continues until fully depleted or until microbial infection causes decay. The stems become independent when they have acquired a leaf area of 200 to 400 cm^2 (Denny, 1929; Headford, 1962).

Headford (1962) found that even after a considerable leaf area was achieved photosynthesis accounted for only a small proportion of dry weight production of the plant suggesting that reserve material in mother tuber influences growth for a period. The presence of mother tuber had a marked suppressing effect on photosynthesis. Bremner and Taha (1966) in their work on the effect of variety (King Edward and Majestic), seed size and spacing on growth, development and yield found that leaf area of large seed tuber plants was initially higher than that of plants from small seed tubers. However, plants from small seed tubers caught up later.

The rapid development of plants produced by large seed tubers is associated with the food reserves in the mother tuber. Large seed tubers have more reserves than small seed tubers. These reports are similar to those of El Saeed (1966) working on Safflower (*Carthamus tinctorius* L.) in Sudan and that of Burris, Edje and Wahab (1973) working on soybeans (*Glycin max* L). These results are contrary to those of Morris (1966) and Wakankar (1944) who found that food reserves in mother tuber play no important role in sprout and early plant development.

2.1.3. Effect of Seed Size on Stem Number

The number of sprouts and stems that develop per seed tuber is dependent on tuber size. The stem is used as a unit of plant density. This has been used by many workers (Reestman & De Wit, 1959; Bleasdale, 1965; Sharpe and Dent, 1968; Wurr, 1974; Jarvis, 1977). The stems can arise directly from the mother tuber or from branching sprouts.

Moorby (1967) considered each stem above the ground to be a separate individual which is potentially capable of separate existence and relies on its own leaves and roots for supplies of carbohydrates, mineral nutrients and water.

Emerging shoots have been shown to compete for nutrients and water in the soil (Moorby 1967). This competition influences the number of stems produced per sprout and the size attained by the stems. Bremner and Taha (1966) working on the varieties King Edward and Majestic and using seed sizes 32-38mm and 44-51mm found that stems per plant were higher for plants derived from larger seed than those derived from small seed. Birecki and Roztropowicz (1963) also found that plants from large seed tubers developed twice as many stems as plants from small seed. Mundy and Bowles (1973) using seed sizes 32-42mm and 41-57mm showed that stem population was lower for the small seed tubers but larger for the large seed tubers. Wurr and Allen (1974) found that the stems per seed tuber increased with an increase in seed tuber size. Field trials in Rumania with cultivars Ostara, Desiree and Ora showed that increasing tuber size from 30mm and 45mm or 60mm led to an increase in the number of stems per hill (Morar, 1981). Increasing stem density either by use of larger seed or more seed tubers is a means of shortening the time taken to reach complete ground cover (Svensson, 1973).

By affecting stem density, seed size in turn determines the intensity of competition within and between plants. Thus, according to Donald (1963) the factors for which competition occurs between plants include water, light, nutrients, oxygen and carbon dioxide. Carbon dioxide can be depleted in rapidly photosynthesising plants that are competing. Competition for soil oxygen is also important especially in poorly structured soils. Harper (1961) showed that the time at which developing plants start to compete or interfere with each other is a function of their density. He also showed that a decrease in plant size and yield per plant with increasing plant density is due to increased intensity of interplant competition for water, light and nutrients. Production of many stems per hill in potatoes leads to more intense competition within the hill. However, the larger the number of stems per hill the larger the photosynthetic apparatus. Overcrowding of leaves however leads to mutual shading resulting in reduced net assimilation rate and early senescence of lower leaves.

Many Kenyan farmers tend to have low plant population since they plant the small seed tubers. Use of large seed tubers might be preferred to obtain high populations. The fact that large seed tubers are more bulky compared to small seed means that handling is more difficult and it would cost more to purchase seed tubers and transport them. The farmers are therefore averse to using large seed tubers. They prefer to sell the large tubers as ware.

Plants grown from different seed sizes take different periods to develop foliage to fully cover the ground. Plants from large size tubers take off fast and are vigorous thus develop more foliage in less time compared to plants grown from small seed tubers. In the initial stages of growth when plants have not reached full ground cover, the leaf area index is less than one, thus little photosynthesis occurs. Such an index does not meet the demands of bulking (Watson, 1952; Borah & Milthorpe, 1959). It is important to point out that dense foliage can result in light becoming a limiting factor due to shading of leaves.

2.1.4. Effect of Seed Size on Total Tuber Yield and Yield Grades

Yield in the potato crop is resultant of the rate and duration of tuber bulking, the latter being a function of the time of tuber initiation and foliage persistence (Radley, Taha and Bremner, 1961). Bulking rate is the major determinant of final tuber yield. The bulking rate is in turn determined by the sink capacity established soon after tuber initiation (Sale, 1973). A large number of developing tubers offers a large sink for assimilates. It is important to point out that individual tubers on a plant grow at varying rates and the largest at any given time may not be the fastest growing. In other words, growing tubers have different capacities of absorbing the assimilates as sinks.

Size of seed tubers influences yield and grade of produce by controlling the number of stems per hill thereby controlling intensity of competition within the hill. Bates (1935) in his study on the factors influencing size of potato tubers, found that large seed tubers gave higher total yield than small seed tubers at the same spacing. He used three sizes 28.4g; 42.6g and 71g of the cultivars Eclipse and King Edward at four within row spacings 30 cm, 37.5cm, 45 cm and 52.5cm. He concluded that size of seed tubers planted influences sizes of tubers produced. Small seed tubers give rise to large individual tubers (more ware potatoes) than large seed tubers at the same spacing. This finding can be explained by the fact that large seed tubers have more sprouts per tuber than small seed tubers and therefore more shoots (stems) per hill. The greater the number of stems per hill, the greater the number of tubers produced and the smaller the size of the tubers, that is, large seed tubers produce less ware potatoes than small seed tubers.

High tuber yields also depend on the adequate supply of soil moisture. As soil moisture decreases, both fresh and dry weight of tubers decrease. The uptake of nutrients from the soil is very sensitive to soil moisture since moisture affects nutrient availability.

The findings of Roer (1957) Wakankar (1944) and McCubbin (1957) like those of Bates (1935) on the effect of seed size show that total yield increases with an increase in seed tuber size but the average size of tubers decrease with an increase in seed tuber size. Working in Norway with the varieties Kerr's Pink and Arran Consul, Roer (1957) showed that average tuber weight was raised but total yield increased with an increase in seed tuber size. He found a significant interaction between variety and seed tuber size. This indicated that a variety inherently having low number of stems and tubers reacted more favourably to an increase in seed size than one with a normal tuber and stem development.

Yield differences between plants from large and small seed tubers appears to arise from a difference in duration rather than the rate of bulking (Taha, 1961; El Saeed, 1963). El Saeed (1963) further suggested that differences in duration of tuber bulking arise from earlier tuber initiation in plants from large seed tubers.

In Kenya, most farmers especially small scale farmers retain some of the harvested crop as seed to be used in the following season for planting. It is usual for them to retain the small sized potatoes which are easier to handle during storage and planting. Work done on potatoes in Kenya is little and information to farmers is lacking. The proper potato husbandry is not known to many farmers that is the right spacing, seed size, and fungicides to use. This then leads to low yields of the crop. Use of clean certified seed that is free of disease may be difficult for most farmers who are not in reach of firms like Kenya Farmers' Association and Agricultural Development Corporation which sell these certified seeds. Turner (1959) working in South Kinangop suggested that farmers should use seed potatoes of the size 30-45 mm. This seed size gives a high proportion of ware potatoes while use of larger seed gives more tubers per plant but of smaller size. He used the varieties Rosslin Elmenteita (E52), Rosslin Mount Kenya (K52), Rosslin Chania (C52) and Kerr's Pink. Surveys have also been done in potato growing areas (Durr $ Lorenzl 1976/77, Ballestrem & Holler, 1977) and recommendations made but these have not reached all potato growing farmers hence lack of knowledge.

2.2. Effect of Seed Size in Other Crops

Studies on the relationship between seed size and plant performance have also been carried in other crops besides potatoes. Working on subterranean clover *(Trifolium subterraneum* L.) , Black (1955) used five classes of seed size in his study on the effect of seed size and depth of sowing on pre-emergence and early vegetative growth. He found that plant dry weight in early vegetative stage, total leaf area and leaf number were proportional to seed size. Critical leaf area was first reached by the plants from large seeds.

Kneebone and Cremer (1955) working on some grass species wanted to determine the importance of seed size on seedling vigour. Characters observed were time of seedling emergence, germination percentage, seedling heights at various time intervals, fresh or dry weight per plot or per 100 seedling and seedling scores. They found that small seeds germinated poorly than larger ones and the latter gave more vigorous seedlings and taller plants.

A study on white clover (*Trifolium repens* (L); red clover (*Trifolium pratense L.)* and lucerne (*Medicago sativa L.)* gave similar observations. In this study, percentage emergence was higher in large seeds. Large seeds also produced larger plants than small seeds. Work to determine effect of seed size on oil content and seedling emergence in safflower (*Carthamus tinctorius* L.) was done in Sudan by El Saeed (1966). Oil content was found to decrease though not significantly with increasing seed size (respectively 37, 36.6 and 35.7 per cent in small, medium and large seeds). His findings were similar to other workers (Black, 1955; Kneebone and Cremer, 1955).that is, plants from large seeds emerged earlier and had greater dry weights and leaf areas than plants from small or medium sized seeds.

Burris, Edje and Wahab (1973) studied seed size effect of soybeans (*Glycine max L.*). Characters studied were seedling performance, seedling growth, photosynthesis and field performance both in the laboratory and in the field. They found that plants from large seeds were superior in terms of emergence percentage, leaf area and plant height. The plants from large seeds also yielded more than plants from small seeds when grown at the same populations. All these findings are consistent;

that is, early development, emergence and vigour of the seedlings are dependent on seed size, the large seeds being superior to small seeds. This is similar to the findings of Roer (1957), Elbe (1957), Reestman (1953) and Taha (1961) whose work on potatoes showed that large seed tubers gave rise to larger plants that were more vigorous.

