Bioscience Research Communications
Vol. 13, No. 2, April 30, 2001
Printed in Nigeria

0795-8072/2001 $3.00 + 0.00

BRC 99123/13211

Effect of Plant Population Density on Growth and Development of Maize (*Zea mays* L.) in Ibadan, Southwestern Nigeria

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(Received August 18, 1999)

ABSTRACT: The effect of plant population density on growth experiment was carried out in 1992 during the first maize growing season (June - Sept.) in Ibadan, Nigeria ($7^{o}24'$ $3^{o}48'$E). The row spacing was 60cm for all the three treatments and the interrow spacing was 75, 90 and 120 to give three different plant population densities of 88,888 pl/ha, 74,074 pl/ha and 55,555 pl/ha with one plant per stand with 20% and 33.3% incremental rate between plant population densities.

All the three growth parameters measured recorded no significant differences aming the three plants population densities (88,000, 72,000 and 55,000 plants/ha) throughout the period of the experiment. Although the highest and medium plant population densities (88,000 and 74,000 plants/ha) had higher values than the lowest plant population density (55,000 plants/ha).

Key Words: Population density; Maize (*Zea mays*); Growth and development; Farming management practices.

Introduction

Maize (*Zea mays*) originated in South and Central America, but its cultivation has today spread to nearly all parts of the world. Maize was introduced to West Africa by the Portuguese in the 16th century (Onwueme, 1979) where it is used for both human and livestock consumption. Maize grain, on the average, contains 60% starch, 13% water, 10% protein, 41% oil, 2% sugar and31% fibre. Yellow maize contains vitamin B complex in addition to the above-mentioned constituents ((Stephen *et al*., 1876). In Nigeria, the grain is used for human consumption in either boiled or roasted form. Dry maize is milled for local dishes such as ogi (pap) or as staple food. It can also be milled and mixed with other ingredients to serve as livestock feeds. Nigeria produces about 1 million tons of maize annually ((Lucas, 1981).

This amount is below the country's total requirement since substantial quantities are still being imported and efforts are being made to increase local production. Most farmers in the humid tropics grow their crops at random spacing as sole crop or as intercrop which involves two or more crops together. These crops are introduced onto a piece of land at various times and allowance is usually made for such introduction. However, as management practice improves and more farmers grown sole crops, specific

plant population is adapted. The situation becomes more and more complicated when the farmers sow 3 to 5 grains per stand without thinning. Plants growing at too close ranges can reduce the growth and development of each other due to competition for nutrient, light and water. Subsequently, the plant metabolic rate is reduced, and this will have a drastic effect on growth.

More severe deficit in these factors, especially water, can permanently reduce the capacity for growth and development. The mechanism whereby this interaction influences the viability of the developing stem is not yet understood (Hawkins and Cooper, 1981). A survey of farming activities in the forest zone of Nigeria reported that one-third of farmers used a spacing of about 90 cm with 2 to 3 plants per stand. A small proportion (24%) reported a modified spacing of 90 cm by 60 cm, 15% used 75 by 75 and none used the recommended 90 by 30, with one plant per stand. Such management practices are bound to affect the crops (Remission and Lucas, 1982).

As part of efforts to monitor the performance of maize growth, observations were made on maize planted at three levels of density, based on personal communications with farmers at different locations within Ibadan metropolis. On the average, a minimum spacing of 60 cm x 75 cm and a maximum spacing of 60 cm x 120 cm was the traditional practice by the farmers interviewed. However, this experiment intends to use a slightly variable form of densities as earlier mentioned with a spacing of 60 cm by 75 cm, 60 cm by 90 cm and 60 cm by 120 cm, with one plant per stand in each case.

Materials and Methods

An experiment was carried out on the effect of plant population density on yield in 1992 during the first maize growing season (June - Sept.). Usually, the first growing season starts from March/April, but because of the shift in the rains in 1992, planting was delayed. the field experiment was conducted at the Nigerian Institute of Science and Technology (NIST) experimental farm in Ibada ($7^{o}24'$N, $3^{o}48'$E) (Lucas, 1986). Using the 90 days open pollinated white hybrid maize seed variety TZPB. The soil characteristics and nutrients status for Ibadan have been described by Titiloye *et al*. (1985). The soil is known to be low in nitrogen (0.15%). The NIST experimental farm has been fallow for the previous three years before the experiment was conducted.

