Effect of N, K and Inter-row Spacing on the Growth and Yield of Intercropped Maize and Groundnut

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Abstract

Three separate field experiments were conducted to study the effect of N, K and inter - row spacing on the growth and yield of Groundnut (*Arachis hypogea* L.) cv. X-14 when intercropped with Maize (*Zea mays* L.) cv. Badra. There were six Nitrogen rates (i.e. 0,10,20,30,40 and 50kg ha^{-1}) in experiment 1, six Potassium rates (i.e. 0,10,20,30,40 and 50 kg ha^{-1}) in experiment 2 and three inter-row spacings (ie. 30cm, 37.5cm and 45cm) with and without root barrier in experiment 3. Maize and Groundnut were grown in a 1 Maize: 3 Groundnut row arrangements in all treatments. The N requirement of maize /X-14 intercrop is different from that of sole crops. The optimum Nitrogen rates for maximum growth and yield performance was 40 kg ha^{-1} which, is lower than the recommended rate (60 kg ha^{-1}) for sole crop Maize and higher than the recommended rate (35 kg ha^{-1}) for sole crop Groundnut. K was not affecting on growth and yield of maize/X-14 intercrop, this is because of high K content of the soil (26.07 ppm) of the experimental site. The optimum inter-row spacing was 37.5cm. Root barrier was not beneficial in inter-row spacing at 30cm and 45cm but dry matter yield and combined biomass yield was increased with the presence of root barrier at the inter-row spacing of 37.5cm.

Introduction

Legume/cereal intercropping systems occupy a prominent place in agricultural systems in the tropics (Ofori and Stern, 1987: 41-90). To derive benefits from intercropping, the competition between species (inter-specific competition) for growth factors should be lower than that of between plants of the same species (intra-specific competition) in single stands (Willey, 1979: 1-10). This is of particular importance in legume/cereal intercropping systems where the legume is a weaker competitor for growth factors than the cereal. In such intercropping systems legume may have more competitive advantage than cereal under low N conditions and vise versa is true in cereals, which have more competitive advantages under high N conditions. Hence, minimization of the competitive depression of the legume in duel stand is of prime importance in identifying benefits from intercropping. Higher yielding by intercrops has been reported when monocrop yield was limited by N (Mutsaers, 1978: 344-353), or K (Senaratne *et al.* 1993: 11), or low population density (Reddy and Willey, 1980:4-7). Therefore, the main objectives of the present experiments were to study the interaction between maize and groundnut in intercropping with emphasis on the use of fertilizer N and K and inter-row spacing of component crops of the Maize-Groundnut intercrop.

Materials and Methods

Three separate field experiments of Maize (cv.Badra) - Groundnut (cv. X-14) intercrops were conducted at the research farm of the Faculty of Agriculture, University of Ruhuna, Mapalana, Kamburupitiya, (6.07^0 and 80.5^0 E, altitude 158 m) which is classified under low-country wet zone, (WL_2) to study the effect of N and K (Nov. 1993 - Feb. 1994), and inter-row spacing (May - Aug. 1993) on growth and yield of Maize and Groundnut intercrops. The soil of the area is classified as Red-

Yellow Podsolic (Alwis and Panabokke, 1972: 26-32). The climate is humid tropical with two distinct seasons. Annual precipitation is more than 2300mm and average temperature is about 28^{0}C. Treatments used in the experiments are shown in Table 1.

Table 1: Treatments used in the experiments

Treatments	Experiment 1 (N-Kg ha-^{1})	Experiment 2 (K-Kg ha-^{1})	Experiment 3
T_1		0	Row spacing of 30cm without root barrier (30cm-B.)
T_2	10	10	Row spacing of 30cm with the root barrier at top 15cm layer (30cm-B+)
T_3	20	20	Row spacing of 37.5cm without root barrier (30cm-B.)
T_4	30	30	Row spacing of 37.5cm with the root barrier at top 15cm layer
T_5	40	40	Row spacing of 45cm without root barrier (30cm-B)
T_6	50	50	Row spacing of 45cm with root barrier at top 15cm layer (30cm-B+)

Land of the experimental site was previously used for growing field crops other than legumes. The experiment was arranged in a Randomized Complete Block Design with 4 replicates. Six plots were prepared in each block and randomized for different treatments. In all experiments, each crop was grown in a 1 Maize: 3 Groundnut row arrangement. In experiment 1 and 2, the inter-row spacing of each crop was 30cm. But in experiment 3, inter-row spacing varied as 30cm, 37.5cm and 45cm in different treatments, and these treatments were again differentiated with and without 15cm deep root barrier between maize and groundnut and the plot size was varied according to the respective inter-row spacing. The within-row spacing of maize was 30cm and groundnut was 15cm in all experiments.