Kaufman and Guitard (1967) studied the effect of seed size on early plant development in barley (*Hordeum vulgare* L.). They found that plants from large seeds were superior to those from small seeds with regard to rate of seedling growth and size of first two leaves. These differences were associated with the amount of substrate nutrient available to the seedling in the seed. Bremner, Eckersall and Scott (1963) similarly observed that differences between plants from small and large seeds of wheat (*Triticum aestivum* L.) were caused by the extent of nutrients or the energy source was found to determine the size of the plant and the extent of leaf surface at the time of exhaustion of reserve material when it becomes wholly dependent on photosynthesis. This is in line with what workers like Denny (1929), Headford (1962) and Mush (1962) found in their work on potatoes. Early rapid development, large and more vigorous plants from large seed tubers was due to more reserves in the seed tubers. The shoots once emerged continue to use the energy derived from the food reserves in the mother tubers until the plants develop their own foliage that will supply the assimilates. Food reserves in mother tubers are utilized until they are depleted or until the mother tuber rots due to microbial infection. Work on the effect of seed size on maize (*Zea mays* L.) had results contrary to other plants. Hunter and Kannenberg (1972) worked on maize in Ontario, Canada. They studied the effects of seed size on the seedling emergence, grain yield and plant height. Sizes used were 39g/100 kernels (large) and 23g/100 kernels (small). Seed size was found to have no effect on the number of days to 50% emergence, final percent emergence or grain yield; however, plants from small seeds were shorter compared to plants from large seeds. Further experiments showed seed size to have no effect on rate of emergence regardless of the hybrid, planting depth or the temperature regime. Some work on maize in Kenya showed that early development was dependent on seed size. Initial plant size was larger for large seeds but development rate was similar for three seed sizes used (Hawkins and Cooper, 1979). These workers also found that the pattern of dry matter production was similar for all the seed sizes used (weights of 1000 grains taken: 225; 432; 649g). However, due to the differences in initial weight of the seed, growth curves were displaced. At any time during the early stages, plants grown from large seeds were larger than those from small seeds and differences became less as the crops matured. The same observation was made by Bremner and Taha (1966) in potatoes: leaf areas of plants from large seed tubers were initially higher than those of plants from small seed tubers but the latter caught up quickly.

CHAPTER THREE

MATERIALS AND METHODS

3.1. Experimental site

The experimental site was on the Faculty of Agriculture Farm, Field Station, Kabete. The site used in season one (short rains, 1981) was fallow the previous season while the site for season two (long rains, 1982) had been under beans the previous season. Gethin-Jones & Scott, (1958), as cited by Nyandat and Michieka (1970), described the soil in the farm as red to strong friable clay with laterite. Scott (1961) placed the soil under red friable clay. According to Nyandat and Michieka (1970) the predominant clay mineral is kaolin whose parent material is the Kabete trachyte.

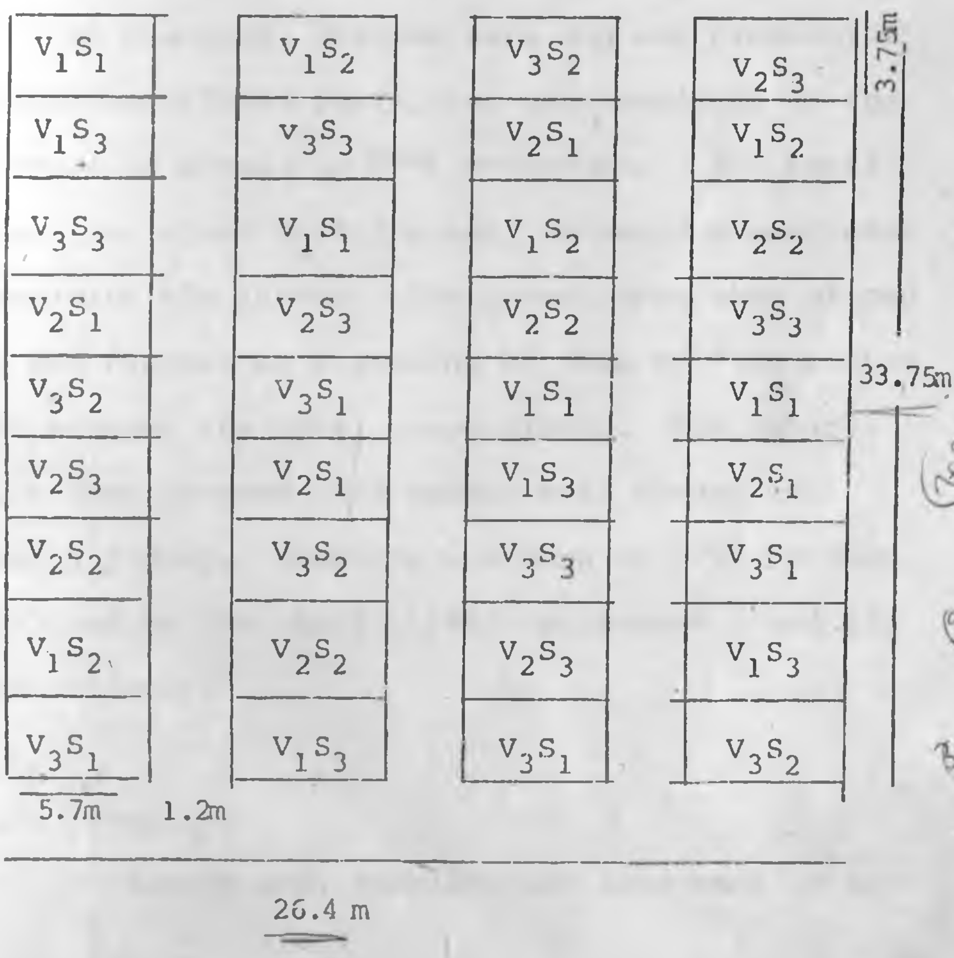
3.2. Experimental Design and Treatments

The experiment was laid out in a completely randomised block design. There were nine treatments: three potato varieties - B53, Anett and Kerr's Pink denoted respectively as V_1, V_2 and V_3 factorially combined with three seed sizes - 35-45mm, 45-55mm and 55-65mm, respectively denoted as S_1, S_2 and S_3. The treatments were replicated four times. The treatments combinations and the field plan (Fig. I) were as follows:

Treatment combinations:

1. V_1S_1
2. V_1S_2
3. V_1S_3
4. V_2S_1
5. V_2S_2
6. V_2S_3
7. V_3S_1
8. V_3S_2
9. V_3S_3

Fig. 1 Field Plan



3.3. The Seed

Three potato varieties B53, Anett and Kerr's Pink commonly grown in Kenya were planted. B53 is a medium late maturing variety (3½-4 months); Anett and Kerr's Pink are early maturing varieties (3-3½ months). In season one, the three sizes of B53 and large size seed of Anett were well sprouted basic seed. Small size and medium size of Kerr's Pink were also basic seed but were not as well sprouted. Due to lack of basic seed, the large size of Kerr's Pink and small size of Anett were not basic seed.

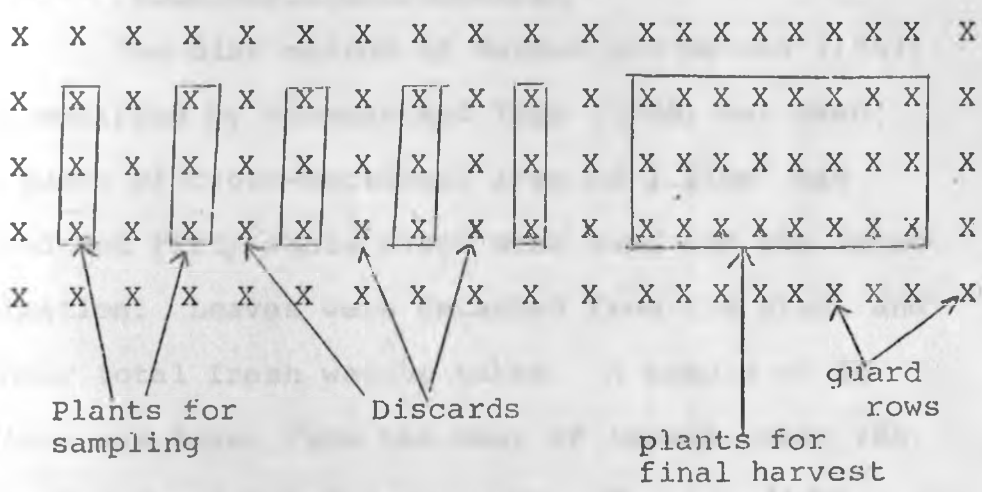
3.4. Planting and Fertilizer Application

At planting, furrows were dug and diammonium phosphate (18:46) fertilizer was broadcast in the furrows at a rate of 500kg per hectare. The fertilizer was mixed with the soil to avoid direct contact with the tubers. The tubers were then placed in the furrows at a spacing of 30cm by 75cm within and between the rows, respectively. The tubers were then covered with enough soil though not making ridges. Planting was done on 30th October, 1981 and on 7th April, 1982 for season I and II, respectively.

3.5. Sampling

In season one, sampling was done once in the ninth week after planting when the plants in all the treatments had fully covered the ground. As a result of uneven emergence, it was not possible to do sequential harvesting. In season two, sampling was started earlier, 46 days after planting. Five samplings were done fortnightly in season two. At sampling, three plants were uprooted from every plot. These plants were put in paper bags for the determinations of fresh weights of leaves, stems and tubers and later the dry weights of the same. Two replicates were sampled on one day while the other two were sampled on the following day. At each sampling, the adjacent plants were left out as discards (Fig. 2).

Fig. 2. <u>Sampling Plan in Season I and II</u>



3.6. Determinations

3.6.1. Fresh and Dry weight of leaves, stems and tubers

The leaves were detached from the stems and weighed separately. The whole samples were put in the oven to dry at $100^{o}C$ for 48 hours. The fresh stems were also weighed and put in the oven to dry at the same temperature and for the same period of time. The tubers were wiped off all the soil and weighed. In order to accelerate drying the tubers were sliced into small, thin pieces and dried. After drying, the dry weight was taken. Whole samples were used throughout the sampling period.

3.6.2. Leaf Area Determination

The disc method of Watson and Watson (1953) as modified by Bremner and Taha (1966) was used. A punch of cross-sectional area of $2.27cm^2$ was used and fifty whole discs were used for the determination. Leaves were detached from the plant and their total fresh weight taken. A sample of 50 discs was taken from the mass of leaves using the punch and was dried separately. The area/dry weight relation was calculated. The area of the whole sample was calculated thus;

$$\text{Total leaf area} = \frac{\text{Area of punch X 50 discs}}{\text{Dry weight of 50 discs}} \text{ X Total leaf dry weight}$$

The total leaf area was later converted to leaf area index.

3.6.3. Final Harvest and Tuber Grading

Plants remaining after the final sampling were used for final tuber yield determination and tuber grading. After harvest tubers were graded into three sizes using sieves of different riddle sizes.

1. Ware grade - tubers whose diameter was greater than 55mm.
2. Seed grade - Tubers whose diameter ranged between 25mm and 55mm.
3. Chats - Tubers whose diameter was less than 25mm.

