Effects of spacing/number of plants per stand and fertilizer placement on performance of two maize varieties intercropped with cowpea in the forest zone of Nigeria

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SUMMARY

Two maize varieties, TZB and Kewesoke, intercropped with cowpea were grown in 1985 and 1986 planting seasons at spacings of 90 cm × 30 cm/ plant per stand, 90 cm × 60 cm/two plants per stand, and 90 cm × 90 cm/ three plants per stand. Fertilizer was placed 5 cm away from maize rows and midway between maize and cowpea rows. Plant height, number of leaves formed, leaf area index, yield components, phosphorus and potassium contents per plant were highest at spacing of 90 cm × 30 cm/ plant per stand. Phosphorus and potassium contents per plant and yield components were higher with fertilizer placed 5 cm away from maize rows than the one placed midway between maize and cowpea rows. There were some interactions between spacing and fertilizer placement. There were no significant differences between the two varieties except in height. There were positive correlations between leaf area index, NPK and total grain yield.

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RÉSUMÉ

AJAYI, M. T.: *Effets de l'écartment/nombre de plantes sur pied et la distribution de l'engrais sur la performance de deux varietés du maïs intercallé avec de la lièbe dans la zone forestière du Nigeria.* Deux variétés du maïs, TZB et Kewesoke, intercallé avec de la lièbe ont été cultivées dans la saison de culture en 1985 et 1986 à des écartments de 90 cm × 30 cm/ plante sur pied, 90 cm × 60 cm/2 plantes sur pied et 90 cm × 90 cm/3 plantes sur pied. L'engrais a été placé à 5 cm des lignes de plantes du maïs et a michemin entre les lignes de plantes du mais et de la lièbe. La taille de la plante, le nombre des feuilles formées, l'indice de l'aire de la feuille, des éléments du rendement, des teneurs en phosphore et potassium des plantes étaient plus élevés à l'écartment de 90 cm × 30 cm/ plante sur pied. Les teneurs en phosphore et potassium par plante et des élements du rendement étaient plus élevés avec l'engrais placé à 5 cm des lignes du maïs que ceux placé à mi-chemin entre les lignes du maïs et de la lièbe. Il y a eu des intéractions entre l'écartment/nombre des plantes sur pied et l'engrais. Il n'y a pas eu des différences importantes entre les deux variétiés sauf dans leurs tailles. Il y a eu des corrélations positives entre l'indice de l'aire de la feuille, NPK et le rendement total.

Introduction

Mixed or intercropping is the dominant system of tropical subsistence farming. Norman (1972) listed 24 different crops that were grown in 174 different crop enterprises in one sample area of northern Nigeria. Less than 17 per cent of these consisted of sole crops. The farmers grew their crop at wide and random spacing with varying number of plants per stand. Seeds were sown up to 3-5 per stand without thinning in many of the farms. Bartlett (1980) reported from his survey of farming practices in the forest zone of Nigeria, that some farmers used spacings of 90 cm × 90 cm, 90 cm × 60 cm, and 75 cm × 75 cm with two to three plants per stand in all without any one using 90 cm × 30 cm with one plant per stand.

The problem of optimum spacing for maximum yield of maize had received the attention of many researchers (Fayemi, 1963; Bolton, 1971; Wilson & Alison, 1978), but farmers were still reluctant to

accept the recommended spacings of 90 cm × 30 cm in Nigeria. Bolton (1971) compared the yields of three varieties of maize in Tanzania at spacings of 45, 30 and 15 cm on the row and found that the highest yields were obtained from 30 cm spacing, which was the recommended spacing to farmers in Tanzania.

Agboola (1967) and Okigbo (1973) made various recommendations of placement of fertilizer for agronomic crop. The importance of placement would not be the same for nitrogen, phosphorus and potassium because of their different chemical properties. In developing countries where farmers cannot afford to spend too much money on fertilizer, it is important to optimize the use of little that can be afforded by placing it in a position where it would be easily accessible to the growing crops, especially when intercropped with any other crops.

Genotypes may differ in their responses to various cultural practices. It is therefore desirable to evaluate the standard cultural practices as new varieties are evolved. Takyi (1967, 1969) as cited by Koli (1971), investigated the effect of spacing on maize and concluded that the optimum spacing for maize depended on the variety, nitrogen level of the soil and the site of the experiment.

This study aimed to investigate the effect of spacing/number of plants per stand and method of fertilizer placement on maize when intercropped with cowpea.