A basal fertilizer application of 20, 50 and 75kg ha^{-1} of N, P and K as Urea, conc. Super Phosphate and Muriate of Potash respectively was applied to all plots in experiment 3. In experiment 1, N fertilizer was applied as 0, 10, 20, 30, 40, and 50 kg ha^{-1} and P and K were added in similar quantities as in the experiment 3. In experiment 2, K fertilizer was applied at 0,10,20,30,40,

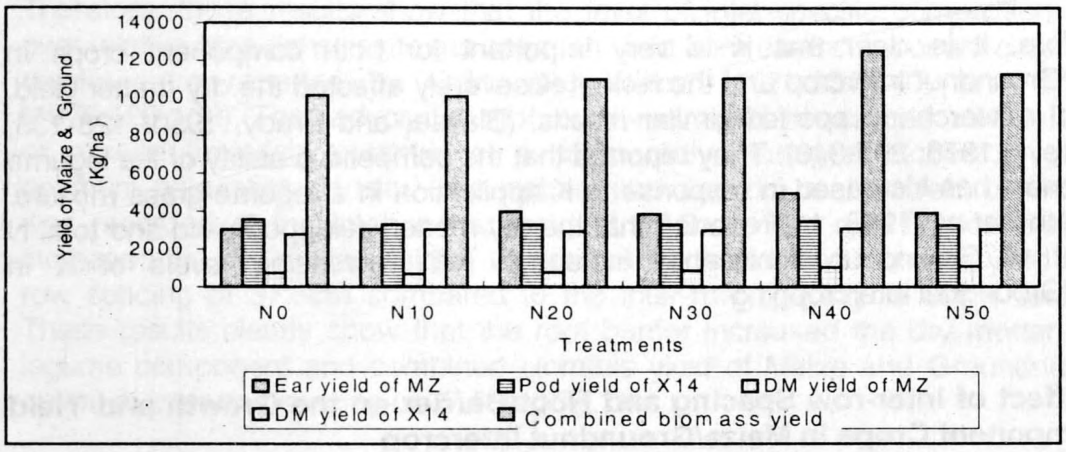
and 50 kg ha^{-1} and N and P were in similar quantities to those in experiment 3. At maturity, ear yield of Maize, pod yield of Groundnut and dry matter yield of Maize and Groundnut (all above-ground parts excluding ear yield of Maize and pod yield of Groundnut were dried in an oven at 85^{0}C until constant weight) were determined. Analysis of variance (ANOVA) was performed on all the parameters measured/calculated and the treatment comparisons were made using Duncan's Multiple Range Test (DMRT).

Results and Discussion

The Effect of N on the Growth and Yield of Component Crops in Maize/Groundnut Intercrop

Growth and yield of Maize and combined biomass yield of maize and Groundnut were marginally increased with increasing levels of nitrogen up to 40kg ha^{-1} and further increase of N gave a negative effect. Dry matter yield of intercropped Maize increased continuously even up to 50kg ha^{-1} of N, which is the highest N rate, tested in this experiment. This clearly indicates that the N requirement of intercrop is different from that of sole crops. The optimum N rate to get the highest combined biomass yield was 40kg ha^{-1} which is lower than the recommended rate (about 60kg ha^{-1}) for sole crop Maize and is higher than the recommended rate (35kg ha^{-1}) for sole crop Groundnut (Fig. 1).

Fig.1: The Effect of N on the Growth and Yield of Component Crops in Maize/Groundnut intercrop