3.7. Field Crop Management

In both seasons, the crop was kept weed free by hand weeding three times before full ground cover. Subsequently, weeds were hand removed by pulling. Season one was notably dry and there was no late blight attack (*Phytophthora infestans* L.). Weekly applications of Dithane M-45 were done at the rate of 2kg per hectare to prevent any attack. In season two, Kerr's Pink was slightly attacked by late blight but this was successfully controlled by applying Ridomil at a rate of 1kg per hectare every fortnight. Aldrin 40% W.P. was also applied at the base of plants during the early stages of growth to control cutworms (*Agrotis* sp.). Rainfall during the two seasons is shown in table 7 in the appendix.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1. General Observations

In season I, emergence was uneven since not all seed tubers were well sprouted especially Anett medium and small size and all sizes of Kerr's Pink. For this reason, only one sampling was done in season I at nine weeks after planting when all treatments had reached full ground cover (this was the sixth week after emergence).

In season II, a few plants had emerged by the third week after planting. Emergence was also uneven as in season I, especially in plots with large size of B53. Unlike season I when the crop was disease free, the crop in season II had a slight attack of leaf roll virus and also yellow mottle virus. The affected leaves later dropped off. Table 4a and 4b show the emergence percentage in season I and II respectively.

At the time when the emergence percentage was determined, it was observed that plants from large seed tubers were biggest while those from small seed tubers were smallest. This observation is similar to the observations made by Roer (1957) and Elbe (1957). They found that plants from large seed tubers emerged earlier and were larger and more

Table 4a. Effect of Seed Size and Variety on Emergence Percentage at 3½ Weeks After Planting (Season I)

Variety	Seed size	Replicates I	II	III	IV	Total	Mean
	S_1	70	100	100	100	370	92.5
B53	S_2	100	100	100	100	400	100.0
	S_3	100	100	100	100	400	100.0
	S_1	70	60	100	100	330	82.5
Anett	S_2	100	100	100	100	400	100.0
	S_3	100	100	100	100	400	100.0
	S_1	70	5	90	0	165	55.0
Kerr's Pink	S_2	5	70	90	70	235	58.7
	S_3	20	5	50	70	145	36.2

Table 4b. Effect of Seed Size and Variety on Emergence Percentage 4 Weeks After Planting (Season II)

Variety	Seed size	Replicates I	II	III	IV	Total	Mean
B53	S_1	57	43	45	69	214	53.5
	S_2	64	59	44	47	214	53.5
	S_3	33	23	16	37	109	27.2
Anett	S_1	45	45	38	46	174	43.5
	S_2	62	68	49	57	236	59.0
	S_3	77	73	62	80	292	73.0
Kerr's Pink	S_1	32	41	36	36	145	36.2
	S_2	36	44	50	46	176	44.0
	S_3	66	85	67	63	281	70.2

vigorous compared to plants from small seed tubers.

Earlier emergence of plants from large seed tubers is an advantage in that plants can utilize the available moisture and nutrients especially if moisture stress sets in before the crop is ready.

4.2. Stem number per hill

In both seasons a stem count was carried out in the ninth week after planting. The mean stem number per hill was highest in Anett followed in order by B53 and Kerr's Pink (Table 5). The number of stems per hill increased with increase in seed size. This finding is in accord with other workers (Birecki and Roztropowicz, 1963; Bremner and Taha, 1966; Mundy and Bowles, 1973; Wurr and Allen, 1974; and Wurr and Morris, 1979). In season II however, the stem number was lower than in season I. This was a result of poor sprouting of seed tubers. In both seasons, stem number per hill was affected significantly (P = 0.05) by the treatments. The interactions however were not significant.

Table 5. Mean Effect of Seed Size and Variety on Number of Stems per Hill (Season I & II)

Season I					Season II				
Seed size	Variety			Mean	Seed size	Variety			Mean
	B53	Annet	K. Pink			B53	Annet	K. Pink	
S_1	4.4	5.3	3.3	4.3	S_1	4.8	4.5	3.0	4.1
S_2	4.6	6.9	4.0	5.2	S_2	4.6	4.8	2.3	3.9
S_3	7.0	10.4	6.2	7.9	S_3	5.4	6.8	4.3	5.5
Mean	5.3	7.5	4.5		Mean	4.9	5.4	3.2	
L.S.D. (P = 0.05) = 0.84					L.S.D. (P = 0.05) = 0.63				
C.V. % = 17.1					C.V. % = 16.7				

Since small seed tubers give rise to fewer stems per hill compared with large seed tubers, it means that the plants from small seed tubers are subject to less inter and intra-plant competition. The higher the number of stems per hill, the greater the photosynthetic apparatus; however overcrowding of leaves leads to mutual shading resulting in reduced net assimilation rate and early senescence of lower leaves. The extent to which this postulate works also depends on spacing used and other environmental factors e.g. moisture, nutrient availability and temperature.

In the present work, this was not so much of a problem especially in the plants derived from small and medium seed tubers. Plants from large seed tubers produced most stems and foliage and these could have subjected the plants to more severe competitions for water and nutrients.

4.3. Effect of Seed Size and Variety on the Fresh and Dry Weight of Leaves and Stems At Sampling

In season I, leaf and stem fresh weight increased with increase in seed tuber size (Table 6a and 6b). B53 had the highest mean leaf and stem fresh weight per plant. Anett had the lowest leaf fresh weight and ranked second in stem fresh weight. Kerr's Pink ranked second in leaf fresh weight but had lowest stem fresh weight.

Table 6a. Mean Effect of Seed Size and Variety on Leaf Fresh Weight (g/plant) 9 weeks after planting - Season I

Seed size	Variety			Total	Mean
	B53	Annet	Kerr's Pink		
S_1	304.4	252.4	290.1	846.9	282.3
S_2	423.8	318.1	377.1	1119.0	373.0
S_3	452.1	384.6	349.5	1186.2	395.4
Total	1180.5	955.1	1016.7		
Mean	393.4	318.4	338.9		

Table 6b. Mean Effect of Seed Size and Variety on Stem Fresh Weight (g/plant) 9 weeks after planting - Season I.

Seed size	Variety			Total	Mean
	B53	Annet	Kerr's Pink		
S_1	244.0	112.7	112.4	469.1	156.4
S_2	380.9	159.4	143.1	683.4	227.8
S_3	421.5	233.7	225.5	880.7	293.6
Total	1046.4	505.8	481.0		
Mean	348.8	168.6	160.3		

Leaf and stem dry weight increased with increase in seed size (Table 7a and 7b) and showed a similar trend as the fresh weight. The only exception was that of plants derived from Kerr's Pink large size, however this difference was not significant (P=0.05). This divergence of Kerr's Pink can be attributed to seed quality: non-certified seed was planted and was not well chitted prior to planting and resulted in poorer performance.

Table 7a. Mean Effect of Seed Size and Variety on Leaf Dry Weight (g/plant) 9 weeks after planting - Season I

Seed size	Variety B53	Annet	Kerr's Pink	Total	Mean
S_1	21.8	21.1	22.0	64.9	21.6
S_2	26.9	23.8	26.3	77.0	25.7
S_3	28.9	25.5	21.4	75.8	25.3
Total	77.6	70.4	69.7		
Mean	25.9	23.5	23.2		

Table 7b. Mean Effect of Seed Size and Variety on Stem Dry Weight (g/plant) 9 weeks after planting - Season I

Seed size	Variety B53	Anett	Kerr's Pink	Total	Mean
S_1	9.8	10.1	7.9	27.8	9.3
S_2	15.2	13.8	9.6	38.6	12.9
S_3	24.6	16.7	10.8	52.1	17.4
Total	49.6	40.6	28.3		
Mean	16.5	13.5	9.4		

In season II, sampling started on the seventh week after planting (about the third week after emergence). Both leaf and stem fresh weights increased to a maximum and then declined towards crop maturity. This was so for the three varieties and seed sizes except the plants from large seed size of Anett which had reached maximum leaf growth at first sampling and so showed a decline in fresh weight for all subsequent samplings. Both leaf and stem fresh weight were lowest in the small seed size plants and highest in plants from the large seed size (Tables 8a and 8b). Anett and Kerr's Pink reached maximum growth in the ninth week after

Table 8a. The mean effect of variety and seed size on leaf fresh weight (g/plant) at different sampling dates (Season II)

Variety and seed size	Sampling Dates (weeks after emergence) 3	5	7	9	11
V_1	159.1	274.1	280.3	160.7	104.4
V_2	202.0	271.1	228.1	117.8	56.1
V_3	118.7	115.2	124.5	80.4	59.7
S_1	129.9	218.2	195.1	111.5	73.3
S_2	140.9	260.3	220.1	114.2	74.8
S_3	208.5	224.8	217.6	133.1	68.1

Table 8b. The mean effect of variety and seed size on stem fresh weight (g/plant) at different sampling dates (season II)

Variety and seed size	Sampling Dates (weeks after emergence) 3	5	7	9	11
V_1	70.6	125.3	159.5	110.4	96.6
V_2	92.6	107.8	100.9	88.4	57.1
V_3	46.9	59.1	50.1	35.7	42.6
S_1	51.5	83.1	83.1	70.6	57.1
S_2	58.0	103.1	78.1	70.4	65.7
S_3	69.9	72.5	129.3	93.5	74.4

planting (about the fifth week after emergence) while B53 reached maximum growth two weeks later. B53 produced more haulm than either Anett or Kerr's pink (see also Figs. 3 and 4).