Materials and methods

The study was carried out in 1985 and 1986 early planting seasons at NARDES farm at Moniya, about 10 km from Ibadan in the forest zone of Nigeria with an annual bimodal rainfall of about 1150 and 1200 mm with a break in July/August. The sandy loam soil was fairly uniform throughout the experimental plots. The maize varieties used were the composite medium maturing, and high yielding TZB, and the lodging resistant and early maturing Kewesoke. The Ife - brown cowpea variety, mostly grown in the forest zone, was intercropped with the maize varieties. The land was prepared by conventional methods of ploughing and harrowing.

The seeds were sown on 15 Apr 85 at spacings of 90 cm × 30 cm with one plant per stand, 90 cm × 60 cm with two plants per stand and 90 cm × 90 cm with three plants per stand. Each of the three spacings gave about 37000 plants per ha. The cowpea rows were planted in between maize rows at 90 cm × 30 cm spacing. A basal application of 200 kg per ha NPK (15:15:15) was placed in bands 5 cm away from the maize rows and midway between maize and cowpea rows.

The experiment was a factorial in a randomized complete block design with treatment combinations replicated three times. There were 36 plots, each plot was 20 m^2 with a 1-m footpath in between plots. Thinning to desired stand was done 2 weeks after sowing. Manual weeding was done at 4 and 6 weeks after planting. There were 22 rows each of maize and cowpea in each plot. Nutrient content of the soil for each plot was determined before the experiment started (Black, 1965). Plant height, number of leaves per plant, and leaf area index (LAI) were determined at 4, 6, 8 and 10 weeks after planting. Ten innermost plants from rows 4, 8, 12, 16 and 20 were used in each plot for data collection.

Plant height was measured as the distance from the ground level to the point where the topmost pair of leaves forked as cited by Haizel & Ahiekpor (1975).

Leaf area was estimated by the equation LA = 0.75 × length × breadth (Saxena & Singh, 1965). LAI was computed as leaf area divided by unit area of ground (Evans, 1972).

Nutrient contents of the plants were determined at period prior to tasselling. The plants were cut at above ground level and weighed before oven-dried. The corresponding dry weights were recorded and used in calculating plant nutrient contents. Nitrogen was determined by the Kjeldahl method, potassium by flame photometer, and phosphorus by emission spectograph.

Ten innermost plants from rows 3, 5, 7, 9 and

11 from each plot were harvested on 16 Aug 85 and used for yield parameters. The yield characters studied were number of seeds per cob, weight of 100 seeds and total grain yield. The experiment was repeated the following year due to inconsistent weather conditions in 1985. Seeds were sown on 17 Apr 86 and harvested on 16 Aug 86. The means for the 2 years were pooled together and used for analysis. Analysis of variance was carried out and LSD was used to compare means.

Results

Morphological and physiological characters

Plant heights of the maize varieties were not significantly affected by the treatments. There was, however, a significant difference in mean plant height of the two varieties. TZB grew taller than Kewesoke (Table 1).

Spacing/number of plants per stand had effect on the number of leaves formed. The spacing 90 cm × 30 cm with one plant per stand produced the highest number of leaves per plant but there was no significant difference between the two other spacings. Fertilizer did not show any significant effect on number of leaves formed but the interaction between spacing and fertilizer placement was significant (Table 1).

LAI increased in both varieties up to the 8th week after sowing before decreasing at the 10th week. The spacing 90 cm × 30 cm with one plant per stand produced the greatest LAI at 4, 6, 8 and 10 weeks after planting in TZB. The spacing effect was only significant at 8th week in Kewesoke (Fig. 1).

TABLE 1

Effect of Spacing/Number of Plants per Stand and Fertilizer Placement on Morphological and Physiological Characters of Two Varieties of Maize

Treatment	*Height (cm)*	*Number of leaves formed per plant*	*Phosphorus content per plant (g)*	*Potassium content per plant (g)*	*Nitrogen content per plant (g)*
Variety					
TZB	121.41*	10.61[a]	1.35[a]	3.17[a]	2.80[a]
Kewesoke	103.77	1.62[a]	1.33[a]	3.03[a]	2.96[a]
Spacing					
90 cm × 30 cm/ plant	114.89*	11.07*	1.64*	3.64*	3.31
90 cm × 60 cm/ 2 plants	112.44[c]	10.22[c]	1.11[c]	2.61[c]	2.62[c]
90 cm × 90 cm/ 3 plants	110.43[c]	10.81[c]	1.27[c]	3.02[c]	2.72[c]
Fertilizer placement					
Between maize and cowpea rows	112.44[b]	10.49[b]	0.98	2.60	2.76[b]
5 cm away from maize	112.73[b]	10.74[b]	1.70*	3.60*	3.01[b]
SE	2.13	1.14	0.097	0.17	0.087

* Significant at $P = 0.05$. Means carrying the same letters are not significantly different from each other at $P = 0.05$.

