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FACTORS AFFECTING THE PERFORMANCE OF INDIVIDUAL MAIZE PLANTS (*Zea mays* L.)

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FACTORS AFFECTING THE PERFORMANCE OF INDIVIDUAL MAIZE PLANTS
(Zea mays L.)

by

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by

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DEPARTMENT: **Plant Production and Soil Science**

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ABSTRACT

Observations on a commercial scale farming operation indicated that irregular in row spacing of maize may be an important determinant of grain yield. Farm data collected during 1994 confirmed that irregular spacing, missing plants, and the occurrence of blind or cobless plants can all contribute towards yield losses. This may be the result of poor seed quality, planter malfunctioning, soil conditions, and seedling losses due to diseases, insects or bird damage. Experiments were conducted in an attempt to quantify the effect of different factors affecting the performance of individual maize plants in the field. Although differences in seed size resulted in differences in germination and seedling development, no effect of seed size on final yield could be detected in a field experiment. The effect of plant spacing arrangement in the row (three plants per meter equally spaced; three plants per meter combined in one hill; two in one position and one in a succeeding position), were studied in a field experiment and the results demonstrate that variability in in-row spacing had an effect on grain yield. The effect of seed orientation, planting depth and soil temperature on rate of emergence of maize demonstrated that seed orientation has a negligible effect on the rate of emergence, and both temperature and seeding depth influence time to emergence.

CHAPTER 1

INTRODUCTION

The exponential population growth in the world causes immense problems in practically all branches of society. It is generally accepted that the growth of the world population must be limited, but until this is accomplished, we must strive to provide the necessary food and other requirements for the growing human population. Today cereals are the most important source of food. Maize, wheat and rice are the most important and together with other grains supply over 75% of man's energy and more than 50% of his protein requirements. There is a serious shortage of food in many countries, and many people are exposed to famine. In fact, the world food situation has greatly deteriorated over the past years and fewer countries now export food or are self-sufficient (FAO, 1998).

Southern Africa faces the same problems as many other countries, namely a rapid population growth and limited agricultural production. Maize is a staple food in southern Africa, but serious shortages often occurs. From a recent report (FAO, 1998) it can be concluded that in southern Africa only South Africa provides an exportable surplus of maize, while other countries face substantial cereal deficits that will have to be met by imports.

In countries like Lesotho, Namibia and Zambia cereal production in 1997/98 declined significantly, while in Angola and Zimbabwe war and reform are causing population displacements and disrupting agricultural activities.

To ensure adequate food production in southern Africa, it is essential that modern science and technology must be applied in agricultural production systems. The maize industry, source of the staple food in Southern Africa, is facing the following challenges:

- to produce maize at competitive prices in sufficient quantities, to meet the needs of a population growing at a million people per year in the SADC countries;
- to develop marketing systems which satisfy the needs of producers and consumers ; and

- to become involved in research on all aspects of the maize industry, in order to increase productivity and supply maize and maize products according to the market needs.

In an attempt to contribute towards solutions for the above stated, it was hypothesized that maize farmers, both on commercial and subsistence scale, often lose an unquantified but substantial fraction of their potential yield due to factors negatively affecting the performance of individual plants. Data collected on a commercial farm during the 1993/1994 season (see appendix) indicated that numerous factors can negatively affect the performance of an individual plant in a population.

This study was conducted to quantify some of the factors affecting the performance of individual maize plants in commercial maize fields.
The effect of:

(1) seed orientation, planting depth and temperature on rate of emergence;

(2) seed size on germination, seedling development and yield under field conditions;

(3) uneven in row spacing on maize development and grain yield,

were specifically investigated.

CHAPTER 2

LITERATURE REVIEW

Apart from climatic and soil conditions, and general agronomic practices (plant population, fertilisation, pest management) many factors can affect the performance of individual maize plants in the field. Such factors may include irregular in-row spacing, variations in planting depth, seed orientation at planting and seed size.
Following a request from the farming community a survey was carried out in commercial maize fields in the Middelburg area in 1994. From the results it was concluded that irregular spacing, missing plants and the occurrences of blind (cobless or barren) plants can be the result of poor seed quality, planter malfunctioning, soil conditions, and seedling losses due to diseases, insects or bird damage(see Appendices). The necessity of good quality seed, favourable soil and climatic conditions, control of seedling diseases, insect pests and bird damage is generally accepted.

Farmers generally prefer medium to large seed compared to small seed. It is evident that a small or runt maize plant in a field of normal plants may produce less grain than adjacent well developed plants. Hunter & Kannenberg (1972) found that plants from small seed (23g/100 kernels) were shorter than those from large seed (39g/100kernels), but the relative differences became less as the crop matured. Hong & Kim (1982) found that small maize plants resulting from small seed yielded less grain than plants originating from bigger seed. Ford & Hicks (1992) reported from a similar experiment that maize seed size affects yield potential under specific conditions.
Hunter & Kannenberg (1972), Sharma (1974) found little correlation between seed size and maize yield. Rammana (1967) obtained significant increases in yield from larger maize seed and concluded that with the exception of very small seed, seed size should not affect grain yield under favourable conditions.

Irregular in-row spacing is one of the factors which affects a maize plant's performance from seedling development to grain yield. Data in the literature generally support the conclusion that uniform plant spacing results in higher maize yield. Benefits from uniform spacing have been reported in experimental results by Hoff & Mederski (1960) & Bunting (1971). Only a few published reports exist concerning effects of uneven in row spacing on maize yield. In the studies at Kansas State University (Krall & VANDERLIP (1977); Schaffer (1979); Onkonkwo 1980), it was found that variability in spacing (within the range normally found in farmers fields) was usually correlated with lower yield. A similar association was found in results of Pinter (1978) in hand planted plots in which uniformity of seeding was ensured by thinning, Glen & Daynard (1974) found that uniform seedling size was associated with higher yields. Contrary to this Vyn (1978) found that although differences in uniformity of in–row spacing and seedling height existed among maize plots planted by different commercial planters, these differences were not correlated with grain yield. Muldoon & Daynard (1981) demonstrated that variability in intra-row plant spacing, similar to the commercial maize fields seeded with adjusted planters had no significant effect on grain yield.

Planting depth variations, seed orientation at planting and temperature can affect the emergence of maize plants. Agness & Luth (1975) found that lack of uniformity of seedling depth caused reduced yields. Martin *et al.* (1976) reported depth of planting may be an important factor determining seedling emergence. The yield of individual plants was reduced by 5% relative to the population mean, for every day delay in seedling emergence after the mean date due to planting depth. Martin & Leonard (1963) reported that maize should be planted deep enough to place the seed in contact with warm moist soil with sufficient cover for protection against birds, rodents and surface drying. No literature is available on the effect of seed orientation on emergence. According to Fortin (1993) soil temperature is an important determinant of plant emergence and development. Bunting *et al.* (1971) reported that seed of most maize hybrids germinate very slowly at temperatures below 10°C. Bonner & Galston (1952) states that seedlings respond to temperature variation. As the temperature is increased, the rate of growth also increases until an optimum value is reached. Above this optimum, a further increase in temperature leads to a decrease in growth rate.

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CHAPTER 3

EFFECT OF SEED ORIENTATION, PLANTING DEPTH AND SOIL TEMPERATURE ON RATE OF EMERGENCE OF MAIZE

THIS CHAPTER IS PART OF A JOINT RESEARCH PROJECT WITH **Mr.C..MASHILE**, AND HIS ASSISTANCE IS GRATEFULLY ACKNOWLEDGED.

Abstract

Maize is often planted in soils that are not at the optimum temperature for germination and emergence. Variation in seedling emergence may also be attributed to uneven planting depth or seed orientation during planting. A growth chamber study was undertaken to determine the effect of seed orientation, temperature (12°C and 22°C) and planting depth (50, 100 and 150mm) on emergence rate. Seed orientation was shown to have a negligible effect on the rate of emergence. Emergence rate was highest in the 22°C growth chamber, with the time to emergence increasing with depth. Both temperature and seeding depth significantly influenced time to emergence. However, temperature had a much greater effect than seed depth.

Introduction

Uneven emergence of seedlings may be a major cause of variation within plants, thus affecting plant growth and ultimately by reducting yield in commercial maize. Numerous factors may result in uneven emergence.

In order to develop appropriate site-specific recommendations on how and when planting should take place, information relating to temperature requirements, seed placement and depth of seeding is crucial. It is against this background that this study was undertaken to determine the effect of seed orientation during planting, soil temperature and seeding depth on the rate of maize emergence.

No literature on the effect of seed orientation could be found. Temperature greatly affect the rate of germination, seedling development and emergence. According to Inglett (1970) low soil temperature is the most common cause of slow emergence of maize. Under ideal conditions healthy maize seed germinate quickly and seedlings emerge within 5 to 6 days after planting. Since germination is nearly at a standstill at 10°C, the temperature must be above that level for a substantial part of the day for germination to proceed normally. Rate of germination increases rapidly with increasing temperature and is nearly twice as rapid at 18,3°C as at 12,7°C. The higher the soil temperature, the larger the increase in both height and leaf area of seedlings.

After a series of field experiments Bland (1971) concluded that seed sown on different dates during early summer in the maize-belt of the USA tended to germinate and emerge at much the same time. When the average temperature is over 10°C, the emergence of maize will take approximately two weeks. At a 22°C soil temperature germination starts earlier and proceeds faster than at lower temperatures, due to rapid elongation of the radicle and shoot.

Sprague (1977) reported that the depth of planting is regulated by the requirements for placing the seed in intimate contact with warm moist soil and protecting it against rodents, birds and drying. A depth of 2 cm under settled soil is considered shallow, while 8 cm is considered deep. He further stated that the seedling develops an underground internode of variable length between the seed and the permanent crown of roots.

The objectives of this study were to determine the effect of:

a) seed orientation

b) planting depth

c) temperature

on the time to emergence

MATERIALS AND METHODS

All the germination experiments were conducted in filter sand in drained wooden boxes of 900mm by 600mm and 300mm deep. The dry sand was leveled at the required depth and after the seed were planted they were covered by dry sand to obtain the required depth. Boxes were watered after planting and every day after emergence.

The boxes were placed in plant growth chambers with accurate temperature control. A 12 hour photoperiod was maintained. Emergence data was recorded three times a day, until all viable seeds emerged. Seeds of the PAN 6479 cultivar were used in all the experiments.

Experiment 1: Effect of plant depth temperature and seed orientation on emergence

Seed were planted at depths of 50mm and 75mm with four seed orientations namely:

a) embryo facing downwards (right side up in Fig. 3.1)

b) embryo facing upwards (upside down in Fig. 3.1

c) radicle pointing downwards (pointed downwards in Fig. 3.1)

d) radicle pointing upwards (pointed upwards in Fig. 3.1)

Temperatures of 20° and 30°C were maintained in two chambers. Each treatment was replicated four times, with 20 seeds per treatment. Emergence rates were determined by counting seedlings three times a day. A seedling was considered emerged as soon as the coleoptile or first leaf emerged above the soil surface.