As for the dry weight for both leaves and stems, it followed the same trend as the fresh weight, that is, increasing to maximum and declining towares crop maturity (Tables 9a and 9b). (also Figs. 5 and 6)

Table 9a. The mean effect of variety and seed size on leaf dry weight (g/plant) at different sampling dates (season II)

Variety and seed size	Sampling dates (weeks after emergence) 3	5	7	9	11
V_1	16.1	28.0	37.7	26.9	18.5
V_2	23.3	30.3	30.6	21.2	9.9
V_3	13.5	18.7	15.8	14.3	10.3
S_1	14.2	24.5	25.7	18.7	13.4
S_2	15.4	27.5	27.7	18.9	13.7
S_3	23.2	25.0	30.3	24.8	11.8

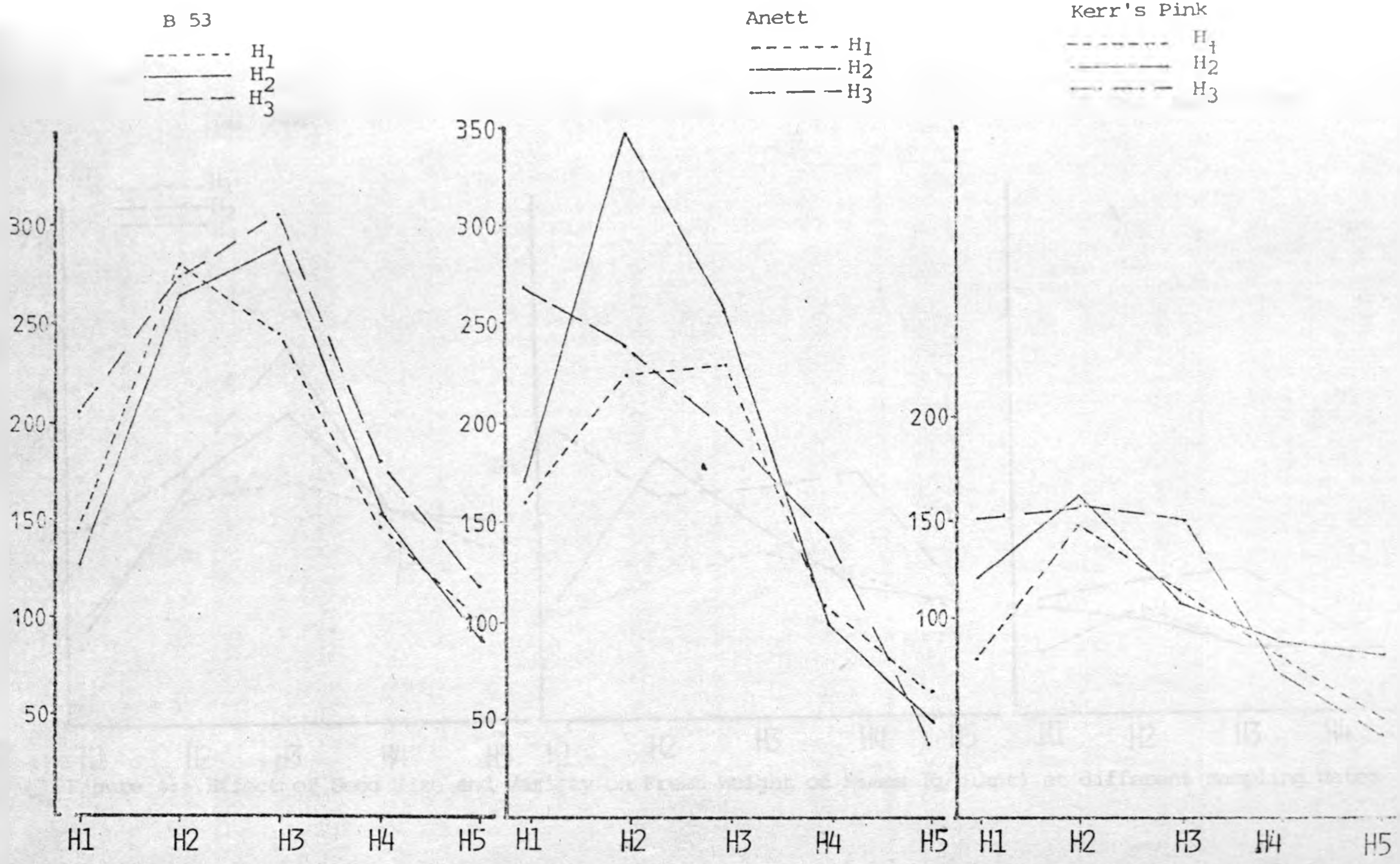


Figure 3. Effect of Seed Size and Variety on Fresh Weight of Leaves (g/plant) at different sampling dates

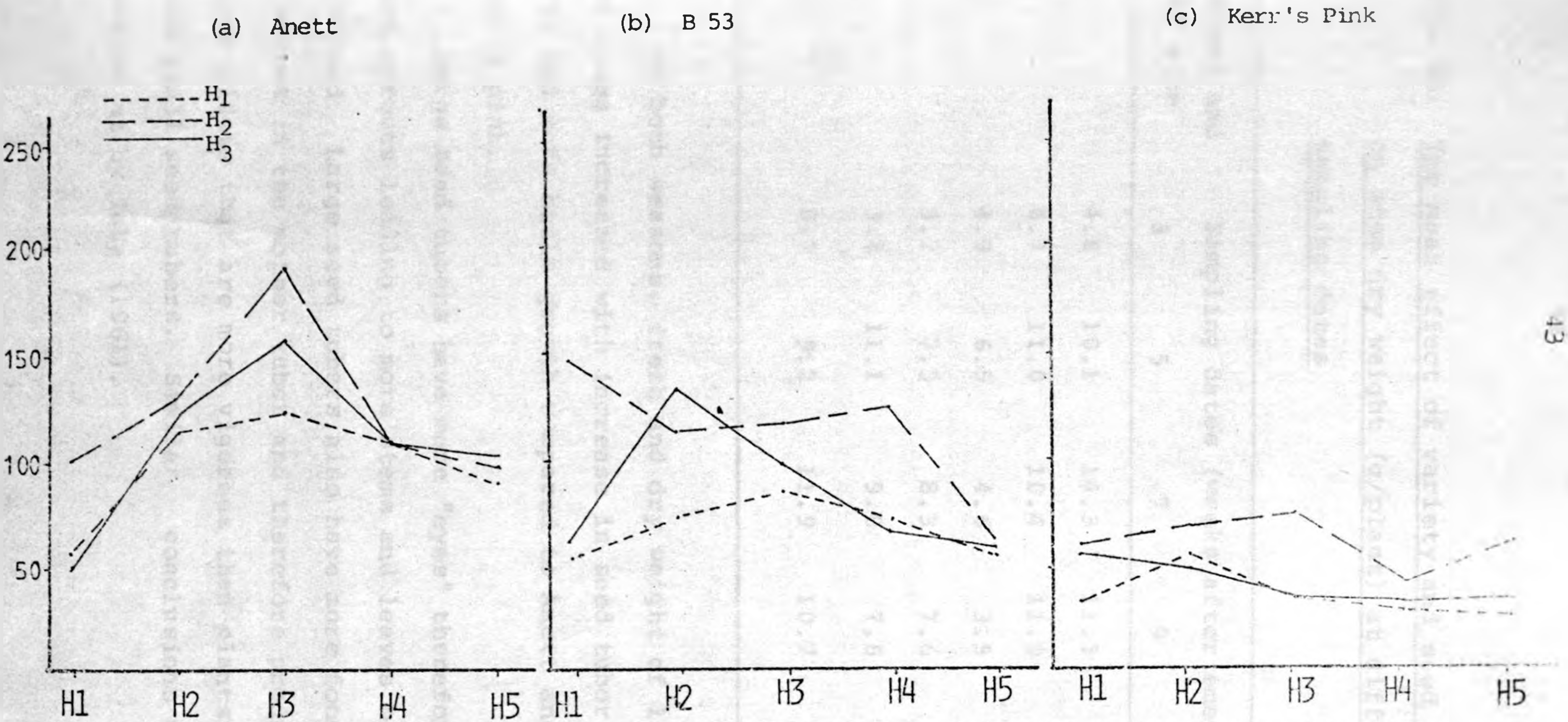


Figure 4: Effect of Seed Size and Variety on Fresh Weight of Stems (g/plant) at different sampling dates

Table 9b. The mean effect of variety and seed size on stem dry weight (g/plant) at different sampling dates

Variety and seed size	Sampling dates (weeks after emergence)				
	3	5	7	9	11
V_1	4.6	10.1	14.3	11.3	8.9
V_2	6.7	11.0	10.4	11.0	6.5
V_3	4.9	6.5	4.6	3.5	4.6
S_1	3.7	7.3	8.3	7.6	5.9
S_2	3.8	11.1	9.0	7.6	6.7
S_3	8.7	9.2	11.9	10.7	7.4

In both seasons, fresh and dry weight of leaves and stems increased with increase in seed tuber size. B 53 had more haulm growth compared to Anett and Kerr's pink.

Large seed tubers have more "eyes" therefore more sprouts leading to more stems and leaves being produced. Large seed tubers also have more food reserves in the mother tuber and therefore produce large plants that are more vigorous than plants from small seed tubers. Similar conclusions were arrived at by Taha (1961).

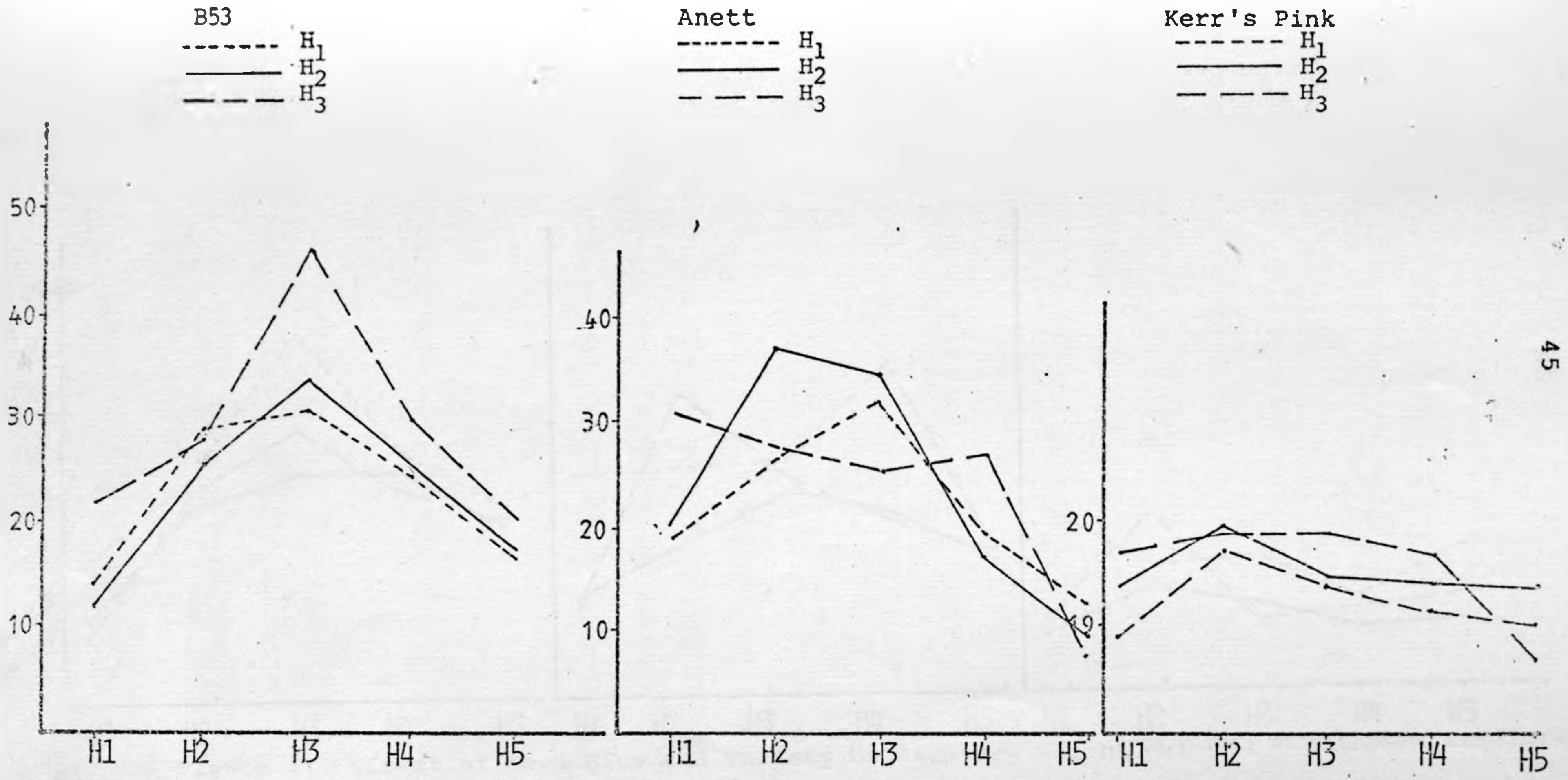


Figure 5: Effect of Seed Size and Variety on Dry Weight of Leaves (g/plant) at different sampling dates