The land was prepared by clearing and ploughing by hand. After preparation, the maize variety was sown by hand on the 30th of May, 1992, on a flat land at the rate of four seeds per hole as suggested by Lucas (1986). Immediately after two weeks of emergence as practised by the local farmers and observed by Muleba *et al*. (1983), the seedlings were thinned to one plant per stand. The row spacing was 60 cm for all the three treatments and the interrow spacing was 75, 90 and 120 to give three different plant population densities of 88,888 pl/ha, 74,074 pl/ha and 55,555 pl/ha. One plant per stand with 20% and 33.3% incremental rate between plant population densities was used. No nitrogen fertilizer was applied in the experiment.

The experiment was randomised complete block design (one variety by three (3) densities) with four (4) replications. the plot size was 11.8 cm by 10.6 cm with one metre between each replication block. Planting was done at the edges leaving one metre between the uncleared land and the experimental plots. the plots were regularly weeded. The first random sampling was done thirty days after sowing, with fortnight sampling for the subsequent measurement giving a total of five samples taken up to maturity and harvest. Each replicate consisted of two plants whose mean were later determined. The block served as replicates, giving eight plants per treatment, and average of twenty-four plants for the three treatments. Average values for plants in each replicate was taken and used for analysis. Sample size was twelve plants.

On the field, sample measurements were taken for the following parameters: number of leaves, stem height measured from base to beginning of tassel branching, leaf area was taken by multiplying the length by the widest part of the leaf and average value was obtained per plant. Date of anthesis was determined from the number of days from planting to 50% pollen production.

Throughout the period of the experiment, rainfall was adequate and well distributed. The experiment fell outside the period of drought (March - May) which was experienced in Ibadan that year.

Statistical Analysis

Statistical analysis was carried out by two way analysis of variance from which least significant difference (LSD) at 5% level was calculated.

Results

Effect of plant population density on growth and development of maize

In this experiment, the growth characters measured, viz. number of leaves, stem height and leaf area reached their maximum value at the same time, 10 weeks after planting (WAP) in the three plant population densities (densities of 55,000; 74,000 and 88,000 plants/ha) and declined thereafter (Figs. 1-3). The decline in all the plant population densities occurred 2 weeks after anthesis (date of anthesis 8 WAP).

All the three growth parameters recorded no significant difference among the three plant population densities (88,000; 74,000 and 55,000 plants/ha) throughout the period of the experiment, although the 88,000 and 74,000 plants/ha population densities had higher values than the 55,000 plants/ha population density.

In spite of the lack of significant difference, the medium plant population density (74,000 plants/ha) had the highest value than the highest and lowest population densities (Fig. 2). In leaf area, the highest plant population density had the highest value than the lowest density, beginning 6 WAP till plant maturity, although the difference was not significant (Fig. 3). In stem height, the values for the highest and lowest population densities overlapped after declining.

Discussion

The results of this study indicate that the number of leaves, stem height and leaf area did not vary significantly among the three plant population densities throughout the period of the experiment. However, the parameters showed higher value with increasing plant population densities although at a very low proportion and declined at the same time (at grain filling stage) but at different rates which is 2 weks after anthesis (anthesis date was 8 WAP). The rate and period of growth and decline was dictated by a number of factors taking place on the onset of anthesis which is a physiological phenomenon.

During the period of anthesis, high amount of growth and development factors such as nitrogen and hormones are required for cell division to produce pollen and synthesis of stored food materials, in maize grain. To achieve good quality, such nutrients are then mostly diverted from growth of vegetative characters to synthesis and development of maize grain. generally, it was reported byTitiloye *et al*. (1985) that the nitrogen level in the southern part of Nigeria was as low as 0.15% which is far below what is required for optimum growth of maize. This situation complicates the rate of growth and development in the highest plant population density where competition is high among plants for nutrients which was in limited supply and most likely to be leached or washed off due to high amount of rainfall. This situation imposes some stress among the plants and leads to deteriorative processes of growth and development of number of leaves, stem height and leaf area expansion, whose growth were simultaneous and were found to have a highly positive correlation with grain yield as indicated by Lucas (1981) and Muleba *et al.* (1983).

Plant height increased to a maximum and then decreased with increasing plant population density (Fig. 2). This trend was also reported by Stinson and Moss (1960), Early *et al*. (1966) and by Tetio-Kagho and Gardner (1998). Plant height was greatest at the highest population density. Internode elongation (etiolation) due to shade effect is believed to be an auxin response based on the theory that there is photodestruction of auxin at high irradiance, which results in reduced plant height (Leopold and Kriedemann, 1975). However, the decrease of plant height at ultra high plant population density was probably associated with limitation of assimilate; mineral water was, perhaps, not a factor.