EXPERIMENT 2: The effect of temperature and depth on the rate of emergence

The seed depth variables namely 50, 100, and 150mm were used. The boxes were divided into three equal compartments using hardboard. Hundred seeds were placed in each compartment at the required depth and covered with sand. Each treatment had three replicates. Temperatures of 12° and 22°C were maintained in the two growth chambers.

RESULTS AND DISCUSSION

Experiment 1: Effect of temperature and seed orientation on emergence

Emergence data is presented in Table 3.1. More than 50% of the seedlings planted at 30°C emerged after three days, while 50% emergence was achieved after four days at 20°C. It is clear that seed orientation had little effect on the rate of emergence. In Fig. 3.1 the remarkable ability of the coleoptile to grow upwards and the radicle to grow downwards with a minimum waste of time and energy is illustrated. It is clear that seed orientation during plant is not a cause of uneven emergence. No literature is available on the effect of seed orientation on emergence.

TABLE 3.1: The effect of temperature and seed orientation on emergence three and four days after planting (average number of seedlings emerged)

Emergence days	Right side up	Upside down	Pointed upwards	Pointed downwards	Mean
Temp: 30°C					
3rd day	14	10	15	13	13,0
4th day	19	19	19	19	19.0
Temp: 20°C					
3rd day	-	-	-	-	-
4th day	11	13	10	9	10.8

Experiment 2: The effect of temperature and depth on the rate of emergence

The effect of temperature and depth on emergence rate is illustrated in Fig. 3.2. To quantify the effect of the treatments on emergence rate, the time required to attain 70% emergence of seedlings of each treatment was calculated and is presented in Table 3.2.

TABLE 3.2: Days to 70% emergence at two temperatures and three planting depths

Temperature °C	50 mm	100 mm	150 mm	Mean
12° C	9,5	10,2	13	10,9
22° C	5,2	6,4	8,2	6,6
Mean	7,4	8,3	10,6	8,75

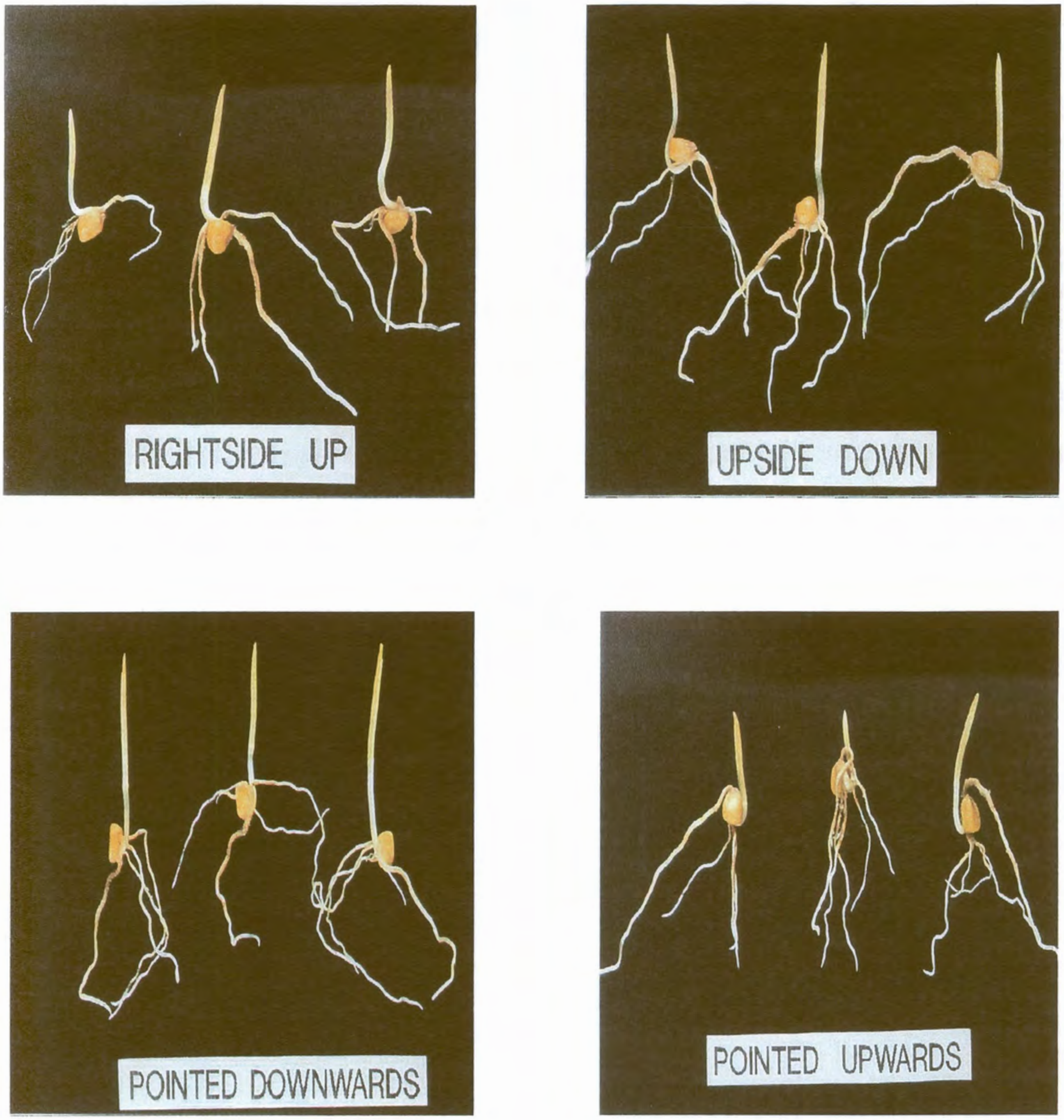

FIGURE 3. 1 Illustration of the ability of maize seedlings to orientate themselves when planted at different seed orientations (7 days after planting)

From this data it is evident that emergence was delayed by approximately 4 days when the temperature was lowered from 22°C to 12°C. The temperature effect was the same for all three planting depths. Allesi & Power (1971) reported that maize planted in a seedbed at temperatures below 10°C had little chance of germination and emergence. They further stated that with temperature above 10°C, depth of seeding will have a small influence on the rate and time to emergence.

Soil temperature rather than air temperature dictate the rate of cell differentiation and elongation prior to the initiation of stem elongation. According to Fortin (1993) soil temperature is an important determinant of plant emergence and development until the appearance of leaf 11, also known as the V6 stage, which is the last stage at which the apical meristem is below ground and exposed directly to soil temperature. Shaw (1971) found that although daily mean soil and air temperature are similar during the spring, the diurnal temperature fluctuation was less in the soil. Soil temperature protect the shoot apex from extreme air temperatures up to a stage when stem elongation has elevated the shoot apex above the surface of the soil.

According to Swan *et al.*(1987) laboratory observations at various growth stages up to and including the six leaf stage indicated a nearly linear growth rate response to seed zone temperature between 13° and 30°C, with growth essentially ceasing at 9°C.

Bunting (1978) reported that seeds of most maize hybrids germinate very slowly at temperatures below 10°C and, although cultivars capable of germinating at 6-8°C have been reported, there appears to be no close correlation between the minimum temperature for germination determined in the laboratory and seedling performance in the field. The start of the growing season for maize is therefore normally determined in temperate areas by the expected date when soil temperature stabilize above 10°C. Provided seeds are sown in contact with moist soil, the time taken for seedlings to emerge is then a function of soil temperature. He further stated that even after emergence soil temperature is important, as the growing point remains below the soil surface for 6 to 8 weeks after sowing.

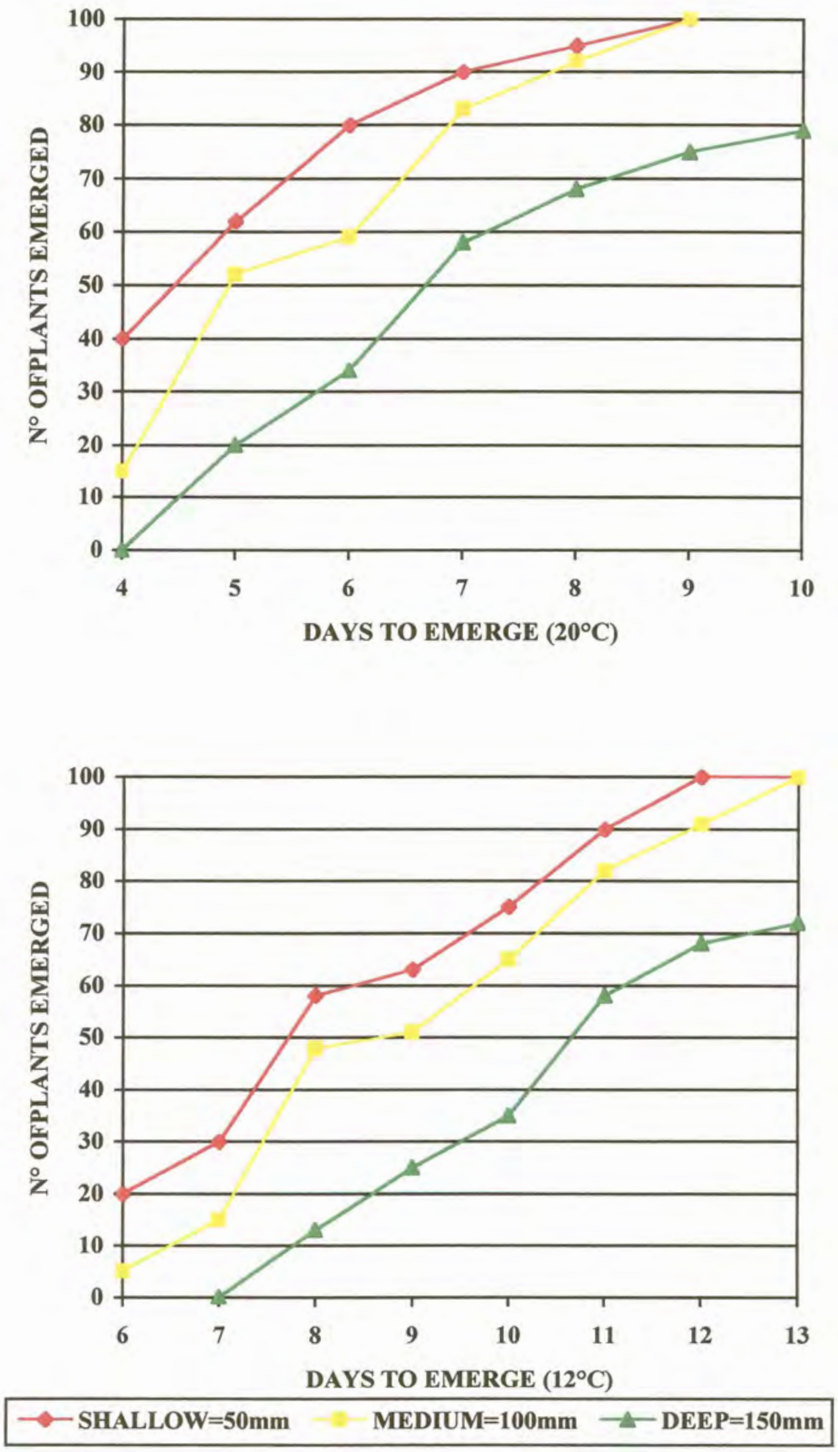

FIGURE 3.2 The effect of temperature and planting depth on emergence

The leaves of young seedlings are yellow if soil temperatures remain low or if maximum daytime temperatures do not exceed 15ºC because higher temperatures are needed for chlorophyll formation than for germination.