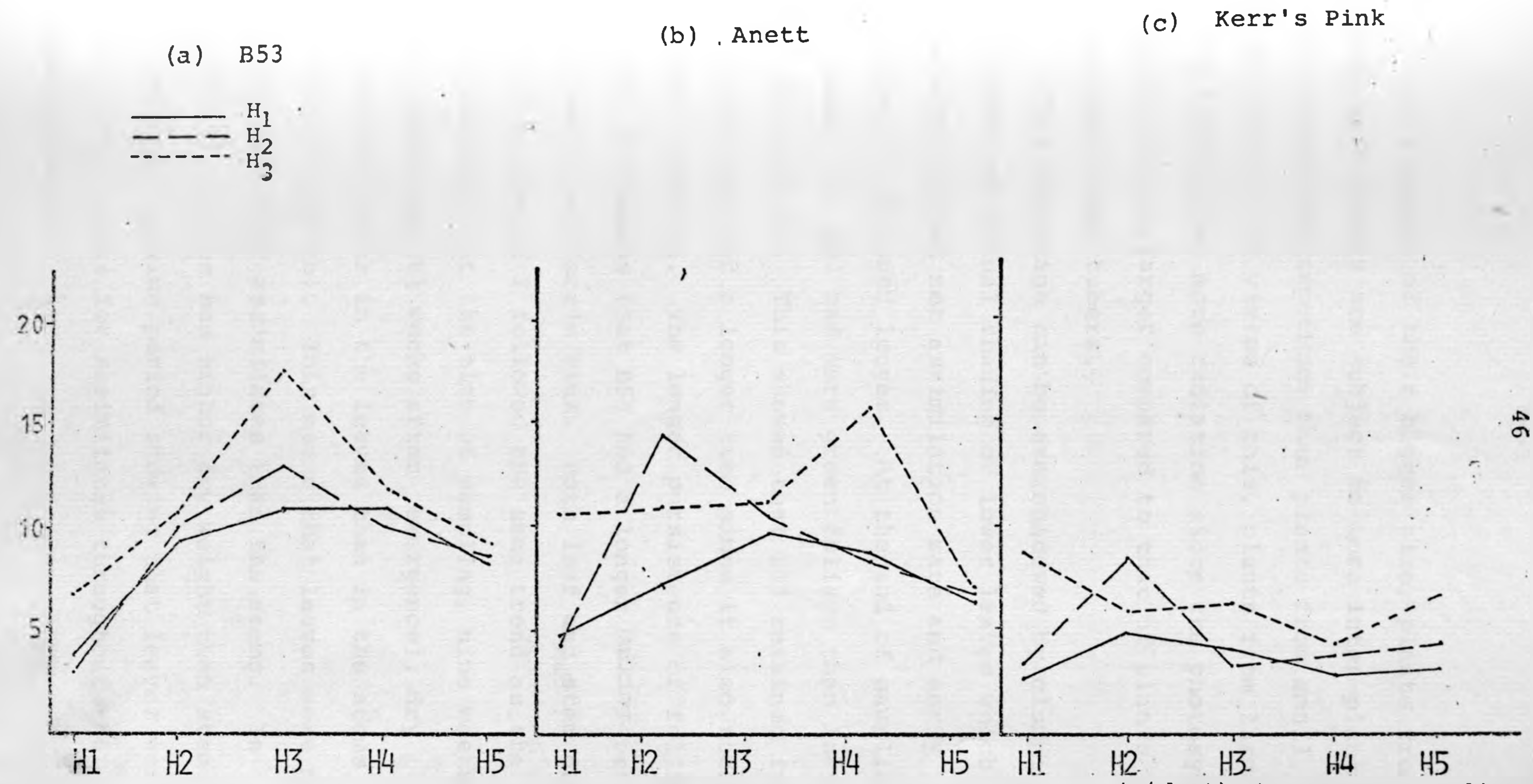


Figure 6: Effect of Seed Size and Variety on Stem Dry Weight (g/plant) at different sampling dates

As a result of their bigger size, plants from large seed tubers are subject to more inter-plant and intra-plant competition than plants from small seed tubers. By virtue of this, plants from large seed tubers trap more radiation since the photosynthetic area is larger compared to that of plants from small seed tubers.

This advantage can be overshadowed by clumping of stems and mutual shading of lower leaves which leads to reduced net assimilation rate and early senescence of lower leaves. At the end of sampling in season II, B53 had more green foliage than Anett and Kerr's Pink. This showed that B53 retained its green foliage for a longer time since it also took longer to mature. The longer persistence of foliage in B53 also means that B53 had a longer bulking period than Anett and Kerr's Pink. Both leaf and stem dry weight in season I followed the same trend as the fresh weight. At the time of sampling, nine weeks after planting (6½ weeks after emergence), dry matter was higher in the leaves than in the stems (Tables 7a and 7b). This means that leaves were more active sinks for assimilates than the stems. In season II, leaves had higher dry weight than stems throughout growing period showing that leaves were more active sinks for assimilates throughout the growing period.

In the present work, it was observed that plants from small seed tubers were small and took longer to cover the ground when compared to plants from large seed tubers. Under Kenyan conditions where weather conditions vary most times, the early take off by plants from large seed tubers would be advantageous by enabling the crop to make better use of favourable growing conditions particularly soil moisture. On the other hand, too large seeds may give rise to stem clumping thus intensifying intra-plant competition which may lead to poor yields in poor seasons. Most Kenyan farmers tend to use medium sized tubers which have obvious advantages over using the small seed tubers.

4.4. Leaf Area Index (L)

In season I, L was determined nine weeks after planting. It was found that the bigger the seed tuber size, the higher the L value. B53 had the highest L indices followed by Anett and then Kerr's Pink (Table 10a). At the time of sampling all the treatments had reached an L value of 3. Analysis of variance showed that the interaction and variety effects were not significant but the seed size effect was significant (P = 0.05).

Table 10a. Mean Effect of Seed Size and Variety on L (Season I)

Seed size	Variety B53	Anett	Kerr's Pink	Total	Mean
S_1	5.2	4.8	5.4	15.4	5.1
S_2	8.2	6.9	6.8	21.9	7.3
S_3	9.4	7.9	6.5	23.8	7.9
Total	22.8	19.4	18.7		
Mean	7.6	6.5	6.2		

In season II, L was determined at each sampling except for the last sampling when most foliage was dry. L increased to a maximum and then started declining towards crop maturity. L was highest in Anett at the initial stages of sampling (Table 10b and 10c). This was due to its earlier emergence compared to the other varieties. Being early maturing varieties, the foliage of Anett and Kerr's Pink senesced earlier than that of B53. B53 had higher L indices in the later stages of the growing period due to its later emergence and by virtue of its late maturity. Kerr's Pink on the other had registered the lowest L values and at no time did the variety attain a mean L value of 3. This was due to its late emergence.

Values of L in season II were lower than in season I. This can be attributed to poor emergence and development of fewer stems in season II which were a result of the low quality of seed used. Though the season was wet, the late take off by plants meant that the moisture conditions were not very favourable for vigorous haulm growth hence the low L values.

Table 10b. The Mean Effect of Variety on L at Different Sampling Dates (Season II)

Variety	Sampling dates (weeks after emergence)			
	3	5	7	9
V_1	1.8	2.7	4.1	2.5
V_2	3.1	3.5	4.2	2.4
V_3	1.6	2.1	2.0	1.2

Table 10c. Mean Effect of Seed Size on L at Different Sampling Dates (Season II)

Seed size	Sampling dates (weeks after emergence)			
	3	5	7	9
S_1	1.7	2.6	3.0	1.8
S_2	1.8	2.8	3.6	1.8
S_3	3.0	2.9	3.8	2.5

Leaf area is important in that it affects the amount of radiation intercepted for photosynthesis thus providing assimilates for tuber growth. Watson (1952) noted that when L was less than one, crops evince low efficiency in light utilisation. Low light utilisation would result in low rates of photosynthesis hence less assimilation and so little tuber growth can take place. The period when plants cover the ground completely and hence utilise more light can be shortened by growing well sprouted large seed tubers whose plants emerge faster and take less time to cover the ground. When water and nutrients are not limiting, yield is determined by competition for light and the efficiency with which the crop utilises the light. Donald and Black (1958) showed that competition for light is not operative early in the season when crop has not developed full ground cover and later in the growing period when most foliage has senesced.

This then means that the crop can intercept all the light falling on it and can utilise it maximally if other conditions like water and nutrients are not limiting. In dense stands where L values are high, the self-shading of leaves may lead to light becoming an important limiting factor hence less assimilation and so less tuber growth. Due to self-shading of leaves, the shaded leaves become sink rather than source, thus providing competition for assimilates with tuber growth. Development of a leaf system capable of intercepting a high proportion of incoming light energy is therefore of great importance in the growth of field crops.

In the present work, Anett and Kerr's Pink quickly developed high leaf area compared to B53. However the latter maintained high L even by the end of sampling unlike Anett and Kerr's Pink whose foliage senesced earlier. It is important to point out that high L could also make a plant more susceptible to drought. Under such a situation, there would not be the advantage of higher yield.

Watson (1952) postulated that the greatest dry matter production would occur when maximum L coincided with seasonal conditions most favourable for photosynthesis. The importance of L in determining yield of the crop and tuber dry matter is affected by leaf persistence since the latter means that the crop can continue to assimilate for a longer period, hence more dry matter accumulation in late maturing varieties.