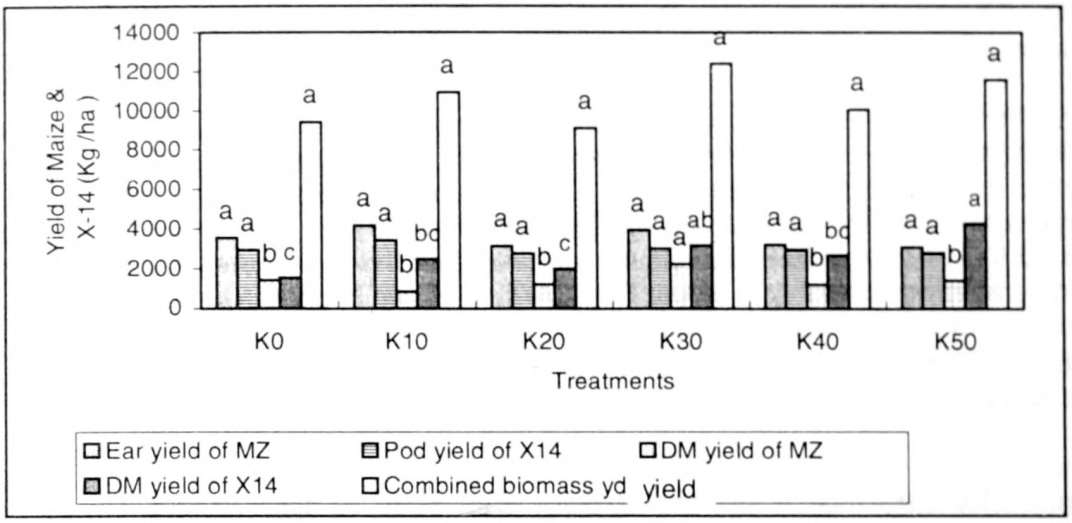
MZ-Maize, X-14-Groundnut cv.X-14, DM- Dry matter yield

Several authors indicated that the response of N is different in different associations. For example, a satisfactory response was noted the Maize-Soybean intercrop to only 60kg N ha^{-1} (Odongo et al. 1988: 38-46). In contrast, a negative effect was found of N at 135 kg ha^{-1} on the Maize component of the Maize-Soybean intercrop (Chui and Shibles, 1984: 194). Ham *et al.* 1975: 293-297 found a significant increase in Soybean yield with the application of 229 kg N ha^{-1} in Maize-Soybean intercrop. Therefore, it is clear that the responses to N applied in crop associations depend on several factors -mainly on the environmental factors, soil N, biological Nitrogen fixation capacity of the legume crop and transfer of Nitrogen from legume crop to associated non-legume crop etc.

The Effect of K on the Growth and Yield of Component Crops in Maize/Groundnut intercrop

K did not affect the ear yield of Maize, the pod yield of Groundnut and the combined biomass yield of Maize/Groundnut. This is because of the high K content in soil. Nevertheless, dry matter yield of Maize and Groundnut increased significantly at 30 and 50 kg ha^{-1} of K respectively compared to the other rates which were used (Fig. 2).

Fig 2: The Effect of K on the growth and yield of component crops of maize/X-14 intercrop



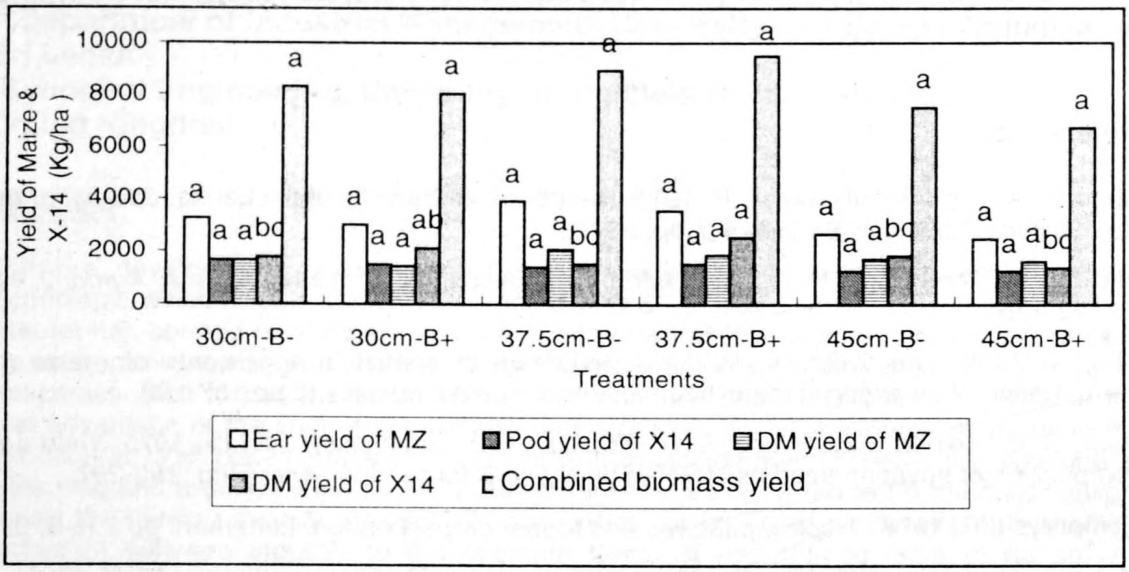
MZ-Maize, X-14-Groundnut cv.X-14, DM- Dry matter
(The values in a bar followed by the same letter are not significant at 5% level)

Therefore, it is clear that K is very important for both component crops in Maize/Groundnut Intercrop and the lack of K severely affected the dry matter yield. Several researchers reported similar results. (Blasser and Brady, 1950: 128-135, Humpreys, 1978: 295-310). They reported that the competitive ability of the legume component has increased in response to K application in a legume-grass mixture. Senaratne *et al.* (1993: 11) reported that the dry matter yield, pod yield and total N content of Groundnut significantly increased with increasing levels of K in Maize/Groundnut intercropping.