According to Bonner & Galston (1952) seedlings respond to temperature variation. As the temperature is increased, the rate of growth also increases until an optimum value is reached. Above this optimum, a further increase in temperature leads to a decrease in growth rate, one reason being that chemical reactions increase in rate as temperature is increased. Seed germination would not take place below 9,5ºC or above 46ºC, while the optimum temperature for germination under his conditions was 34ºC.

Martin *et al.* (1976) reported depth of planting may be an important factor determining the seedling emergence. He mentioned that seeds will emerge from greater depths in sandy soil than in clay soil, and in warm soil than in cold soil. It is customary to plant deep in dry soil in order to place the seeds in contact with moisture.
In general, the larger the seed the deeper it can be planted and still emerge. According to Martin *et al.*(1976) the normal depth of seeding is 5-7cm and the maximum depth for emergence is 10-19cm.
Martin & Leonard (1963) reported that maize should be planted deep enough to place the seed in contact with warm moist soil with sufficient cover for protection against birds, rodents and surface drying. Planting depth usually ranges from 2-7 cm, but under favorable conditions maize is able to emerge from even greater depths. They further reported that in a Wisconsin experiment, sweet maize single crosses and their inbred lines were planted in peat soil at depths of 3-10 cm in greenhouse flats. Deep planting failed to reduce stands significantly, except where the germinated seeds were exposed to a low temperature of 10ºC for 10 days.

Conclusions

Both temperature and seeding depth significantly influenced the time and the rate of emergence. However, temperature had a much greater effect than seed depth. The orientation of the seed had virtually no effect on the time of emergence. It can be concluded that uneven planting depth in commercial maize production systems may result in uneven emergence. Late emerging plants may not be able to compete successfully with their bigger neighbours, and this may affect grain yield.

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CHAPTER 4

EFFECT OF SEED SIZE ON GERMINATION RATE, EARLY GROWTH AND YIELD

Abstract

Experiments were conducted in controlled environments and in the field to determine the effect of seed size on germination rate, growth and yield. In a standard germination test it was found that small seed germinated quicker than large seed. Growth and yield experiments were conducted in the field. The results show that differences in the seedling mass from different seed sizes were small and no significant differences in the yield were obtained.

It was concluded that differences in the rate of germination and early growth due to seed size were too small to affect the yield under field conditions, and that plants from the seed sizes which were compared can perform equally under normal growing conditions.

Introduction

Maize seed size and shape vary due to genotype, environmental conditions and the location of kernels on the ear. On a maize ear the grain development from the base to the top varies, with large round grains at the base of the ear, flat grains in the middle ear and small round grains at the top of the ear. Many farmers prefer flat seed rather than round seed, and large seed rather than small seed. Information related to the effect of seed size of maize on germination, early growth as well as yield under field conditions was difficult to be found because little is published about the topic.

Hunter & Kannenberg (1972) reported that plants from small seed (23g/100 kernels) were shorter than those from large seed (39g/100kernels), but the relative differences became less as the crop matured. On the other hand, Hong & Kim (1982) reported that the seed size of hybrid maize affected the germination and early growth, and small plants resulting from small seed yielded less than larger plants from larger seed. Ford & Hicks (1992) reported from a similar experiment that maize seed size affects yield potential under specific conditions. Rammana (1967) obtained significant increases in yield from larger maize seeds and Sharma (1974) found little correlation between maize yield and seed size.

The objectives of this study were to determine the effect of maize seed size on germination rate, early growth and grain yield under field conditions.

MATERIALS AND METHODS

Experiment 1: Effect of maize seed size on germination

Seed samples were obtained from a field of hybrid maize on the experimental farm of the University of Pretoria. The cobs of cultivar CRN **3852** were shelled and healthy uniform small (22 g per 100 kernels) and large (56g per100 kernels) seeds were selected

The germination experiment was conducted in filter sand in drained wooden boxes (depth 5 cm, temp 22°C) using a standard germination test (Maguire,1962). Daily observations were made commencing after a period of four days.

To determine the germination rate, the calculation was made according to the formula of Maguire (1962).

Germination rate = $(x1 / y1) + (x2 - x1) / y2 + ...(xn\text{-}xn\text{-}1) / yn$

Where ***xn*** = percent of seed germinated at the ***nth*** counting date, and ***yn*** = number of days from seed placing to ***nth*** count.

Experiment 2: Effect of seed size on early growth of maize.

Uniform healthy seed of the cultivar CRN **3852** were sorted into four size groups, namely

S1= (27 per 100 kernels),

S2 = (36g per 100 kernels),

S3 = (41g per 100 kernels),

S4 = (52 g per 100 kernels)

The seed lots were compared in a field experiment with a completely randomized block design (CRBD), with four treatments and four replicates.

For each seed size one row of 20m with a 30 cm in row spacing was planted per replicate. The row spacing was 1m . Treatments were randomized with a border row planted between replicates. The trial was conducted on the Experimental Farm of the University of Pretoria on a red loamy clay soil with a pH 4,5–5,6. The rainfall was 704 mm between October and March. Weeds were controlled by hand and four weeks after emergence LAN at 25g / m² was applied a top dressing.

Stalkborer (*Busseola fusca*) was controlled by applying carbofuran. In the experiment on the effect of seed size on early growth the dry mass of young plants was determined. The sampling was done from two weeks after emergence at weekly intervals for a period of five weeks. Ten plants from each row were cut at ground level. Dry weight (DM) was obtained after drying at 75 °C in the laboratory.

Experiment 3: Effect of seed size on grain yield under field conditions

In this experiment the effect of seed size on grain yield and components were determined under field conditions. Uniform healthy seed of the cultivar CRN **3852** were sorted into four size groups, namely

S1= (27g per 100 kernels),

S2=(36g per 100 kernels),

S3 = (41g per 100 kernels),

S4 = (52g per 100 kernels).

The seed lots were compared in a field experiment in a completely randomized block design (CRBD) with four treatments and four replicates. Plots consisted of 4 rows, 1m apart and 20m in length. The spacing between plants was 30 cm, which produced a stand of 33 000 plants / ha. The trial was conducted on the Experimental Farm of the University of Pretoria on a red loamy clay soil. Two seeds were planted per hill and one plant was removed after emergence to obtain a 100% plant population. Weeds were controlled by hand and four weeks after emergence LAN at 25g/m² was applied as a top dressing. Stalkborer (*Busseola fusca*) was controlled by applying carbofuran.

Harvest was done by hand, with 20 plants harvested from each row. The nett plot size was limited to 20 plants due to limited available space in the drying ovens. Dry mass of the plant components and grain mass were determined. Data was analyzed by analysis of variance using SAS (Statistical Analysis Systems) program.

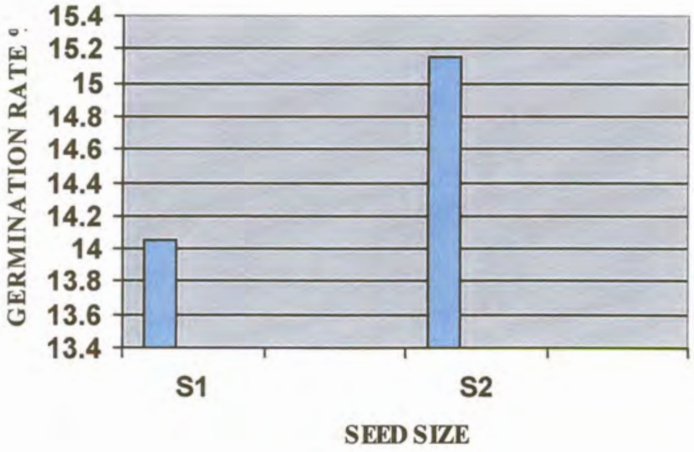
RESULTS AND DISCUSSION

Experiment 1: Effect of maize seed size on germination

The germination results are presented in Fig. 4.1 and Fig.4.2. Initially small seed germinated quicker than large seed. After four days 25% of the small seed had germinated compared to 8% of the large seed. Both seed lots reached 100% germination after seven days. The germination rate of small seed was higher than that of large seed according to Maguire's (1962) definition. This is probably due to the fact that small seed has a larger surface area to seed mass ratio than large seed, thus increasing the water absorption rate. According to Hunter & Kannenberg (1972) the differences in the rate of germination of small and large seed are too small to have any significant effect under field conditions.

Experiment 2: Effect of seed size on early growth of maize

The results in Fig. 4.3 show that differences between the plants were small during the first six weeks. During the early stages, plants grown from large seed (52g per 100 kernls), were larger than those from small seed (27g per 100 kernls), but the relative differences decreased over the following weeks . In this experiment differences in seedling mass were insignificant, indicating little or no benefit in planting large seed compared to small seed.