4.5. Effect of Seed Size and Variety on the Fresh and Dry Weight of Tubers.

In season one, both fresh and dry weight of tubers increased with increase in seed tuber size. The mean variety effect on tuber fresh weight shows that Anett produced the highest fresh weight followed by Kerr's Pink and then B53 (Table 11a). These variety differences were significant (P = 0.05) but the seed size and interaction effects were not significant. Tuber dry weight followed the same trend as the fresh weight (Table 11b). Similarly, the variety effect on tuber dry weight was significant (P = 0.05) but the seed size effect and the interaction were not significant.

Table 11a. Mean effect of Seed Size and Variety on Tuber Fresh Weight (g/plant) 9 weeks after planting (Season I)

Seed size	Variety B53	Annet	Kerr's Pink	Total	Mean
S_1	122.5	246.1	259.0	627.6	209.2
S_2	152.2	307.1	334.1	793.4	264.5
S_3	207.5	387.7	215.6	810.8	270.3
Total	482.2	940.9	808.7		
Mean	160.7	313.6	269.6		

Table 11 b. Mean Effect of Seed Size and Variety on Tuber Dry Weight (g/plant) 9 weeks after planting.

Seed size	Variety B53	Annet	Kerr's Pink	Total	Mean
S_1	16.3	32.5	34.9	83.7	27.9
S_2	22.1	45.6	48.7	116.4	38.8
S_3	28.8	52.5	30.1	111.4	37.1
Total	67.2	130.6	113.7		
Mean	22.4	43.5	37.9		

In season two, the mean effect of seed size on tuber fresh weight showed that the weight increased throughout the growing period. It was lowest in the plants from small seed tubers and highest in the plants from large seed tubers (Table 12a). The analysis of variance showed that both the interaction and seed size effects were not significant but the variety effect was significant (P = 0.05) throughout the growing period. Anett outyielded both Kerr's Pink and B53 (Table 12b). The dry weight of the tubers followed the same trend as the fresh weight.

Table 12a. Mean Effect of Seed Size on Tuber Fresh Weight (g/plant) at Different Sampling Dates (Season II)

Seed size	Sampling dates (weeks after emergence) 3	5	7	9	11
S_1	76.3	182.6	295.7	377.5	397.1
S_2	55.6	189,9	331.9	340.1	416.7
S_3	121.5	244.9	414.8	429.1	464.9

Table 12b. Mean Effect of Variety on Tuber Fresh Weight (g/plant) at Different Sampling Dates (Season II)

Variety	Sampling dates (weeks after emergence) 3	5	7	9	11
V_1	29.4	186.7	286.1	340.5	398.9
V_2	110.9	275.6	437.3	581.2	543.2
V_3	100.3	188.4	257.1	224.9	336.5

In season one when sampling was done at nine weeks after planting, the tubers had the highest dry weight when compared to the leaves and stems.

This shows that at this time, the tubers were the most active sinks for photosynthetic assimilates.

Results of Season II were similar to those of Season I with Anett yielding more both in terms of fresh and dry weight followed by B53 and Kerr's Pink with the lowest. Initially, B53 had the lowest tuber fresh weight but later this increased more than that of Kerr's Pink but not more than Anett. The variety effect was significant (P = 0.05) throughout the sampling period. From the results it can be conluded that Anett has a higher bulking rate than both B53 and Kerr's Pink.

Once the tubers are initiated, growth of all other organs slows down and tubers become the dominant sinks for organic and inorganic nutrients. In the present work, both fresh and dry weight of the the haulm reached a maximum at about 7 weeks after emergence for B53 and at about five weeks for Anett and Kerr's Pink after which the weight of the haulm declined. On the other hand, both fresh and dry weight of tubers continued to increase up to maturity. This clearly shows that assimilates were diverted from the haulm into the tubers after maximum haulm growth. It is important for the potato plant to maintain tuber growth after initiation. This is dependent on the presence of enough foliage to produce the necessary assimilates and on the adequate supplies of water and mineral nutrients from the soil. At the beginning of sampling B53 had the lowest L values and also lowest tuber dry weight compared to Anett and Kerr's Pink. However, by the end of the sampling period, eleven weeks after emergence, B53 had more green foliage and more dry weight in tubers than either Anett or Kerr's Pink (Table 13a). This then shows that the longer persistence of green foliage in B53 continues assimilation and so leads to accumulation of more dry matter in the tubers. The seed size effect on dry matter percentage in the tubers was not significant. There was no trend shown by the different seed sizes (Table 13b), however dry weight increased throughout sampling for all sizes.

Table 13a. Mean Variety Effect on Percentage Tuber Dry Weight at Different Sampling Dates (Season II)

Variety	Sampling dates (weeks after emergence)				
	3	5	7	9	11
V_1	14.4	15.5	18.9	24.7	26.2
V_2	16.4	16.0	18.3	21.7	21.8
V_3	16.2	13.9	18.4	24.9	22.7

Table 13b. Mean Seed Size Effect on Percentage Tuber Dry Weight at Different Sampling Dates (Season II)

Seed Size	Samping dates (weeks after emergence) 3	5	7	9	11
S_1	16.8	15.6	18.6	23.9	23.3
S_2	16.1	14.0	18.9	22.8	22.6
S_3	14.1	15.9	18.2	24.7	24.8

Ivins and Bremner (1965) working under British conditions state that early varieties initiate tubers at low leaf area index and that the duration of foliage is restricted and senescence occurs early. This is also true in Kenya and early varieties such as Anett and Kerr's Pink initiate tubers earlier and their foliage senesces earlier when compared to late varieties such as B53. In the present work sampling started when tuber initiation had occurred and so it is not possible to tell the exact L values for the different varieties at tuber initiation.

4.6. Effect of treatments on total dry weight

In season I, total dry weight determined at nine weeks after planting increased with increase in seed tuber size. Plants from the large seed tubers had the highest total dry weight while plants from the small seed tubers had the lowest total dry weight (Table 14a).

Table 14a. Mean Effect of Variety and Seed Size on Total Dry Weight (g/plant) 9 weeks after planting (Season I)

Seed size	Variety			Total	Mean
	B53	Annet	Kerr's Pink		
S_1	47.9	63.7	64.7	176.3	58.7
S_2	64.2	83.1	81.9	229.2	76.4
S_3	82.3	94.7	62.9	239.9	79.9
Total	184.4	241.5	209.5		
Mean	61.5	80.5	69.8		

In season II, total dry weight continued to increase throughout the growing period. However at the last sampling some seed sizes showed a decline in total dry weight since most foliage had senesced (Table 14b). The increase in total dry weight was true for the three varieties (Table 14c).

Table 14b. Mean Effect of Seed Size on Total Dry Weight at Different Sampling Dates (Season II)

Seed size	Sampling dates (weeks after emergence) 3	5	7	9	11
S_1	94.9	181.1	262.2	324.6	335.6
S_2	84.7	204.2	299.0	306.7	338.8
S_3	141.6	228.0	330.0	418.6	398.7

A comparison for the total dry weight accumulated by the three varieties in season I and II was done for the period when the plants had reached peak vegetative growth.

Table 14c. Mean Variety Effect on Total Dry Weight (g/plant) at Different Sampling Dates (Season II)

Variety	Sampling dates (weeks after emergence) 3	5	7	9	11
V_1	74.4	196.1	317.6	348.5	394.9
V_2	138.6	256.5	384.5	477.4	404.3
V_3	108.2	160.7	199.1	222.0	273.9

The same comparison for the total dry weight accumulated by the three seed sizes was also done for the same period for both seasons. This comparison of varieties (Season I versus Season II) and seed sizes (Season I versus Season II) showed little differences at peak vegetative growth which was the ninth week after planting in both seasons. In season I, B53, Anett and Kerr's Pink respectively accumulated 184.4g, 241.5g and 209.5g, while in Season II the dry weights were 196.1g, 256.5g and 160.7g respectively. Similarly, the seed sizes in Season I had 176.3g, 229.2g and 239.9g for S_1, S_2 and S_3 respectively, while Season II it was 181.1g, 204.2g and 228.0g for S_1, S_2 and S_3 respectively. Before tuber initiation most assimilates are used for haulm growth. Once tubers are initiated, some of the assimilates are diverted for tuber growth and this continues throughout the tuber growing period. When peak vegetative growth is reached, and haulm growth stops then most of the assimilates are diverted to the tubers and these become the dominant sinks for photosynthetic assimilates. This accumulation of dry matter in the tubers is determined by the amount of photosynthetic assimilates available for tuber growth and the capacity of the growing tubers to absorb these assimilates (Bremner and Taha, 1966).

4.7. Effect of Seed Size and Variety on Total Tuber and Ware Grade Yield

In season I, Anett had highest final tuber and ware grade yield than B53 and Kerr's Pink at the final harvest (Tables 15a and 15b). Total tuber yield was not significantly affected by the size of seed planted. Ware grade yield decreased when seed tuber size was increased. The plants from small seed tubers had more ware grade yield than plants from the large seed tubers. Seed size did not significantly affect ware grade yield. The variety effect was however significant (P = 0.05) with Anett yielding most ware grade followed by Kerr's Pink and finally B53.

Table 15a. Effect of Seed Size and Variety on Final Total Tuber Yield (Tonnes/ha) (Season I)

Seed size	Variety			Total	Mean
	B53	Annet	Kerr's Pink		
S_1	22.6	24.6	18.9	66.1	22.0
S_2	18.8	25.4	22.7	66.9	22.3
S_3	18.7	24.8	21.3	64.8	21.6
Total	60.1	74.8	62.9		
Mean	20.0	24.9	20.9		
L.S.D.	(P = 0.05) = 4.7		C.V.% = 25.4		

Table 15b. <u>Mean Effect of Seed Size and Variety on Ware Grade Yield (Tonnes/ha) Season I</u>

Seed size	Variety			Total	Mean
	B53	Annet	Kerr's Pink		
S_1	1.5	8.3	4.1	13.9	4.6
S_2	0.6	6.4	6.7	13.7	4.6
S_3	0.02	2.3	4.1	6.4	2.1
Total	2.12	17.0	14.9		
Mean	0.7	5.7	4.9		

L.S.D. (P = 0.05) = 2.8

In season II, final total tuber yield increased with increase in seed tuber size (Table 16a). As in season I, Anett had the highest final tuber yield followed by B53 and then Kerr's Pink. Ware grade yield in this season was highest in Annet and lowest in B53. These variety differences were significant (P = 0.05) (Table 16b). Unlike season I where ware grade decreased with increase in seed tuber size, season II showed no such a trend however, there was no interaction.