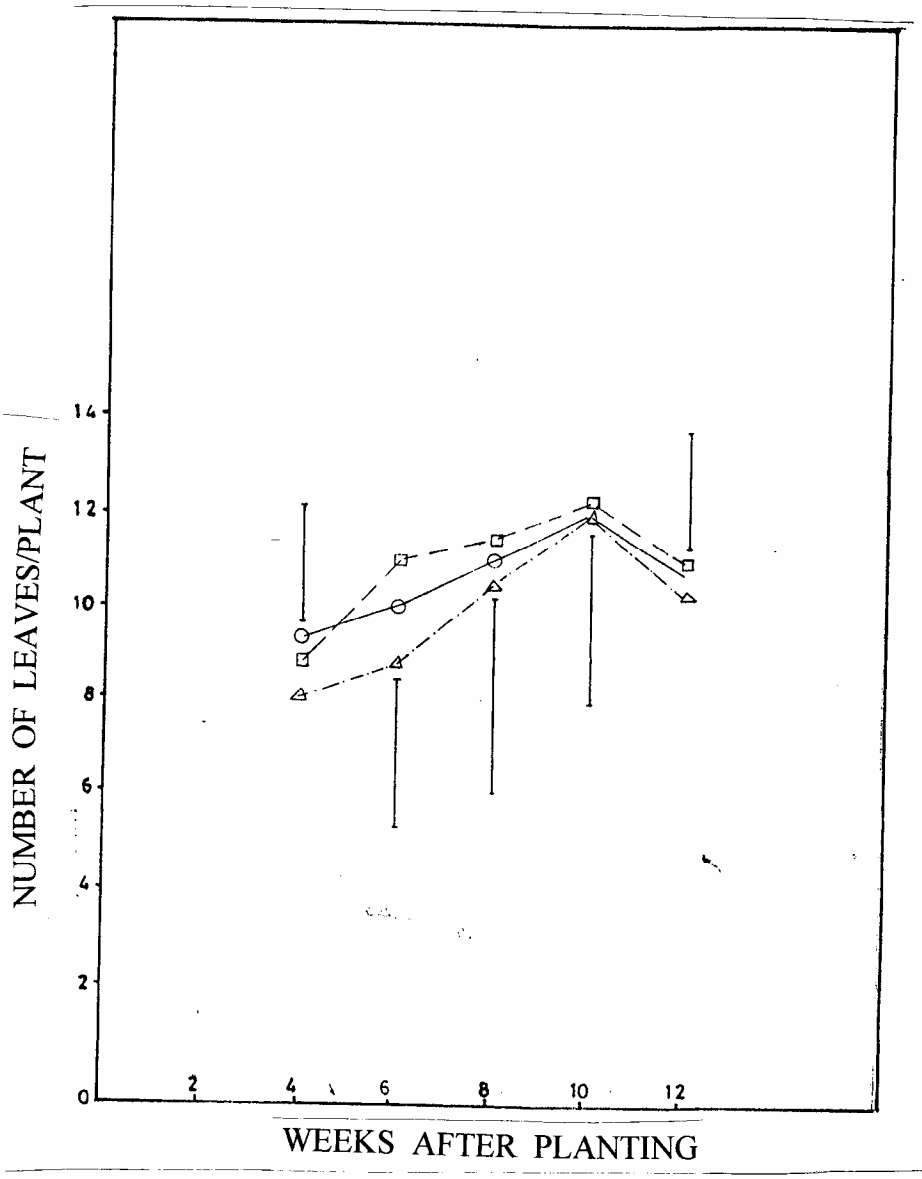


Fig. 1: The effect of plant population density on number of leaves/plant in maize cv TZPB grown in Ibadan in 1992. (O) T_1 60 x 75 cm; (□) T_2 60 x 90 cm; (Δ) T_3 60 x 120 cm. Vertical bars represent L.S.D. (P = 0.05)