S1- Large Seed S2 – Small Seed

FIGURE 4.1 Germination rate of large and small seed according to the Maguire (1962) definition

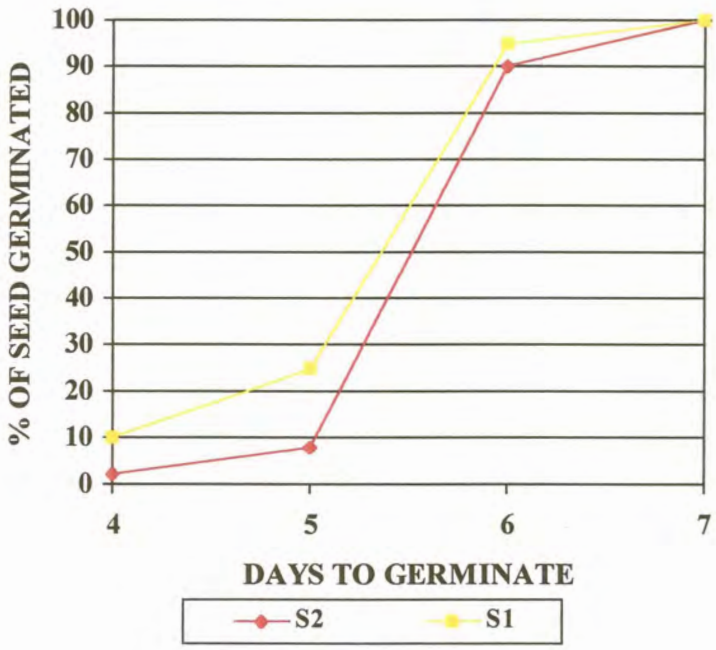


FIGURE 4.2 Percent germination of large (S2) and small (S1) seed over time

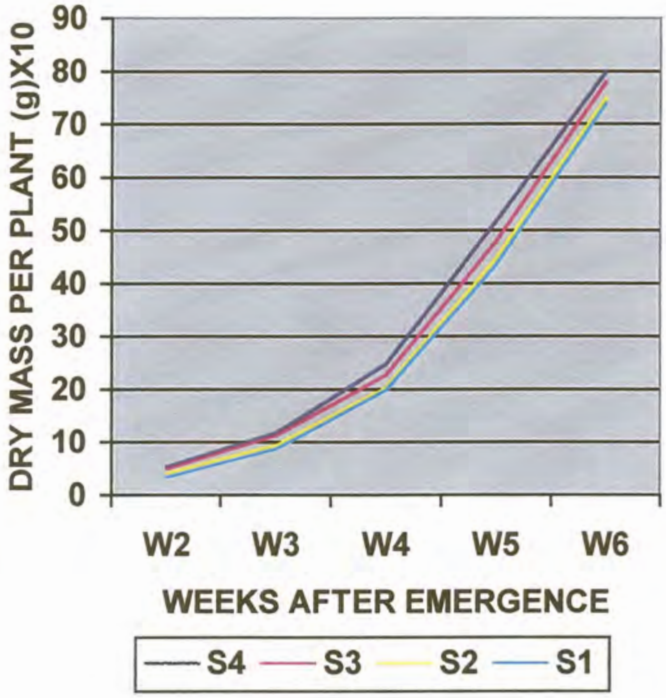


FIGURE 4.3 Effect of seed size on seedling mass during the first six weeks after emergence

S_1 = 27g S_2 = 36g S_3= 41g S_4 = 52 g per 100 kernels

Experiment 3: Effect of seed size on grain yield under field conditions

Comparisons of yield components are reported in the Table 4.1. Differences in the number of cobs, total cob mass of 20 plants, and yield per cob were not statistically significant. There were no significant differences in the total kernel mass obtained from the seed size treatments Reports in the literature indicate that seed size can affect the size of young plants, and that uneven plant size can affect maize yield (Vyn 1978). In this study, maize plants from different seed grades had no effect on yield although plants from different seed sizes differed somewhat in size. These results show that different maize seed sizes can perform equally under normal planting conditions. However, agronomic conditions in this trial were favourable for maize growth, and it is conceivable that adverse conditions such as soil crusting or weed competition, which could selectively affect plants of different sizes during the early growth stages, might produce a different result.

Table 4.1. Effects of maize seed size on yield components (∗)

	COBS no	COB MASS kg	KERNEL MASS kg	YIELD PER COB kg
S1	**21 a**	**3.9 a**	**3.5 a**	**0.15 a**
S2	**21 a**	**3.9 a**	**3.3 a**	**0.14 a**
S3	**22 a**	**4.3 a**	**3.4 a**	**0.15 a**
S4	**22 a**	**4.4 a**	**3.7 a**	**0.16 a**
CV %	**4.49**	**9.17**	**11.82**	**14.23**

∗ net plot size 7 m row lenght consisting of 20 plants

S1 = (27 per 100 kernels),

S2 = (36g per 100 kernels),

S3 = (41g per 100 kernels),

S4 = (52 g per 100 kernels)

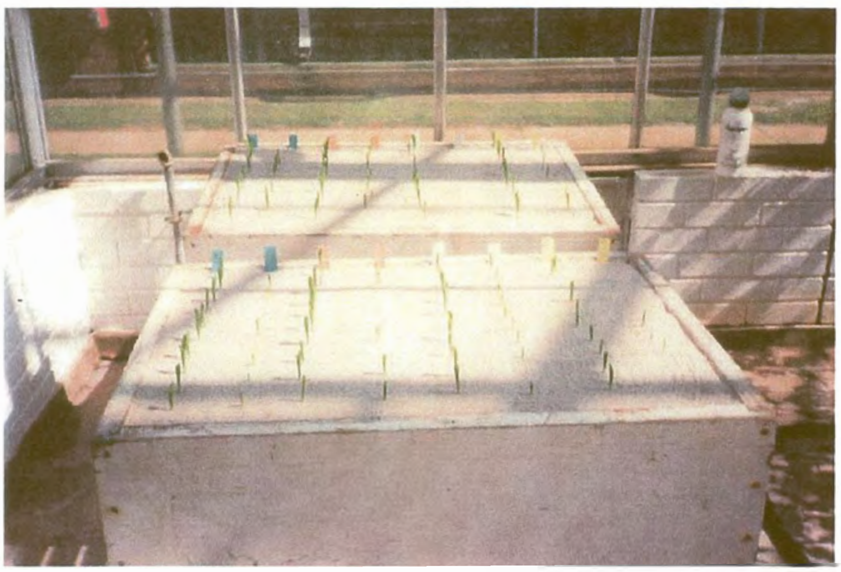


Figure 4.4 Sand boxes used to determine the effect of seed size and depth on rate of emergence

a)

b)

c)

Figure 4.5 Field trial to compare the effect of seed size on growth and yield

a) Emergence stage

b) Vegetative stage

c) Inflorenscence stage

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CHAPTER 5

EFFECT OF UNEVEN SPACING ON MAIZE DEVELOPMENT AND GRAIN YIELD

Abstract

Many factors determine the effect of spacing on maize development and grain yield (Yao & Shaw ,1964). Mutual shading of plants, the supply of available soil moisture, the supply of plant nutrients, plant diseases and CO_2 movement may all have an effect. The effect of uneven spacing in the row on maize development and grain yield was studied in a field experiment. The objective was to quantify the effect of uneven spacing on maize development and grain yield. At same plant population uneven in row spacing resulted in significantly higher cob and grain yields, than where three plants were grouped together in a hill.

Introduction

Observations on a commercial farm in the Middelburg district indicated that irregular in-row spacing of maize may be a major determinant of grain yield. This may result from planter malfunctioning, and / or seedling loss due to diseases, insects or bird damage.

Data in the literature support the hypothesis that uniformity in plant spacing results in higher maize yields. Comparing hill-planted and drilled maize various authors reported a yield superiority for drilled planting (Kohnke & Miles, 1951; Pendleton *et al.*, 1966). Exceptions were reported by Dungan & Lange (1958) and Wooley & Baracco (1962). Benefits from uniform spacing have been reported in experimental results where equidistant seed placement has been compared to conventional rows (Hoff & Mederski, 1960; Bunting, 1971). Only a few published reports exist concerning effects of variability in intra-row spacing on maize yield. Krall & Vanderlip (1977), Schafer (1979) and Okonkwo (1980) found that within row variability in spacing (within the range normally found in farmers fields) was generally correlated with lower yield. A similar association was evident in results of Pinter (1978). Erback & Wilkins (1972) also presented data suggesting that perfect uniformity, relative to that normally produced by properly adjusted planters, resulted in a yield improvements.

Materials and Methods

This experiment was conducted at Experimental farm of the University of Pretoria. The The cultivar PAN **6364** was in a field experiment with a completely randomized block design with three treatments according the following arrangements:

(S1) - 3 plants/m row equally spaced

(S2) - 3 plants/m row in two hills with 2 plants in one position and one in another

(S3) - 3 plants /m row combined in one hill

The plant population for all treatments were 33 000 plants per hectare. The plots consisted of single rows which were thinned in the seedling stage to produce the required stands. The emerging plants were protected against damage by birds by covering the plots with bird netting.

Weeds were controlled using atrazine , and four weeks after emergence LAN at 25g /m^2 was applied as top dressing . Stalk borer (*Busseola fusca*) was controlled by applying carbofuran.

Samples from the trial were harvested for yield (dry matter) analysis six weeks after emergence, before tasselling and during anthesis. The plants were divided in leaves, stems, husks and cobs and weighed after oven drying to constant mass. Data of height, leaf area, mass/leaf, and husk was recorded during plant development. At maturity 15 plants, representing a row length of 5m, were harvested, dried to a constant mass and the yield components recorded. Data was analyzed by analysis of variance using SAS (Statistical Analysis Systems) program.

Results and Discussion

In sampling before maturity no significant differences were found between the spacing treatments, except for the dry mass of leaf sheaths. However, since this is of little agronomic importance the data is not presented.

After grain maturity differences were observed between the spacing treatments for total cob mass and kernel mass (Table 5.1). An increase in plant number per hill caused a decrease in cob mass where the S3 - treatment with three plants per hill yielded significantly less (2,05kg of cobs) than the equally spaced S1 – treatment (2,61 kg of cobs). The kernel yielded did not differ between treatments S1 and S2, but both yields were significantly higher than the treatment with three plants per hill (S3).

Hoff & Mederski (1960) found that equidistant planting apparently reduced competition between plants for soil phosphorus, or in some other way enabled the individual plants to absorb more phosphorus. Wooley & Peters (1962) reported yield increases for oriented positioning of maize in the row over random seeding . They attributed the yield increase to increased shading of the soil surface, conservation of soil moisture, and improved utilization of solar energy. Equidistant planting provides a uniform vegetative canopy early in the season and may reduce soil erosion.

Viewed in this context, the result of this experiment support the concept that increased variability in in-row spacing is associated with lower yields. This in agreement with the results of Hoff & Mederski (1960) ; Krall (1977) ; Schafer (1979) and Okonkwo (1980).

The experimental results demonstrated that variability in in-row plant spacing, to the extent likely to be encountered in most commercial maize fields, had a effect on grain yield. Steps to obtain uniform in-row spacing deserves more attention from scientists and farmers.

Table 5.1 Effect of variability in in-row spacing on number of cobs, total cob mass and total kernel mass of maize. (*)

	COBS no	COB MASS kg	KERNELMASS kg	EQUIVALENT YIELD T / ha
S1	15 **a**	2,61 **a**	2,17 **a**	**4.773**
S2	14,75 **a**	2,30 **ab**	2,03 **a**	**4.465**
S3	11,75 **a**	2,05 **b**	1,69 **b**	**3.717**
CV %	16,4	9,6	8,9	

(*) Net plot size of 5m row length consisting of 15 plants

S1 - 3 plants/m row equally spaced

S2 - 3 plants/m row in two hills with 2 plants in one position and one in another

S3 - 3 plants /m row combined in one hill

a)

b)

c)

Figure 5.1 Field trial with uneven spacing treatments

a) Field preparation

b) Emerging plants protected by netting

c) Plants in inflorescence stage

Figure 5.2 Uneven spacing trial illustrating the treatment with three plants per hill

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CHAPTER 6

SUMMARY

1. Many factors can affect the performance of individual maize plants in the field apart from climate, soil conditions, and general agronomic practices. Such factors, may include irregular in-row spacing, variations in planting depth, seed orientation at planting and seed size. In a survey carried out in commercial maize fields of Omnia Farms, Middelburg in 1994 it was concluded that irregular spacing, missing plants and the occurrence of blind (cobless) plants can be the result of poor seed quality, planter malfunctioning, soil conditions, and seedling losses due to diseases, insects or bird damage. The necessity of good quality seed, favorable soil and climatic conditions and control of seedling diseases, insect pests and bird damage is generally accepted.