Table 16a. Mean Effect of Seed Size and Variety on Total Final Tuber Yield (tonnes/ha) Season II

Seed size	Variety B53	Anett	Kerr's Pink	Total	Mean
S_1	17.0	20.3	11.3	48.6	16.2
S_2	19.3	21.6	14.7	55.6	18.5
S_3	13.6	27.1	16.9	57.6	19.2
Total	49.9	69.0	42.9		
Mean	16.3	23.0	14.3		

L.S.D. (P = 0.05) = 4.2

C.V. % = 27.9

Table 16b. Mean Effect of Seed Size and Variety on Ware Grade Yield (tonnes/ha) Season II

Seed size	Variety B53	Anett	Kerr's Pink	Total	Mean
S_1	3.6	11.1	5.3	20.0	6.7
S_2	3.2	9.5	5.9	18.6	6.2
S_3	2.7	11.6	4.5	18.8	6.3
Total	9.5	32.2	15.7		
Mean	3.2	10.7	5.2		

L.S.D. (P = 0.05) = 2.0

CV % = 37.6

Yield in the potato crop is the resultant of the rate and duration of tuber bulking; the latter being a function of the time of tuber initiation and foliage persistence (Radley, Taha and Bremner, 1961). The fact that Anett outyielded both B53 and Kerr's Pink in both seasons shows that Anett had the highest bulking rate. Despite longer foliage persistence in B53, the prolonged bulking period did not result in higher yields. B53 could have maintained its foliage at the expense of tuber growth. Also poorer environmental conditions especially later in the season may have removed any advantages of longer period for bulking and most likely bulking was not taking place. The bulking rate for B53, Anett and Kerr's Pink in season II was 1.75 tonnes/ha/week, 2.38 tonnes/ha/week and 1.33 tonnes/ha/week respectively.

The increase in total final tuber yield with an increase in seed tuber size as was observed in season II was similar to the findings of Bates (1935) Roer (1955), Wakankar (1944), McCubbin (1957) and Morar (1981). In the present study, plants from the large seed tubers had more foliage and higher leaf area index than plants from the small seed tubers at the end of the sampling period. This shows that these plants from large seed tubers still had higher photosynthetic areas hence higher bulking rates than plants from small seed tubers. Yield differences in this study can therefore be attributed to differences in bulking rate rather than bulking duration.

Size of seed tubers affects both the final total tuber yield and also the final size of the potato tubers at harvest. This is true because seed tuber size determines the number of stems per hill thereby controlling the intensity of competition within the hill. Bates (1935) in his study with different seed tuber sizes, found that large seed tubers gave higher total final yields than small seed tubers but the average tuber size was smaller. Conversely, small seed tubers gave lower final total yield but with larger average tuber size. Small seed tubers therefore give a greater percentage of tuber yield in the ware grade than large seed tubers.

In both seasons, Anett produced more ware grade potatoes (diameter > 55mm) and less seed potatoes (diameter 25 - 55mm) and chats (diameter < 25mm) when compared to B53 and Kerr's Pink. The variety effect was significant while seed size and interaction effects were not significant.

4.8. Effect of Seed Size and Variety on Tuber Dry Matter at Final Harvest

Tuber dry matter percentage determined at the final harvest in both seasons showed that B53 had the highest percentage dry matter content while Anett and Kerr's Pink were about equal. Dry matter content was slightly higher in season II compared to season I. Mean percentage tuber dry matter in season I for B53, Anett and Kerr's Pink was 20.7%, 17.5% and 19.3% respectively, while in season II it was 25.4%, 21.9% and 21.8% respectively. (Table 17a and 17b)

Table 17a. Mean Effect of Seed Size and Variety on Tuber Dry Matter Percentage at Final Harvest (Season I)

Seed size	Variety B53	Anett	Kerr's Pink	Total	Mean
S_1	21.3	17.9	19.3	58.5	19.5
S_2	20.7	17.2	19.4	57.3	19.1
S_3	20.1	17.4	19.1	56.6	18.9
Total	62.1	52.5	57.8		
Mean	20.7	17.5	19.3		

L.S.D. (0.05) = 1.1 CV% = 7.1

Table 17b. Mean Effect of Seed Size and Variety on Tuber Dry Matter Percentage at Final Harvest (Season II)

Seed size	Variety B53	Anett	Kerr's Pink	Total	Mean
S_1	25.8	22.4	22.3	70.5	23.5
S_2	25.4	22.1	21.6	69.1	23.0
S_3	25.0	21.1	21.4	67.5	22.5
Total	76.2	65.6	65.3		
Mean	25.4	21.9	21.8		

L.S.D. (P = 0.05) = 1.0

C.V.% = 5.3

High dry matter accumulation in tubers is associated with late maturity. Late maturing varieties such as B53 maintain green foliage for a longer period than early maturing. B53 has a longer period in which to accumulate more dry matter in their tubers.

The fact that dry matter percentages in season I were lower than in season II could be attributed to the moisture supply during growth. In season I, the total rainfall received during the growth period was 98mm while in season II was 524.2mm. This then shows that the maturing tubers in season I had little moisture supply than in season II (Appendix Table 7). Low moisture supply also leads to low dry matter since this lowers assimilation in the leaves hence low accumulation of dry matter in the tubers.

There was a slight decrease in percentage tuber dry matter content in both seasons as seed size was increased. The effect however was not significant (P = 0.05). This variety effect was however significant.

4.9. Summary of Results

4.9.1. - Plants from the large seed tubers emerged earlier. They were more vigorous and took shorter time to cover the ground when compared to plants from medium and small seed tubers. Plants from the large seed tubers therefore utilize available moisture and nutrients in the early part of the growing season. Should conditions become unfavourable later in the growing season, these plants can still give some yield compared to the plants from small and medium seed tubers. In the present work seed size did not significantly affect total tuber yield.

4.9.2. - Seed size significantly affected the number of stems per hill in the three varieties. More stems per hill were produced by the large seed tubers hence higher L values. B53 had most haulm growth but lowest tuber yield. This can be attributed to competition for assimilates between the haulm and the growing tubers. More assimilates could have been used to maintain the haulm at the expense of tuber growth. Vigorous haulm growth could also have subjected the crop to moisture stress later in the season thus leading to less availability of assimilates and nutrients for tuber growth.

4.9.3. - Anett and Kerr's Pink developed high leaf area more quickly than B53 but the latter maintained its foliage for a longer period. B53 is a late maturing variety and therefore maintains its foliage for a longer period. Consequently, B53 has a longer bulking period than Anett and Kerr's Pink, however, this can only be so if the growing conditions during the season are favourable. The fact that B53 had higher dry matter content at harvest could be the result of its late maturity. Seed sizes used in this study did not significantly affect tuber dry matter content.

4.9.4. - In both seasons, both total final tuber yield and ware grade yield were highest in Anett followed by Kerr's Pink and finally B53. B53 had most of its yield as seed grade (25-55 mm). The find out the effects of seed size more closely than was done in the present study. This would be justified on the basis that many farmers use a very wide range of seed sizes.

4.10.2. - Work combining seed size and spacing should be carried out so as to find the optimum spacing and seed size that would give maximum yields. Interaction effects of seed size and variety and spacing can also be studied.

4.10.3. - More work with locally adapted varieties should be carried out to identify the varieties that respond to changes in seed tuber size. This can help farmers to plant varieties of their own choice depending on their production objectives.

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A P P E N D I X

Table 1. A. Variety Effect On Leaves' Fresh Weight At Different Sampling Dates (Weeks After Planting) Season II

Sampling Date	Variety	Replicates I	II	III	IV	Total	Mean g/plant
7 weeks	V_1	640.3	532.1	453.9	282.9	1909.2	159.1
	V_2	728.8	833.0	385.1	477.4	2424.2	202.0
	V_3	359.6	469.1	430.0	161.9	1420.6	118.4
9 weeks	V_1	895.7	913.0	676.6	803.3	3288.6	274.0
	V_2	1124.5	848.7	780.7	499.4	3253.3	271.0
	V_3	428.7	705.6	428.1	335.7	1898.1	158.2
11 weeks	V_1	1006.7	1137.9	647.0	811.5	3603.1	300.2
	V_2	907.3	649.1	626.6	554.1	2737.1	228.1
	V_3	374.0	476.4	445.5	197.9	1493.8	124.5
13 weeks	V_1	551.7	512.0	295.9	569.4	1929.0	160.7
	V_2	503.0	442.3	254.1	214.1	1413.5	117.8
	V_3	229.0	264.3	212.6	259.3	965.2	80.4
15 weeks	V_1	252.0	364.1	280.1	357.4	1253.6	104.5
	V_2	176.0	173.5	99.8	175.2	624.5	52.0
	V_3	115.2	215.6	169.6	127.3	627.7	52.3

Table 2.A. Variety Effect on Stem Fresh Weight at Different Sampling Dates (Weeks After Planting) Season II

Sampling Date	Variety	Replicates I	II	III	IV	Total	Mean g/plant
7 weeks	V_1	290.6	198.5	227.4	131.3	847.8	70.6
	V_2	338.9	381.8	147.6	199.3	1067.6	88.9
	V_3	111.8	300.0	107.6	83.5	602.9	50.2
9 weeks	V_1	332.6	486.0	325.5	359.0	1503.1	125.3
	V_2	419.3	366.0	280.6	228.1	1294.0	107.8
	V_3	175.3	285.3	151.5	97.8	709.9	59.1
11 weeks	V_1	598.5	610.1	284.3	421.2	1914.1	159.5
	V_2	372.9	294.7	269.9	274.1	1211.6	100.9
	V_3	160.6	202.9	164.1	73.5	601.1	50.1
13 weeks	V_1	325.0	351.6	236.1	412.3	1325.0	110.4
	V_2	357.5	290.0	226.5	186.9	1060.0	88.4
	V_3	82.6	126.6	94.4	91.8	395.4	32.9
15 weeks	V_1	256.1	381.1	223.9	298.5	1159.6	96.6
	V_2	236.8	159.4	123.3	166.4	685.9	57.1
	V_3	70.7	105.1	146.6	65.5	387.9	38.8

Table 3 A. Variety Effect on Tuber Fresh Weight at Different Sampling Dates (Weeks After Planting) Season II

Sampling Date	Variety	Replicates I	II	III	IV	Total	Mean g/plant
7 weeks	V_1	66.1	143.0	18.3	8.1	235.5	19.6
	V_2	327.9	563.2	101.5	227.6	1220.2	110.9
	V_3	333.2	201.0	395.0	73.7	1002.9	100.3
9 weeks	V_1	629.3	533.8	307.9	369.9	1840.9	153.4
	V_2	1226.0	722.9	845.6	512.6	3307.1	275.6
	V_3	430.5	567.4	623.8	439.4	2061.1	171.7
11 weeks	V_1	964.0	1136.8	526.4	805.7	3432.9	286.1
	V_2	1751.2	1366.0	997.2	1132.7	5247.1	437.3
	V_3	724.3	935.9	972.8	452.5	3085.5	257.1
13 weeks	V_1	1010.3	705.2	648.2	1722.9	4086.6	340.5
	V_2	1809.2	2414.8	1535.9	1214.1	6974.0	581.2
	V_3	452.8	906.8	604.2	735.2	2699.0	224.9
15 weeks	V_1	1049.4	1375.7	1067.9	1294.6	4787.6	398.9
	V_2	2097.7	1468.2	1472.0	1480.9	6518.8	543.2
	V_3	790.3	685.9	1522.8	1039.6	4038.6	336.6