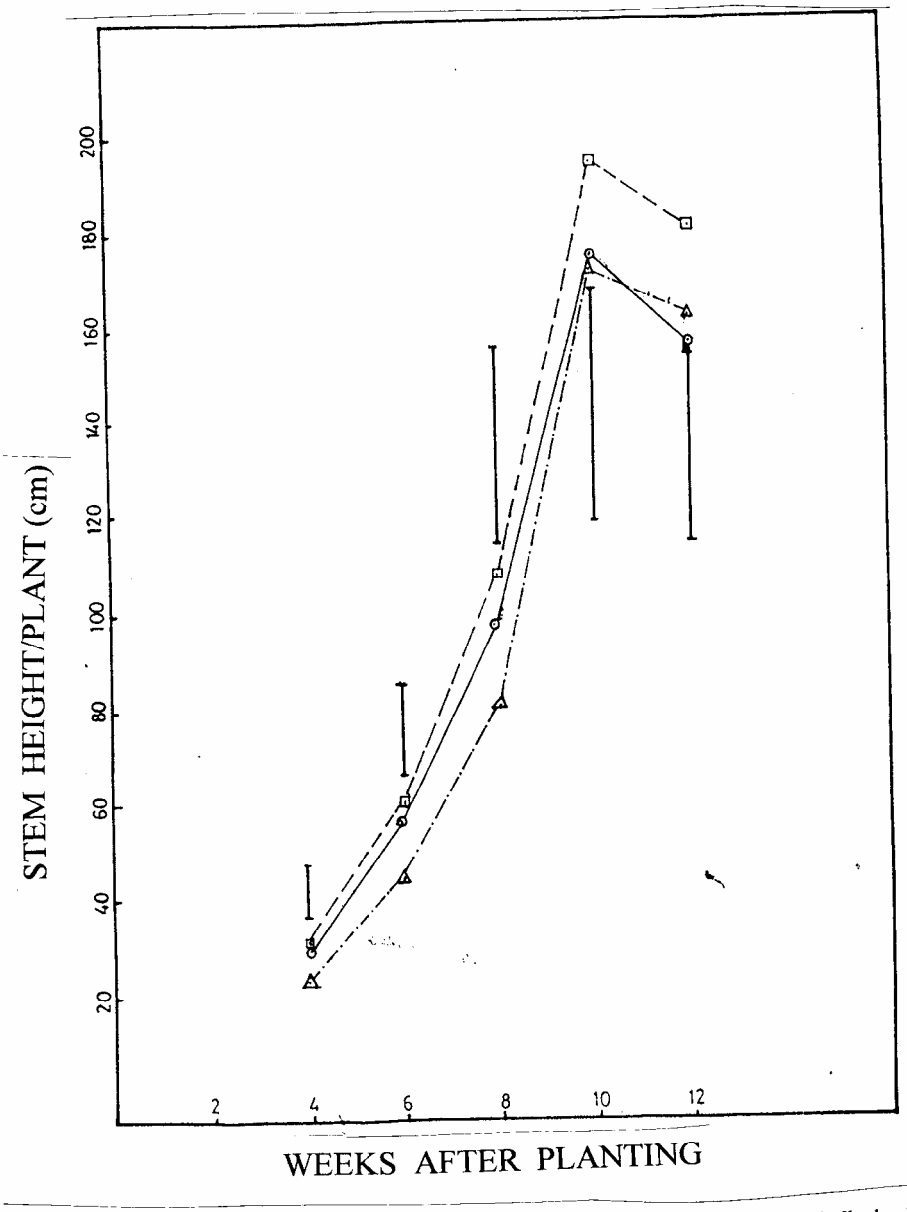
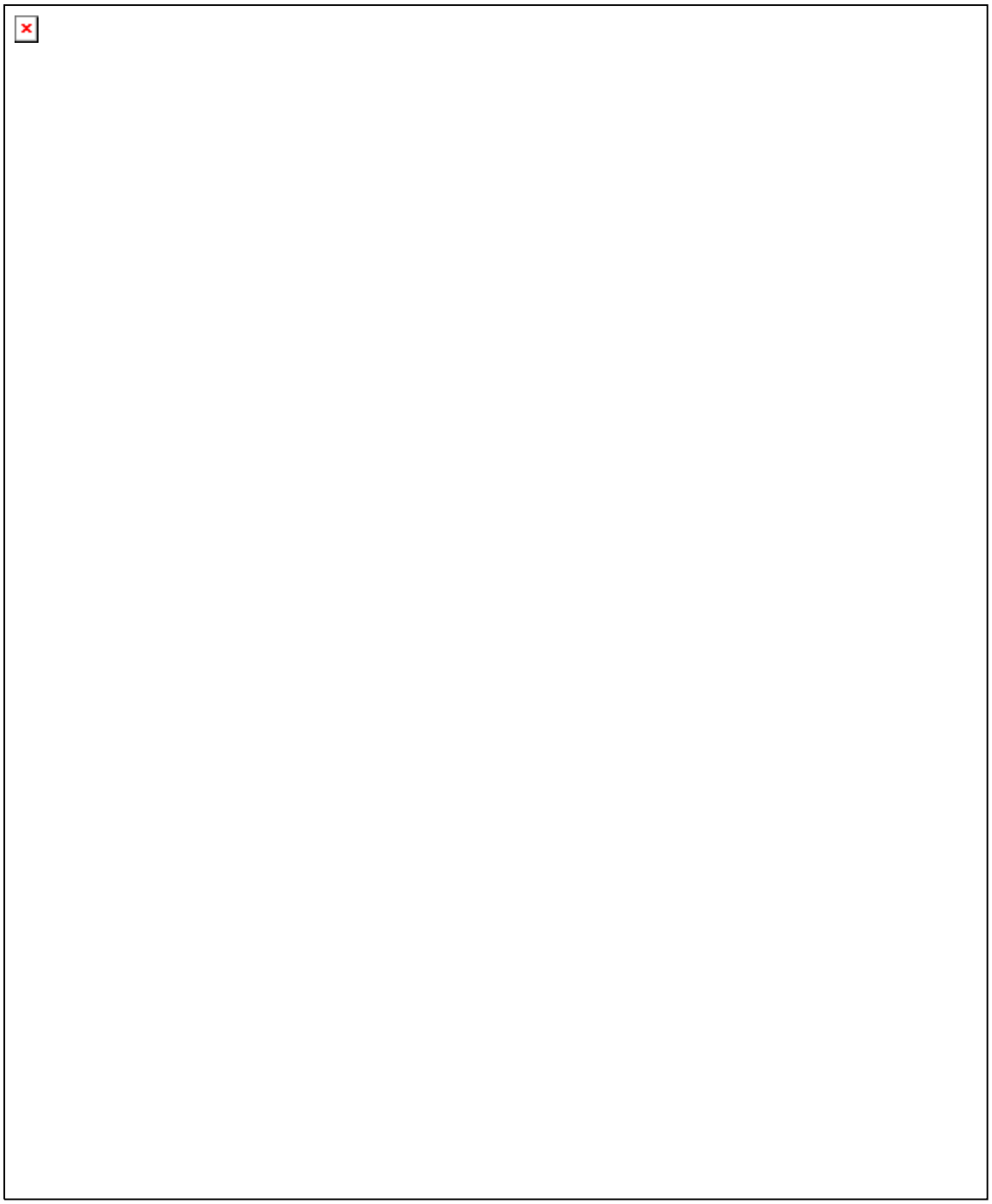