2. Temperature and seeding depth significantly influenced the time and rate of emergence. However, temperature had a much greater effect than seed depth. The orientation of the seed had virtually no effect on the time of emergence. Uneven planting depth in commercial maize fields is probably a major cause of uneven emergence. Late emerging plants may not be able to compete successfully with their bigger neighbors , and this my affect grain yield.

3. Small seed germinated quicker than large seed. Maize plants from different seed sizes had no effect on yield, although plants from different seed sizes differed somewhat in size, it had no substantial influence on the final yield, demonstrating that different maize seed sizes can perform equally under normal planting conditions.

4. Irregular in-row spacing is one of the factors which affects a maize plant's performance from seedling development to grain yield. Differences were observed between the spacing treatments for total cob mass and kernel mass.

Increasing the number of plants per hill caused a decrease in cob mass where the treatment with three plants per hill yielded significantly less cobs than the equally spaced treatment. Data in the literature generally support the conclusion that uniform plant spacing results in higher maize yield.

APPENDIX A

SURVEY OF MAIZE CULTIVARS PERFORMANCE ON A COMMERCIAL FARM

OBJECTIVE

To compare a number of new and existing maize cultivars with regards to yield components and related characteristics under commercial farming conditions.

PROCEDURE

Trial blocks of mainly Carnia hybrid maize were planted on a commercial scale in the Wonderfontein area by Omnia Farming Pty during the summer of 1993/94. Sixteen cultivars were planted, and in order to aid comparison of the cultivars 8 rows of a standard yellow (A1556) or white (CRN 4403) cultivar were planted in each block. Soil preparation, fertilization, control of insects and weed, planting and harvesting was done according to commercial farming practices. Differences in soil conditions, planting date (and thus climatic conditions during the different growth stages) and probably some biotic factors make a direct comparison between cultivars unreliable.
In July 1994, after the maize had ripened, a survey was undertaken by post-graduate students of the University of Pretoria. At pre-determined positions six replicates were harvested from each plot. A sample plot consisted of a 10 meter row. Plant population was determined and main cobs were harvested separately from secondary cobs.

The following observations were made on main and secondary cobs.

- Cobs were graded according to relative size into cobs contributing significantly to the yield and non significant cobs.
  The significant cobs were then counted and weighed.
- Kernel counts per cob were made.
- Grain mass was determined.
- Moisture content and seed size were determined.

Omnia Farming also harvested 8 rows of approximately 200 m with a combine harvester in order to estimate the comparative yield of the various cultivars

RESULTS

The results are summarized in Table A1, and illustrated in Figure A1 (plant population data), Figure A2 (yield per plant) and Figure A3 (yield per hectare).
The following preliminary observations can be made:

1- **Plant population : Figure A1**

Plant population varied greatly among the different blocks, from less than 25 000 to more than 55 000 . The variation in population of the control (standard cultivars) indicate that the variation was due to environmental conditions (implements, climate, insect pests) rather than to variation in germination percentage of the seed lots. With a few exceptions the cultivar and the control had similar populations on any specific field (block). This seems to indicate that reliable comparisons are possible in most instances.

2- **Yield per plant : Figure A2**

The grain yield per plant varied from approximately 100 to 200g. To a large extent grain yield per plant reflects differences in plant population, with high yields per plant in the instances where the plant populations were low, and *vice versa*.

Data in Table A1 shows that second cobs generally made a small contribution (less than 10%) towards total yield. Prominent exceptions are CRN 3414 and PAN 6480, where the second cobs produced almost a third of the total yield. These are typical prolific cultures. In both these cases, (as well as other cultivars with relatively high yields from second cobs) large second cobs were associated with low plant densities.

3- **Yield per hectare : Figure A3**

In general the yield obtained by manual sampling of a total row length of 60m (6 x 10m) adequately predicted the actual yield obtained by combine harvesting a total row length of 1600m, with a tendency of over estimating the yield when sampling. Yield estimates varied from 3,5t per hectare to more than 10t per hectare.

This large variation in yield was the result of variations in environmental conditions (soil, climate, biotic factors) rather than cultivar differences. In almost all cases the yield of the control (standard cultivar) varied just as much among blocks. Especially where higher yields were obtained there was a tendency for the control to out-yield the cultivar under trial.

4- **Other characteristics**

Observed differences in kernel size were small with the exception of PAN 6364 and CRN 3584 producing larger kernels and A 1598 producing smaller kernels than those of the other cultivars.

A poor correlation between plant population and percentage of barren plants were observed, although there was a tendency towards more barren plants at higher plant populations.