Table 4 A. Effect of Seed Size on Leaves Fresh Weight at Different Sampling Dates (Weeks After Planting) Season II

Sampling Date	Seed size	Replicates I	II	III	IV	Total	Mean g/plant
7 weeks	S_1	460.3	529.3	282.6	287.3	1559.5	129.9
	S_2	295.5	171.1	423.3	255.5	1691.4	140.9
	S_3	972.9	587.8	563.2	379.3	2503.2	250.3
9 weeks	S_1	608.5	891.0	586.3	532.2	2618.0	218.2
	S_2	870.7	945.1	666.7	641.9	3124.4	260.4
	S_3	969.8	631.3	632.6	464.4	2698.2	224.8
11 weeks	S_1	743.1	738.7	370.0	489.2	2341.0	195.1
	S_2	816.0	754.4	521.6	549.9	2641.9	220.2
	S_3	728.9	770.3	827.6	524.3	2851.1	237.6
13 weeks	S_1	243.5	518.9	256.3	319.3	1338.0	111.5
	S_2	501.6	333.7	229.5	306.7	1371.5	114.3
	S_3	538.5	366.0	276.8	416.9	1598.2	133.2
15 weeks	S_1	168.7	266.9	162.5	282.6	880.7	73.4
	S_2	184.5	320.6	160.7	349.9	1015.7	84.6
	S_3	190.1	165.6	226.3	145.2	727.2	60.6

Table 5 A. Effect of Seed Size on Stem Fresh Weight at Different Sampling Dates (Weeks After Planting) Season II

Sampling date	Seed size	Replicates I	II	III	IV	Total	Mean g/plant
7 weeks	S_1	157.7	217.9	96.6	110.5	582.7	48.6
	S_2	118.8	372.7	116.5	87.8	695.8	57.9
	S_3	464.8	289.7	269.5	215.9	1239.9	103.3
9 weeks	S_1	229.9	324.3	237.7	206.9	998.8	83.2
	S_2	305.5	419.1	246,5	267.0	1237.6	103.1
	S_3	392.4	393.8	273.4	210.9	1270.5	105.8
11 weeks	S_1	331.2	308.2	135.2	223.1	997.7	83.1
	S_2	408.0	350.5	191.8	226.7	1177.0	98.1
	S_3	392.8	449.0	391.3	319.0	1552.1	129.3
13 weeks	S_1	154.0	330.5	130.8	232.2	847.5	70.6
	S_2	261.4	181.4	206.8	196.1	845.7	70.5
	S_3	349.7	256.3	219.5	262.7	1088.2	90.7
15 weeks	S_1	144.0	248.1	121.4	171.7	685.2	57.1
	S_2	214.6	244.9	160.7	171.2	791.4	65.9
	S_3	205.1	152.5	211.8	187.5	756.9	75.7

Table 6 A. Effect of Seed Size On Tuber Fresh Weight at Different Sampling Dates (Weeks After Planting)

Season II

Sampling date	Seed size	Replicates I	II	III	IV	Total	Mean g/plant
7 weeks	S_1	305.0	214.6	113.7	53.6	686.9	57.2
	S_2	15.5	222.1	234.5	84.1	556.2	46.3
	S_3	406.7	470.5	166.5	171.7	1215.4	101.3
9 weeks	S_1	448.7	695.4	531.6	515.0	2190.7	182.6
	S_2	737.0	698.7	499.7	344.1	2279.5	189.9
	S_3	1099.6	630.0	746.0	462.8	2938.4	244.9
11 weeks	S_1	946.1	1129.1	770.8	702.7	3548.6	295.7
	S_2	1159.2	1322.1	706.6	794.7	3987.6	331.9
	S_3	1627.4	987.5	1469.0	893.6	4977.5	414.8
13 weeks	S_1	961.1	1652.5	853.4	1080.5	4529.5	377.4
	S_2	974.3	1274.7	941.2	890.8	4081.0	340.1
	S_3	1336.7	1099.6	1011.8	1700.9	5149.0	429.1
15 weeks	S_1	1073.0	1265.6	1215.7	1211.4	4765.7	397.1
	S_2	1438.6	1123.5	1236.7	1201.6	5000.4	416.7
	S_3	1425.7	1140.8	1610.4	1402.1	5579.0	464.9

Table 7. A. Rainfall Data for 1981 and 1982

Month	Rainfall 1981	(mm) 1982
January	2.7	0.5
February	6.7	13.4
March	12.3	49.9
April	506.0	241.8
May	213.7	243.2
June	10.5	14.9
July	18.0	29.7
August	20.9	11.0
September	65.2	45.1
October	68.7	140.0
November	26.0	233.6
December	58.1	112.6
Total	1120.3	1135.7

Table 8 A. Analysis of Variance for Stem Number

Season I

Source	df	Sum of squares	MSS	F
Total	36	1389.25		
Level	1	1212.20		
Blocks	3	4.29		
Treatments	8	149.12	18.64	18.92**
Variety	2	60.53	30.26	30.72**
Seed Size	2	80.76	40.38	40.99**
Interaction	4	7.83	1.96	1.99 n.s
Error	24	23.64	0.985	
CV% = 17.1				

Table 9 A. Analysis of Variance For Stem Numbers

Season II

Source	df	Sum of squares	Mean sum of squares	F
Total	36	821.18		
Level	1	732.60		
Blocks	3	22.37	7.45	12.02**
Treatments	8	51.29	6.45	10.34**
Variety	2	31.29	15.64	25.22**
Seed size	2	17.18	8.59	13.85**
Interaction	4	2.82	0.705	1.14n.s
Error	24	14.92	0.62	

CV % = 17.5

Table 10 A. Analysis of Variance for Final Tuber Yield

Season II

Source	df	Sum of squares	MSS	F
Total	36	13000.58		
Level	1	11642.41		
Blocks	3	32.77		
Treatments	8	719.54	89.94	3.56**
Variety	2	487.41	243.70	9.66**
Seed size	2	58.25	29.12	1.15n.s
Interaction	4	173.88	43.47	1.72n.s.
Error	24	605.86	25.24	

CV% = 27.9

Table 11 A. Analysis of Variance for Ware Grade Yield Season II

Source	df	Sum of squares	MSS	F
Total	36	2036.24		
Level	1	1474.56		
Blocks	3	38.74		
Treatments	8	383.6	47.95	8.27**
Variety	2	368.85	184.42	31.79
Seed size	2	1.58	0.79	0.14n.s
Interaction	4	13.17	3.29	0.57n.s
Error	24	139.34	5.80	

CV % = 37.5

Table 12 A. Analysis of Variance for Final Tuber Yield (Season I)

Source	df	SS	MSS	F
Total	36	18464.9		
Level	1	17440.3		
Blocks	3	41.9	13.9	0.44 n.s
Treatments	8	229.4	28.7	
Variety	2	161.9	80.9	2.58 n.s
Seed size	2	3.1	1.6	0.05 n.s
Interaction	4	64.4	31.3	0.52 n.s
Error	24	752.2		

CV % = 25.4

Table 13 A. Analysis of Variance for Tuber Dry Matter Percentage at Harvest (Season I)

Source	df	SS	MSS	F
Total	36	13339.9		
Level	1	13218.9		
Blocks	3	8.7	2.9	1.56 n.s
Treatments	8	77.3	9.7	5.19**
Variety	2	63.3	31.6	16.96 n.s
Seed size	2	2.3	1.1	0.63 n.s
Interaction	4	1.7	0.4	0.22 n.s
Error	24	44.8		

CV % = 7.1

Table 14 A. Analysis of Variance for Tuber Dry Matter Percentage at Harvest Season II

Source	df	SS	MSS	F
Total	36			
Level	1			
Blocks	3	28.7	9.6	6.40**
Treatments	8	107.8	13.5	9.01**
Variety	2	101.3	50.7	33.87**
Seed size	2	5.7	2.8	1.91 n.s
Interaction	4	0.8	0.2	0.14 n.s
Error	24	35.9	1.5	

CV % = 5.3

Table 15 A. Analysis of Variance for Ware Grade Yield Season I

Source	df	SS	MSS	F
Total	36			
Level	1			
Blocks	3	46.8	15.6	1.43ns
Treatments	8	271.6	135.8	12.46**
Variety	2	173.4	86.7	7.94**
Seed size	2	48.3	24.1	2.21ns
Interaction	4	49.9	12.5	1.14ns
Error	24	262.2	10.9	

Table 16 A. Effect of Seed Size and Variety on Final Total Tuber Yield (tonnes/ha)

Season I

Variety	Seed size	Replicates I	II	III	IV	Total	Mean
B 53	S_1	22.8	26.0	25.5	16.3	90.6	22.6
	S_2	17.7	25.0	12.7	19.9	75.3	18.8
	S_3	19.1	21.1	13.0	20.9	75.0	18.7
Anett	S_1	23.5	22.3	25.7	27.1	98.6	24.6
	S_2	27.5	32.3	20.1	21.8	101.7	25.4
	S_3	17.8	24.1	33.5	23.7	99.1	24.8
Kerr's pink	S_1	17.2	15.2	28.1	15.4	75.9	19.0
	S_2	12.3	24.1	23.1	31.2	90.7	22.7
	S_3	22.5	14.5	20.9	27.2	85.1	12.3
Total		181.2	204.7	202.6	203.5	792.0	

Table 17 A. Effect of Seed Size and Variety on Final Total Tuber Yield (Tonnes/ha)

Season II

Variety	Seed size	Replicates I	II	III	IV	Total	Mean
B 53	S_1	17.4	17.0	16.9	16.9	68.2	17.1
	S_2	21.2	15.2	8.9	31.8	77.1	19.3
	S_3	10.9	13.9	16.3	13.3	54.4	13.6
Anett	S_1	22.0	19.1	21.5	18.8	81.4	20.4
	S_2	21.7	26.9	18.7	19.1	86.4	21.6
	S_3	33.9	26.7	22.4	25.3	108.3	27.1
Kerr's pink	S_1	11.9	17.0	10.0	6.2	45.1	11.3
	S_2	19.7	14.5	13.3	11.4	58.9	14.1
	S_3	16.8	12.5	25.8	12.5	67.6	16.9
Total		175.5	162.8	153.8	155.3	647.4	