Fig. 2: The effect of plant population density on stem height/plant in maize cv TZPB grown in Ibadan in 1992. (O) T_1 60 x 75 cm; (□) T_2 60 x 90 cm; (Δ) T_3 60 x 120 cm. Vertical bars represent L.S.D. (P = 0.05)



Competition for growth factors like nitrogen (which was low), added to light reduction in the lower canopy probably inhibited stem growth in the highest plant population density. These findings contrast with those of Lucas (1986) where the highest number of leaves was found in the widest spacing. Such a situation can only happen if the required nutrients was restricted to the widest density and below requirement of the highest density.

The density of 88,000 plants/ha will seem adequate for maize in this ecological zone. Although this density of planting is lower than the one reported for optimum growth for temperate maize by Milbourn *et al*. (1978), it is however higher than the density recommended in this country for maize which ranges from 51,000 to 73,000 plants/ha. The optimum growth at the highest population density can be improved given a good cultural practice by farmers in Ibadan, such as crop rotation, mulcing to prevent leaching and the application of the appropriate amount of nitrogen fertilizer under optimum temperature and moisture which was not used in this experiment and is difficult to recommend. Lucas (1986) obtained a similar result of 7.5 t/ha at a population density of 80,000 plants/ha with the application of fertilizer and indicated that there is still room for improvement through cultural practice. However, other findings by Lucas *et al*. (1986) recommended that doubling the rate of fertilizer from 75 kg/ha as suggested by Fayemi (1986), Agboola (1968) and Jones (1973) to 150 kg/ha will give more revenue to farmers in this part of the country. Consideration should also be given to the current price of fertilizer in the market. A population density of 88,000 plants/ha will be adequate for growing maize in Ibadan, South-Western Nigeria.

ACKNOWLEDGEMENTS: The author wishes to thank Dr. A. O. Togun of the Department of Agricultural Biology, University of Ibadan, and Dr. A.I. Sanni of the Department of Botany and Microbiology, University of Ibadan, for their supervision and advice. Thanks are also due to the Registrar, Nigerian Institute of Science Technology, Mr. S. O. Onifade, for his permission to use their experimental farm. The University of Maiduguri sponsored the author's study at NIST for which gratitude is also expressed.

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