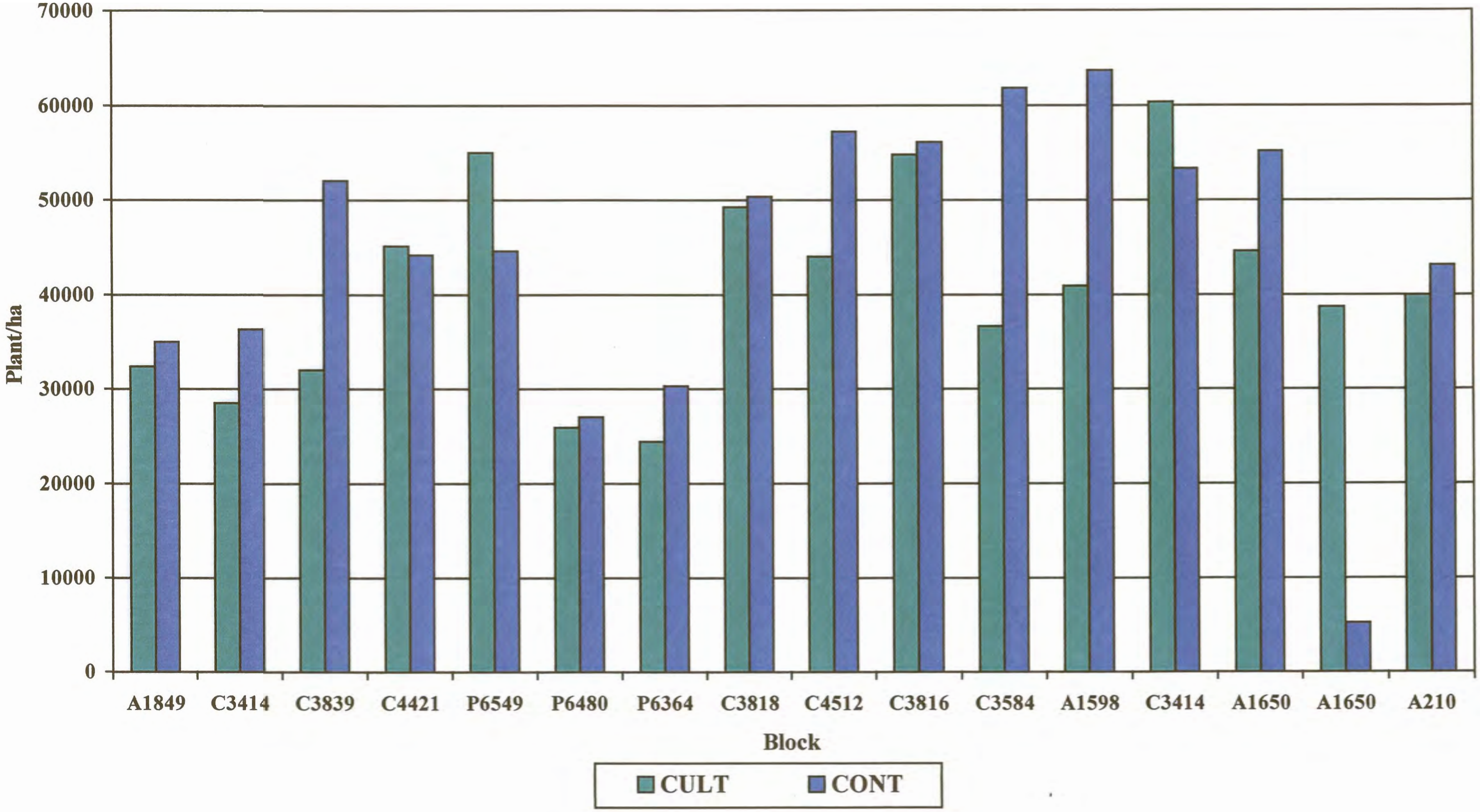

FIGURE A1. Final plant populations as determined during July 1994

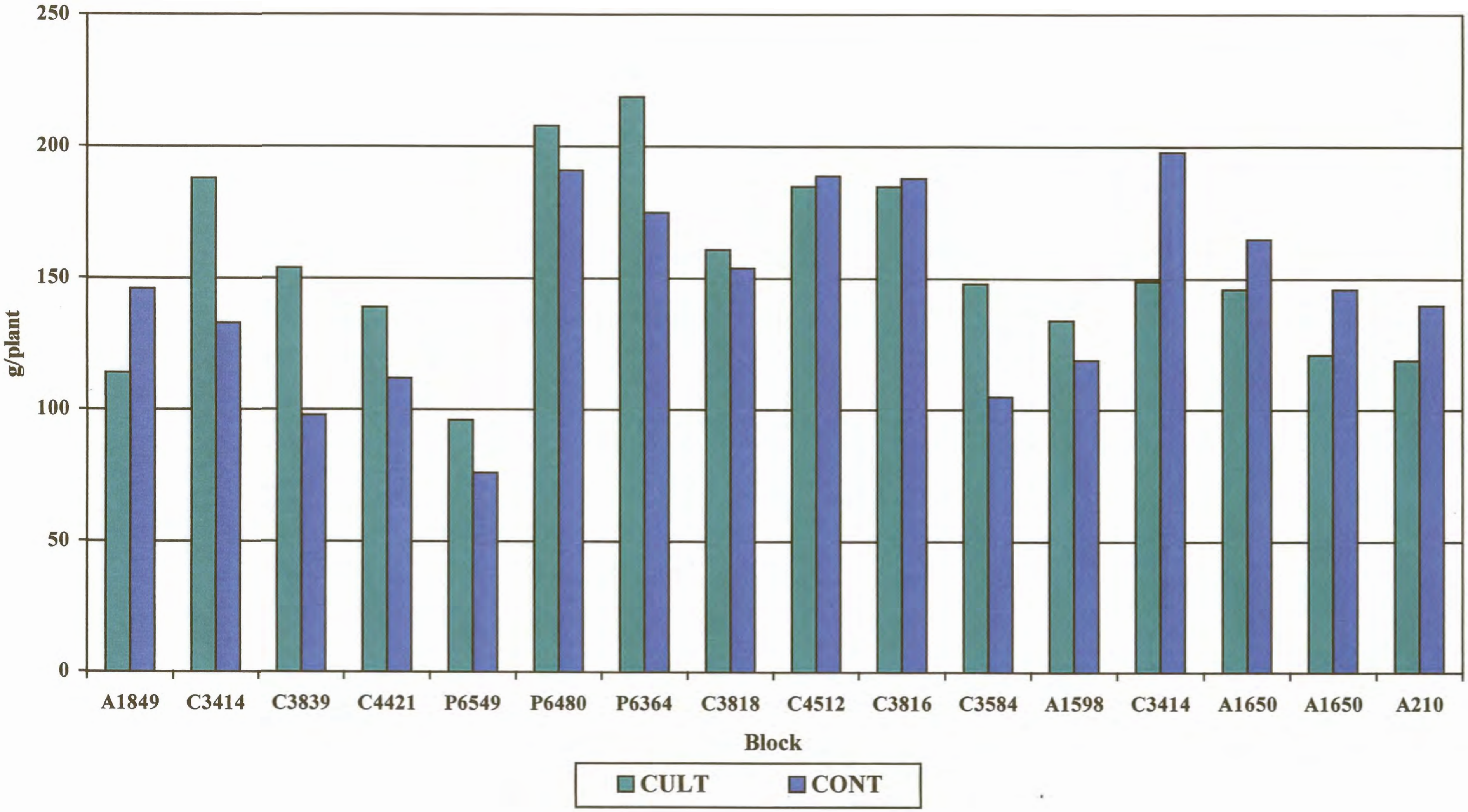

FIGURE A2. Mean yield per plant determined by sampling during July 1994

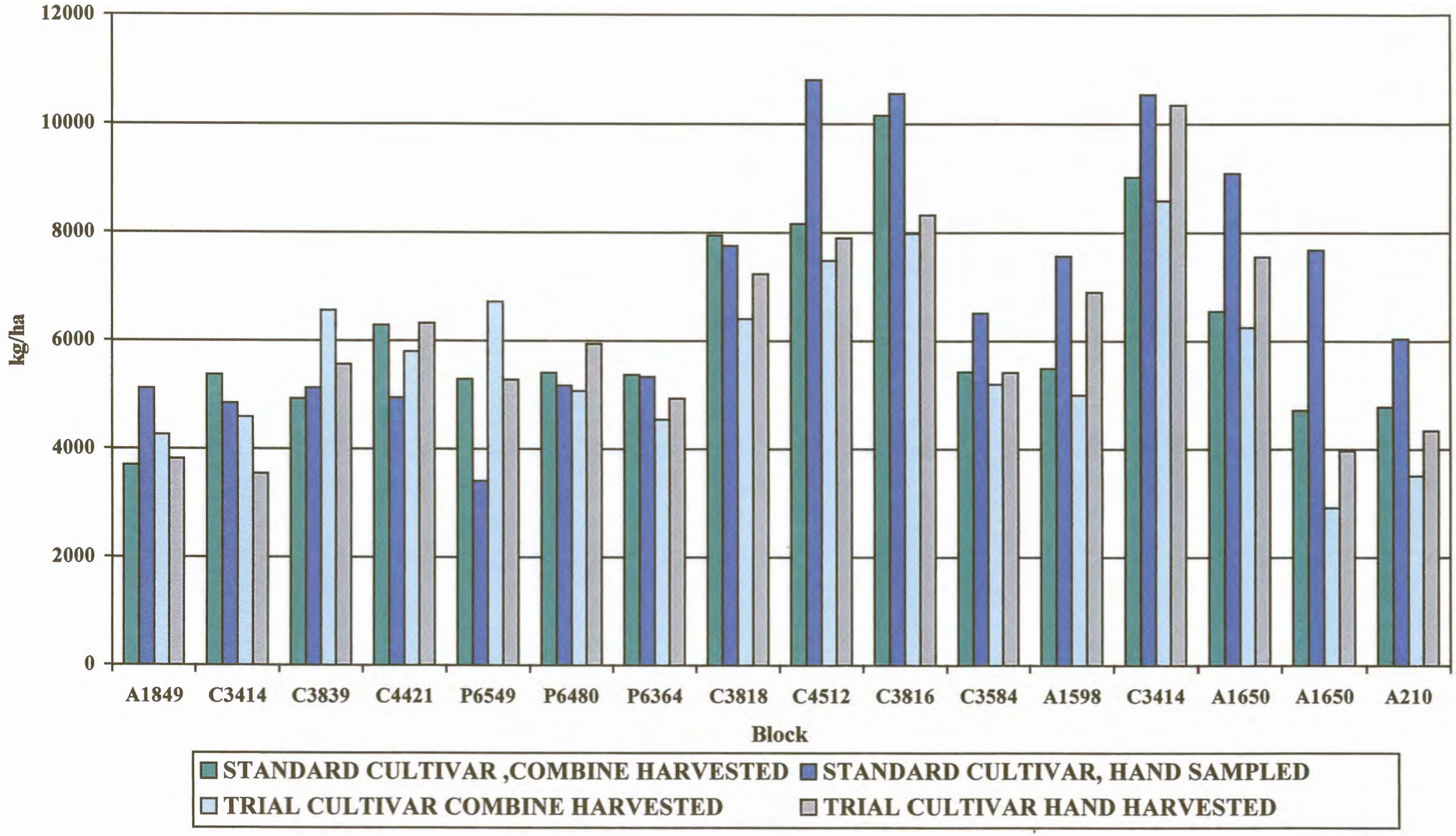

FIGURE A3. Grain yield of 16 trial cultivars compared to adjacent control cultivars

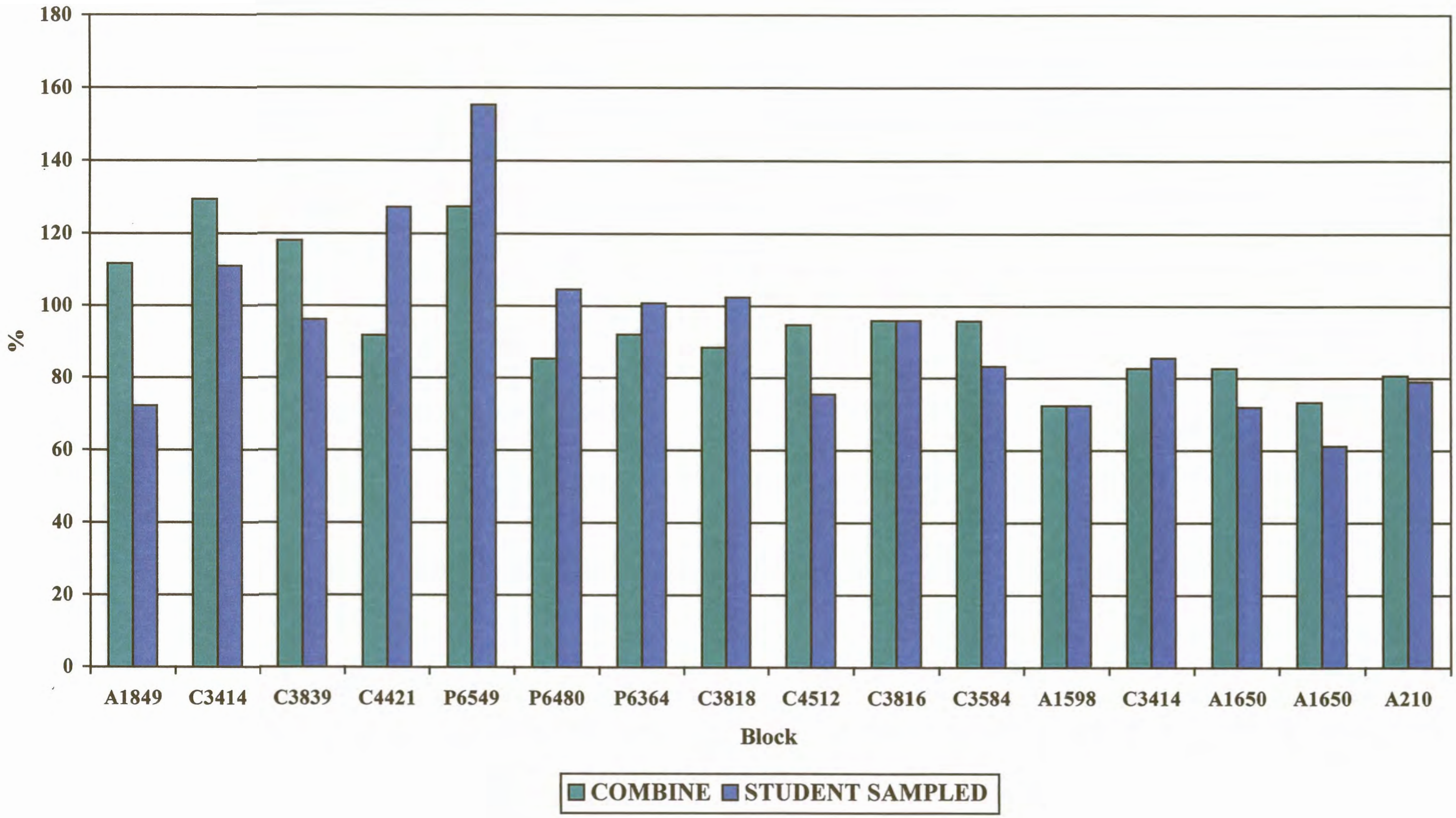

FIGURE A4. Relative yield of cultivars obtained by student sampling and by combine harvesting , Cultivar yield expressed as % control

TABLE A1.1 Field data from Omnia Farms

Block No. 3		Sample		Omnia	
		Cultivar	Control	Cultivar	Control
Combrink Block 2b		A 1849	CRN 4403	A 1849	CRN 4403
1	No. plants 10m	29.17	31.50		
2	Plant population per ha	32410	34999		
3	No. significant first cobs	20.17	31.25		
4	Kernel rows per cob	13.67	15.00		
5	Kernels per row	31.17	36.75		
6	Total kernel mass/kg	2.89	4.70		
7	Moisture %	7.6	7.4		
8	Dry Kernel mass/kg	2.67	4.35		
9	Mass per kernel (g)	0.30	0.31		
10	No. significant sec cobs	5.00	3.00		
11	Kernel rows per cob	14.25	15.00		
12	Kernels per row	24.75	28.00		
13	Total kernel mass/kg	0.72	0.27		
14	Moisture %	8.17	6.70		
15	Dry Kernel mass/kg	0.66	0.25		
16	Mass per kernel (g)	0.37	0.28		
17	(8+15) total kernel mass	3.33	4.60		
18	Yield per hectare kg	3701	5115	4259	3814
19	Cult: yield as % of Control	72,36		111,6	