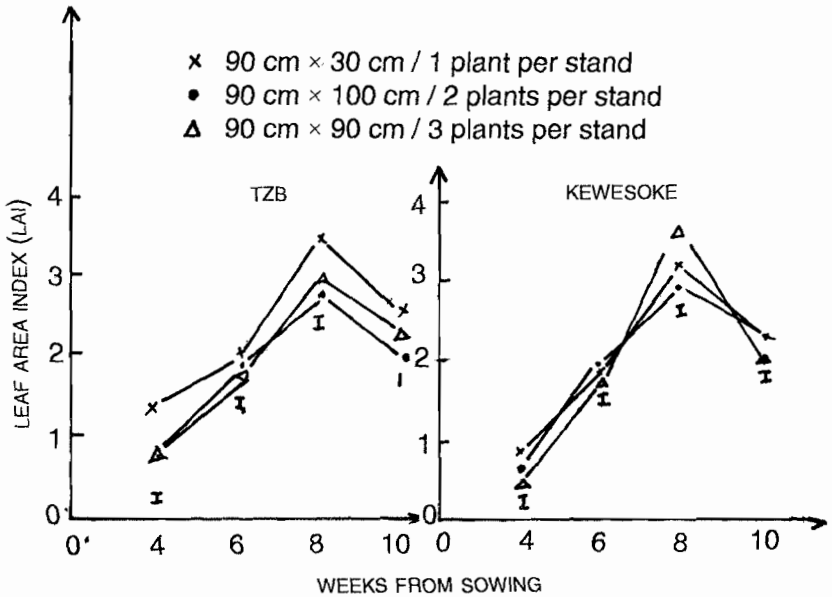

Fig. 1. Effect of spacing/number of plants per stand on LAI of maize.

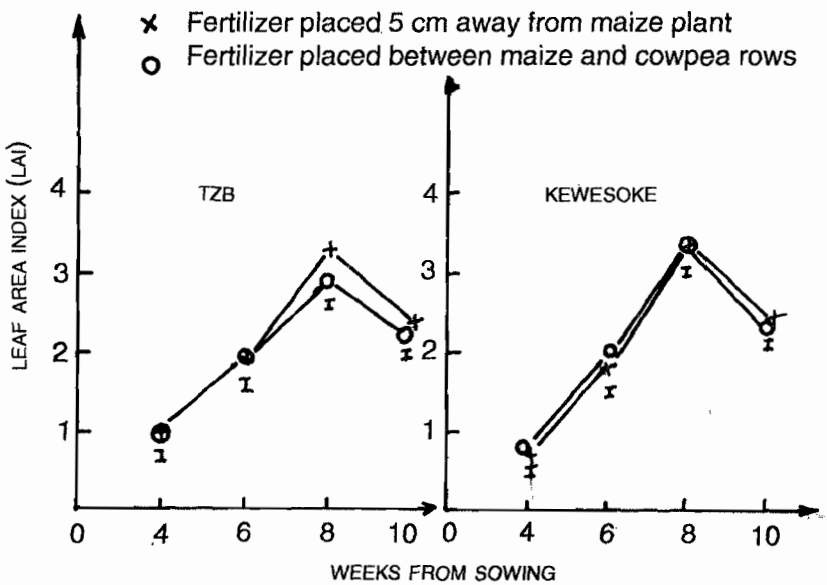

Fig. 2. Effect of fertilizer placement on the LAI of two maize varieties.

Fertilizer placement did not show any significant effect on LAI of both varieties (Fig. 2). However, interaction between spacing and fertilizer placement was significant ($P<0.05$). Fertilizer placed 5 cm away from maize rows produced the highest LAI at 90 cm × 30 cm spacing while the one placed midway between maize and cowpea rows had the highest LAI at 90 cm × 90 cm spac-

ing.

Both spacing/number of plants per stand and fertilizer placement had significant effect on phosphorus and potassium contents per plant of the two maize varieties ($P<0.05$). There was also significant spacing × fertilizer placement interaction ($P<0.05$) for both varieties. Spacing and fertilizer placement had no effect on the nitrogen contents of the plants.

Yield and components of yield

Both spacing and fertilizer placement had significant effect on the number of seeds per cob ($P<0.05$). Spacing at 90 cm × 30 cm with one plant per stand produced the highest number of seeds per cob. There was significant difference between 90 cm × 60 cm and 90 cm × 90 cm spacings (Table 2). Fertilizer placed 5 cm away from maize rows produced higher number of seeds per cob than the other method of placement.