TABLE A1.2 Field data from Omnia Farms

Block No. 6		Sample		Omnia	
		Cultivar	Control	Cultivar	Control
EERSTELING BLOCK 1		CRN 3414	A 1556	CRN 3414	A 1556
1	No. plants 10m	25.67	32.67		
2	Plant population per ha	28521	36299		
3	No. significant first cobs	22.5	29		
4	Kernel rows per cob	-	-		
5	Kernels per row	-	-		
6	Total kernel mass/kg	3.61	4.67		
7	Moisture %	6.8	6.7		
8	Dry Kernel mass/kg	3.36	4.36		
9	Mass per kernel (g)	0.30	0.33		
10	No. significant sec cobs	12.40	-		
11	Kernel rows per cob	-	-		
12	Kernels per row	-	-		
13	Total kernel mass/kg	1.60	-		
14	Moisture %	8.00	-		
15	Dry Kernel mass/kg	1.47	-		
16	Mass per kernel (g)	0.27	-		
17	(8+15) total kernel mass	4.84	4.36		
18	Yield per hectare kg	5373	4841	4583	3541
19	Cult: yield as % of Control	111		129.4	

TABLE A1.3 Field data from Omnia Farms

Block No. 7		Sample		Omnia	
		Cultivar	Control	Cultivar	Control
Middelblock 1		CRN 3839	CRN 4403	CRN 3839	CRN 4403
1	No. plants 10m	28.83	46.83		
2	Plant population per ha	32033	52032		
3	No. significant first cobs	24.17	29.83		
4	Kernel rows per cob	14.67	14.17		
5	Kernels per row	35.33	38.17		
6	Total kernel mass/kg	4.43	4.56		
7	Moisture %	8.45	6.8		
8	Dry Kernel mass/kg	4.06	4.25		
9	Mass per kernel (g)	0.31	0.28		
10	No. significant sec cobs	3.17	4.20		
11	Kernel rows per cob	13.67	12.40		
12	Kernels per row	26.67	24.00		
13	Total kernel mass/kg	0.41	0.39		
14	Moisture %	8.60	7.25		
15	Dry Kernel mass/kg	0.37	0.36		
16	Mass of 1 kernel	0.31	0.24		
17	(8+15) total kernel mass	4.43	4.61		
18	Yield per hectare kg	4922	5124	6555	5555
19	Cult: yield as % of Control	96.069		118	

TABLE A1.4 Field data from Omnia Farms

Block No. 8		Sample		Omnia	
		Cultivar	Control	Cultivar	Control
Middelblok 2		CRN 4421	CRN 4403	CRN 4421	CRN 4403
1	No. plants 10m	40.67	39.83		
2	Plant population per ha	45188	44225		
3	No. significant first cobs	34.17	26.67		
4	Kernel rows per cob	16.00	14.83		
5	Kernels per row	37	36.17		
6	Total kernel mass/kg	5.83	4.53		
7	Moisture %	6.6	7.7		
8	Dry Kernel mass/kg	5.45	4.18		
9	Mass per kernel (g)	0.31	0.29		
10	No. significant sec cobs	2.00	2.67		
11	Kernels rows per cob	12.50	14.00		
12	Kernel per row	22.00	24.67		
13	Total kernel mass/kg	0.23	0.29		
14	Moisture %	8.20	7.80		
15	Dry Kernel mass/kg	0.21	0.27		
16	Mass of 1 kernel	0.27	0.29		
17	(8+15) total kernel mass	5.66	4.45		
18	Yield per hectare	6284	4942	5798	6319
19	Cult: yield as % of Control	127,150		91.75	

TABLE A1.5 Field data from Omnia Farms

Block No. 9		Sample		Omnia	
		Cultivar	Control	Cultivar	Control
Middelblok 3		PAN 6549	CRN 4403	PAN 6549	CRN 4403
1	No. plants 10m	49.5	40.17		
2	Plant population per ha	54999	44632		
3	No. significant first cobs	38.83	24.5		
4	Kernel rows per cob	11.83	13.00		
5	Kernels per row	35.67	31.67		
6	Total kernel mass/kg	5.13	3.21		
7	Moisture %	9	7.7		
8	Dry Kernel mass/kg	4.67	2.96		
9	Mass per kernel (g)	0.29	0.29		
10	No. significant sec cobs	1.00	1.00		
11	Kernel rows per cob	13.50	9.33		
12	Kernels per row	26.75	29.33		
13	Total kernel mass/kg	0.10	0.11		
14	Moisture %	10.50	9.70		
15	Dry Kernel mass/kg	0.09	0.10		
16	Mass per kernel (g)	0.24	0.27		
17	(8+15) total kernel mass	4.76	3.06		
18	Yield per hectare kg	5286	3402	6722	5277
19	Cult: yield as % of Control	155.37		127.3	

TABLE A1.6 Field data from Omnia Farms

Block No. 10		Sample		Omnia	
		Cultivar	Control	Cultivar	Control
V/N SvVlei Besproeiing		PAN 6480	A 1556	PAN 6480	A 1556
1	No. plants 10m	23.33	24.33		
2	Plant population per ha	25921	27033		
3	No. significant first cobs	22.17	21.17		
4	Kernel rows per cob	12.50	13.50		
5	Kernels per row	36.17	28.83		
6	Total kernel mass/kg	3.48	4.44		
7	Moisture %	7	7.5		
8	Dry Kernel mass/kg	3.24	4.11		
9	Mass per kernel (g)	0.29	0.26		
10	No. significant sec cobs	14.50	4.00		
11	Kernels rows per cob	13.17	14.00		
12	Kernel per row	31.33	38.25		
13	Total kernel mass/kg	1.77	0.59		
14	Moisture %	8.05	8.20		
15	Dry Kernel mass/kg	1.63	0.54		
16	Mass of 1 kernel	0.39	0.33		
17	(8+15) total kernel mass	4.86	4.65		
18	Yield per hectare kg	5404	5165	5069	5937
19	Cult: yield as % of Control	104.631		85.38	

TABLE A1.7 Field data from Omnia Farms

Block No. 11		Sample		Omnia	
		Cultivar	Control	Cultivar	Control
V/N SvVlei K 1 & 2		PAN 6364	A 1556	PAN 6364	A 1556
1	No. plants 10m	22.00	27.33		
2	Plant population per ha	24444	30366		
3	No. significant first cobs	25.16	24.33		
4	Kernel rows per cob	13.80	13.50		
5	Kernels per row	36.33	38.83		
6	Total kernel mass/kg	3.96	4.97		
7	Moisture %	8.9	8.5		
8	Dry Kernel mass/kg	3.61	4.55		
9	Mass per kernel (g)	0.38	0.28		
10	No. significant sec cobs	12.16	2.00		
11	Kernel rows per cob	13.16	13.00		
12	Kernels per row	28.66	35.60		
13	Total kernel mass/kg	1.35	0.27		
14	Moisture %	9.10	7.40		
15	Dry Kernel mass/kg	1.23	0.25		
16	Mass per kernel (g)	0.33	0.28		
17	(8+15) total kernel mass	4.83	4.80		
18	Yield per hectare kg	5371	5330	4541	4930
19	Cult: yield as % of Control	100.77		92.11	

TABLE A1.8 Field data from Omnia Farms

	Block No. 12	Sample		Omnia	
		Cultivar	Control	Cultivar	Control
	V/N SvVlei KT3	CRN 3818	A 1556	CRN 3818	A 1556
1	No. plants 10m	44.33	45.33		
2	Plant population per ha	49255	50366		
3	No. significant first cobs	39	40.17		
4	Kernel rows per cob	12.67	13.50		
5	Kernels per row	93.67	37.83		
6	Total kernel mass/kg	7.01	7.29		
7	Moisture %	7.6	7.6		
8	Dry Kernel mass/kg	6.48	6.74		
9	Mass per kernel (g)	0.32	0.33		
10	No. significant sec cobs	6.40	2.50		
11	Kernels rows per cob	3.80	13.00		
12	Kernel per row	28.40	24.00		
13	Total kernel mass/kg	0.74	0.27		
14	Moisture %	8.70	8.40		
15	Dry Kernel mass/kg	0.68	0.25		
16	Mass per kernel (g)	0.26	0.28		
17	(8+15) total kernel mass	7.16	9.98		
18	Yield per hectare kg	7949	7759	6402	7236
19	Cult: yield as % of Control	102.42		88.48	

TABLE A1.9 Field data from Omnia Farms

Block No. 13		Sample		Omnia	
		Cultivar	**Control**	**Cultivar**	**Control**
V/N SvVlei Kt 4a		**CRN 4512**	**A 1556**	**CRN 4512**	**A 1556**
1	No. plants 10m	39.67	51.50		
2	Plant population per ha	44077	57221		
3	No. significant first cobs	38.67	47.83		
4	Kernel rows per cob	-	-		
5	Kernels per row	-	-		
6	Total kernel mass/kg	7.76	10.43		
7	Moisture %	11.18	8.9		
8	Dry Kernel mass/kg	6.89	9.5		
9	Mass per kernel (g)	0.36	0.36		
10	No. significant sec cobs	3.50	1.33		
11	Kernel rows per cob	-	-		
12	Kernels per row	-	-		
13	Total kernel mass/kg	0.46	0.25		
14	Moisture %	0.15	7.80		
15	Dry Kernel mass/kg	0.46	0.23		
16	Mass per kernel (g)	0.29	0.33		
17	(8+15) total kernel mass	7.35	9.73		
18	Yield per hectare (kg)	8168	10813	7482	7901
19	Cult: yield as % of Control	75.54		94.7	

TABLE A1.10 Field data from Omnia Farms

Block No. 14		Sample		Omnia	
		Cultivar	**Control**	**Cultivar**	**Control**
V/N SvVlei Kt 4b		**CRN 3816**	**A 1556**	**CRN 3816**	**A 1556**
1	No. plants 10m	49.33	50.50		
2	Plant population per ha	54810	56110		
3	No. significant first cobs	45.33	46.5		
4	Kernel rows per cob	-	-		
5	Kernels per row	-	-		
6	Total kernel mass/kg	9.36	9.89		
7	Moisture %	7.6	8.7		
8	Dry Kernel mass/kg	8.65	9.03		
9	Mass per kernel (g)	0.34	0.34		
10	No. significant sec cobs	4.40	4.00		
11	Kernels rows per cob	-	-		
12	Kernel per row	-	-		
13	Total kernel mass/kg	0.54	0.49		
14	Moisture %	9.00	0.00		
15	Dry Kernel mass/kg	0.49	0.49		
16	Mass of 1 kernel	0.28	0.28		
17	(8+15) total kernel mass	9.14	9.52		
18	Yield per hectare kg	10155	10557	7986	8319
19	Cult: yield as % of Control	96.01		95.99	