Spacing and fertilizer placement had the same effect on the weight of 100 seeds and grain yield. The spacing 90 cm × 30 cm with one plant per stand produced the highest weight of 100 seeds and total grain yield. There was no significant difference between the other two spacings on weight of 100 seeds but there was difference in the total grain yield (Table 2). There was spacing × fertilizer placement interactions in weight of 100 seeds and total grain yield. Fertilizer placed 5 cm away from maize rows produced higher number of seeds per cob, weight of 100 seeds, and total grain yield than that placed between maize and cowpea rows.

TABLE 2

Effect of Spacing/Number of Plants per Stand and Fertilizer Placement on Yield and Yield Components of Two Maize Varieties

Treatment	*No. of seeds per cob*	*Weight of 100 seeds*	*Grain yield kg/ha*
Variety			
TZB	265[a]	20.39[a]	4136[a]
Kewesoke	263[a]	20.04[a]	4090[a]
Spacing/number of plants per stand			
90 cm × 30 cm/ plant	301*	22.11*	4492*
90 cm × 60 cm/ 2 plants	252*	19.73[c]	3985*
90 cm × 90 cm/ 3 plants	239	18.80[c]	3861
Fertilizer placement			
Between maize and cowpea rows	244	18.49	3556
5cm from maize rows	283*	21.94*	4669*
SE	8.30	0.65	138.0

* Significant at $P = 0.05$. Means having the same letter are not significantly different from each other at $P = 0.05$.

Discussion

Spacing and fertilizer placement did not show any significant effect on height of the plants in this study, but Giesbrecht (1969) reported significant difference in the heights of the two varieties which might probably show the importance of breeding and testing of varieties. The highest number of leaves in plants at 90 cm × 30 cm spacing with one plant per stand was probably due to better early utilization of water for growth resulting from less competition when compared with the other two spacings.

The decline in LAI after 8th week was probably due to leaf senescence after full development of the leaves. There is always a transfer of metabolites at grain filling sites after silking, and photosynthetic activity is likely to decline at this stage. Hence, there was a positive correlation between the LAI and total grain yield (Table 3).

The highest LAI in the spacing 90 cm × 30 cm with one plant per stand might be due to more light reaching the single plants than the double or triple plants, especially the lower leaves. Sticker (1964) reported that LAI decreased with increase in plant density. Wilson & Alison (1978) also

TABLE 3
Correlation Between Grain Yield and Some Plant Characters

Characters	*Correlation coefficient*
Leaf area index	0.367
Phosphorus content	0.836*
Potassium content	0.577
Nitrogen content	0.382
Number of seeds per cob	0.781*

*Significant at $P = 0.05$.

reported a decrease in growth rate of maize planted at wider spacing with more than one plant per stand when contrasted with the growth rate of those planted at close spacing with one plant per stand; this was due to better water utilization by the single plants. The difference in LAI of the two varieties might be due to genetic variability. The non-significant effect of fertilizer placement on the LAI of the two varieties might probably indicate that the effects of nutrients are more pronounced in grain and dry matter formation than in leaf area formation. For example, nitrogen uptake is low during the developed stage, but increases at tasselling stage when most of the leaves must have been formed.

The significant effect of fertilizer placement on the phosphorus and potassium contents of plants might be connected with the non-mobility of these nutrients in the soil. Fertilizer placed close to plants always increases early growth and nutrient contents and reduces fixation of phosphorus and potassium (Bates *et al.*, 1965). Fertilizer placement did not show any significant effect on the nitrogen content of plants. This might be due to mobility of nitrogen and the general lack of responses to nitrogen beyond 75-100 kg N/ha in most ecological zones in Nigeria.

The highest yield components recorded at 90 cm × 30 cm with one plant per stand should probably be the result of better utilization of competitive factors like nutrients and water. The reduction in yield in two and three plants per stand might be due to competition amongst plants. Roberto & Eugene (1969) obtained higher yields from maize plots spaced 53 cm rows as compared to 106 cm rows. Koli (1971) also cited similar results obtained by Takyi (1967,1969). Fayemi (1963) also reported higher yields from closer spacing.

The significant effect of fertilizer placement on grain yield was probably due to better early utilization of nutrients for growth when placed 5 cm away from the plants; nutrients are then better utilized for grain formation than foliage formation. Bates *et al.* (1965) reported a 470 kg/ha increase in grain yield from fertilizer placed with the seed over that of conventional fertilizer alone. Nelson & Randall (1968) also reported significant responses in early growth and grain yield when band and "pop up" (fertilizer placed in the row with the seed) were used with no significant difference between the two. Hence there were positive correlations between grain yield and NPK (Table 3).

The results suggest that under favourable conditions in the forest zone of Nigeria, a farmer may gain significantly by planting at closer spacing of 90 cm × 30 cm with one plant per stand and at the same time, place fertilizer containing phosphorus and potassium at distances that would be beneficial to the two maize varieties.

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