TABLE A1.11 Field data from Omnia Farms

Block No. 15		Sample		Omnia	
		Cultivar	Control	Cultivar	Control
V/N SvVlei Kt 5		CRN 3584	A 1556	CRN 3584	A 1556
1	No. plants 10m	33.00	55.67		
2	Plant population per ha	36666	61854		
3	No. significant first cobs	28.83	40.33		
4	Kernel rows per cob	12.67	14.83		
5	Kernels per row	35	34.67		
6	Total kernel mass/kg	4.97	6.36		
7	Moisture %	8	7.8		
8	Dry Kernel mass/kg	4.57	5.86		
9	Mass per kernel (g)	0.34	0.32		
10	No. significant sec cobs	2.80	-		
11	Kernel rows per cob	12.00	-		
12	Kernels per row	28.80	-		
13	Total kernel mass/kg	0.34	-		
14	Moisture %	8.60	-		
15	Dry Kernel mass/kg	0.31	-		
16	Mass per kernel (g)	0.30	-		
17	(8+15) total kernel mass	4.88	5.86		
18	Yield per hectare kg	5425	6515	5194	5416
19	Cult: yield as % of Control	83.27		95.89	

TABLE A1.12 Field data from Omnia Farms

Block No. 16		Sample		Omnia	
		Cultivar	Control	Cultivar	Control
V/N SvVlei Kt 6		A 1598	A 1556	A 1598	A 1556
1	No. plants 10m	36.83	57.33		
2	Plant population per ha	40921	63699		
3	No. significant first cobs	28.67	45.83		
4	Kernel rows per cob	-	-		
5	Kernels per row	-	-		
6	Total kernel mass/kg	4.66	7.35		
7	Moisture %	9.4	7.35		
8	Dry Kernel mass/kg	4.3	6.8		
9	Mass per kernel (g)	0.28	0.31		
10	No. significant sec cobs	5.67	-		
11	Kernels rows per cob	-	-		
12	Kernel per row	-	-		
13	Total kernel mass/kg	0.70	-		
14	Moisture %	9.20	-		
15	Dry Kernel mass/kg	0.63	-		
16	Mass per kernel (g)	0.25	-		
17	(8+15) total kernel mass	4.90	6.80		
18	Yield per hectare kg	5485	7566	5000	6904
19	Cult: yield as % of Control	72.48		72.42	

TABLE A1.13 Field data from Omnia Farms

Block No. 17		Sample		Omnia	
		Cultivar	Control	Cultivar	Control
V/N SvVlei Kt 7		CRN 3414	A 1556	CRN 3414	A 1556
1	No. plants 10m	54.33	48.00		
2	Plant population per ha	60366	53333		
3	No. significant first cobs	48.33	44.5		
4	Kernel rows per cob	-	-		
5	Kernels per row	-	-		
6	Total kernel mass/kg	8.03	8.74		
7	Moisture %	8.05	8		
8	Dry Kernel mass/kg	7.38	8.04		
9	Mass per kernel (g)	0.31	0.35		
10	No. significant sec cobs	7.40	9.50		
11	Kernel rows per cob	-	-		
12	Kernels per row	-	-		
13	Total kernel mass/kg	0.80	1.57		
14	Moisture %	8.42	8.10		
15	Dry Kernel mass/kg	0.73	1.44		
16	Mass per kernel	0.28	0.30		
17	(8+15) total kernel mass	8.12	9.48		
18	Yield per hectare kg	9017	10537	8583	10347
19	Cult: yield as % of Control	85.58		82.72	

TABLE A1.14 Field data from Omnia Farms

Block No. 18		Sample		Omnia	
		Cultivar	Control	Cultivar	Control
V/N SvVlei Kt 1		A 1650	A 1556	A 1650	A 1556
1	No. plants 10m	40.17	49.67		
2	Plant population per ha	44632	55188		
3	No. significant first cobs	36.67	45.33		
4	Kernel rows per cob	11.83	13.17		
5	Kernels per row	34.67	37.35		
6	Total kernel mass/kg	5.98	8.75		
7	Moisture %	7.8	7.5		
8	Dry Kernel mass/kg	5.51	8.09		
9	Mass per kernel (g)	0.31	0.34		
10	No. significant sec cobs	4.20	1.00		
11	Kernels rows per cob	13.20	12.00		
12	Kernel per row	26.25	31.00		
13	Total kernel mass/kg	0.42	0.09		
14	Moisture %	8.70	9.10		
15	Dry Kernel mass/kg	0.38	0.09		
16	Mass per kernel (g)	0.29	0.28		
17	(8+15) total kernel mass	5.90	8.18		
18	Yield per hectare kg	6552	9092	6250	7555
19	Cult: yield as % of Control	72.05		72.72	

TABLE A1.15 Field data from Omnia Farms

Block No. 19		Sample		Omnia	
		Cultivar	Control	Cultivar	Control
V/N SvVlei Kt 5b		A 1650	A 1556	A 1650	A 1556
1	No. plants 10m	34.83	47.33		
2		38699	5258		
3	No. significant first cobs	27.33	38.67		
4	Kernel rows per cob	14.17	13.50		
5	Kernels per row	38	36.5		
6	Total kernel mass/kg	4.6	7.30		
7	Moisture %	11.8	7.3		
8	Dry Kernel mass/kg	4.07	6.77		
9	Mass per kernel	0.33	0.37		
10	No. significant sec cobs	2.00	1.00		
11	Kernelrows per cob	10.00	12.00		
12	Kernels per row	19.00	21.00		
13	Total kernel mass/kg	0.19	0.16		
14	Moisture %	12.60	8.00		
15	Dry Kernel mass/kg	0.17	0.15		
16	Mass per kernel	0.29	0.15		
17	(8+15) total kernel mass	4.24	6.91		
18	Yield per hectare kg	4712	7682	2916	3972
19	Cult: yield as % of Control	61.33		73.43	

TABLE A1.16 Field data from Omnia Farms

Block No. 20		Sample		Omnia	
		Cultivar	Control	Cultivar	Control
V/N SvVlei Kt 6		A 210	A 1556	A 210	A 1556
1	No. plants 10m	36.00	38.83		
2	Plant population per ha	39999	43144		
3	No. significant first cobs	25.5	30		
4	Kernel rows per cob	13.83	13.67		
5	Kernels per row	35.67	35.83		
6	Total kernel mass/kg	4.37	5.38		
7	Moisture %	9.3	7.6		
8	Dry Kernel mass/kg	3.9	5.1		
9	Mass per kernel	0.32	0.34		
10	No. significant sec cobs	3.33	3.33		
11	Kernel rows per cob	11.33	12.00		
12	Kernels per row	19.33	21.33		
13	Total kernel mass/kg	0.34	0.31		
14	Moisture %	9.20	9.30		
15	Dry Kernel mass/kg	0.34	0.28		
16	Mass per kernel (g)	0.30	0.27		
17	(8+15) total kernel mass	4.30	5.44		
18	Yield per hectare kg	4777	6040	3506	4340
19	Cult: yield as % of Control	79.08		80.8	

TABLE A1.17 Field data from Omnia Farms

Block		3	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Cultivar		A 1849	CRN 3414	CRN 3839	CRN 4221	PAN 6549	PAN 6480	PAN 6364	CRN 3818	CRN 4512	CRN 3816	CRN 3584	A 1598	CRN 3414	A 1650	A 1650	a 210
Lodge/ Plant	Cultivar	34	1	23	67	16	13	19	48	68	32	13	48	46	23	59	39
	control	36	2	62	57	24	2	7	13	19	29	33	43	16	13	50	14
Stalk bor	Cultivar	4	3	4	0	5	15	9	1	0	6	9	0	0	17	3	1
	control	0	16	0	0	4	9	10	11	2	5	12	7	0	55	9	10
Diplodia/crobot	Cultivar	0	3	0	2	7	0	3	4	7	8	0	2	4	2	3	5
	control	6	1	0	3	1	0	3	4	3	2	8	0	4	5	3	5

APPENDIX B

SURVEY OF MAIZE PLANT POPULATION ON A COMMERCIAL FARM

INTRODUCTION

A commercial farming operation (OMNIA FARMING, MIDDLEBURG) requested the University of Pretoria to assist in estimating maize plant populations on various fields, identifying reasons for sub-optimal or uneven plant populations, and ultimately quantifying the effect of plant population on yield.

OBJECTIVES

To determine plant population in 16 blocks cultivated under commercial farming conditions and to chech of the planters used in planting process.

PROCEDURE

Blocks of A.1849, PAN.6479, CRN.3816 hybrid maize were planted on a commercial scale in the Wonderfontein area by OMNIA Farming (PTY) Ltd during summer of 1994/95. The cultivars were planted in 16 blocks. During December 1994, plant population cultivar and control rows were counted in sub –plots consisting of 30m each. The plant population was estimated by counting number of plants per 30m row length in each of the 8 rows. Due to the difference observed between the plant population in the field and the target plant population, testing of the planters was carried out.

RESULT AND DISCUSSION

The results of the plant population survey are summarized in Table B1 and planter testing in Table B2.

Plant population varied among the blocks from less than 18 000 to more than

30 000. The average plant population obtained was 85% of the target density. (Refer to population trials)

The testing of planters showed that none of planters tested was adjusted properly in order to satisfy the requirements of the target population (35 000 plants /ha). This is the main reason of the low populations observed.

Table B1. Number of plants per ha during field survey (Population expressed as percentage of the target density of 35 000 plants)

BLOCK	CULTIVAR	%	CONTROL	%
Elf East	28595	82	29328	84
Elf bock 2kt3	31161	89	30428	87
Elf bock 3kt2	30061	85	29695	85
Elf bock dkt3	32261	92	30794	89
Suvlei kt2	30794	87	29695	85
Suvlei kt3	30428	87	30428	87
Suvlei kt4	32627	93	28595	81
Suvlei kt6	30625	83	28228	81
Combrik block 2	28595	81	30428	87
Combrik block 3	24924	71	17597	50
Combrik block 4	30428	87	26395	75
Combrik block 5	30061	85	28961	82
MEAN	30.047	85%	28.381	81%

Table B2. Number of seeds per 30m row obtained during testing of planters.

Planter No.1:			Target 105 kernels per 30 m row	
	1.1	1.2	1.3	1.4
CRN " 4523	91	87	92	66
PNA " 6043	88	76	90	65
A " 1819	89	90	94	79
Planter No.2:			Target 120 kernels per 30 m row	
	2.1	2.2	2.3	2.4
CRN " 4523	102	113	123	116
PNA " 6043	88	119	110	116
A " 1819	116	121	117	124
Planter No.3:			Target 120 kernels per 30m row	
	3.1	3.2	3.3	3.4
CRN " 4523	96	79	84	92
PNA " 6043	95	82	80	89
A " 1819	95	92	91	92

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