The Effect of Inter-row Spacing and Root Barrier on the Growth and Yield of Component Crops in Maize/Groundnut Intercrop

Even though the effect was statistically not significant, ear yield and dry matter yield of intercropped Maize and combined biomass yield were the highest in inter-row spacing of 37.5cm compared to the inter-row spacing of 30 cm and 45 cm. In spite of lack of statistical significance, pod yield of Groundnut was highest in the 30cm inter-row spacing (lowest considered), and it decreased with increasing inter-row spacing (Fig.3).

Fig. 3: The Effect of Inter-row Spacing and Root Barrier on the Growth and Yield of Component Crops in Maize/Groundnut Intercrop



MZ-Maize, X-14-Groundnut cv.X-14, DM- Dry matter
B+ -With root barrier B- - Without root barrier
(The values in the bars followed by the same letter are not significant at 5% level)

The results revealed that the inter-row spacing of 30cm was not enough to get maximum yield due to inter-specific competition by Groundnut. In this experiment, the optimum inter-row spacing between Maize and Groundnut was 37.5 cm to get maximum ear and dry matter yield of Maize as well as combined biomass yield. Therefore, these results show that the level of inter-specific competition differed over relative crop densities to get optimum yield from each component crop. Similar results were reported by Osiru and Willey, (1972:531-540) and Trenbath, (1976:126-169). They advocated that a well-managed intercrop is unlikely to equal or exceed the yield potential of a comparably managed monocrop grown at optimum population density. The highest pod and dry matter yield of Groundnut was recorded at the inter-row spacing of 37.5cm. The root barrier significantly increased the dry matter yield of Groundnut and combined biomass yield at inter-row spacing of 37.5cm compared to the inter-row spacing of 30cm and 45cm. These results clearly show that the root barrier increased the dry matter yield of legume component and combined biomass yield of Maize and Groundnut at the optimum inter-row spacing of 37.5cm (Fig. 3).

Conclusion

The N requirement of intercrop is different from that of sole crops. In Maize/Groundnut intercropping, the optimum N rate to get maximum yield was 40 kg ha^{-1}. Since soils of the experimental site have high level of K (26.07 ppm), K did not affect the ear yield of Maize and pod yield of Groundnut. But the lack of K severely affected the dry matter yield. The optimum inter-row spacing is 37.5 cm compared to the other two inter-row spacing of 30 cm and 45 cm for the maximum growth and yield performance. Eventhough root barrier was not beneficial for ear yield of Maize or pod yield of Groundnut, it increased the dry matter yield of legume component at 37.5 cm inter-row spacing.

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References

Alwis, K. A . and Panabokke, C.R. 1972. Handbook of the soils of Sri Lanka. *Journal of the Soil Science Society of Sri Lanka 2*, pp. 26 32.

Blasser, R.E. and Brady N.C. 1950. Nutrient competition in plant associations. *Agron. J* 42: pp.128-135.

Chui, J. A. N. and Shibbles, R. 1984. Influence of spatial arrangements of maize on performance of an associated soybean intercrop. *Field Crop Res.*8: pp 197-198.

Ham, G. E., Leiner, I. E., Evans, S. D., Frazier, R. D. and Nelson , W. W 1975 Yield and composition of soybean seed as affected by N and S fertilization. *Agron.* pp. 293-297

Humpreys L.R. 1978. *Tropical pastures and fodder crops*. London: Longman. pp 295-310.

Mutsaers H. J. W., 1978. Mixed cropping experiments with maize and groundnuts. *Neth. J Agric Sci.*, 26: pp. 344-353.

Odongo, J. C. W. , Veresoglou, D.S., Papakotsu, D. and Sficas, A. G. (1988). Biomass and nitrogen yield of intercropped maize and soyabeans as affected by applied nitrogen, rhizobium, maize hybrids and Population density. *J. Agron Crop Sci. , 160,* pp. 38-46.

Ofori F. and Stern W. R. 1987. Cereal-legume intercropping systems. *Adv. Agron.* 41: pp. 41-90.

Osiru, D.S. O. and Willey R.W. 1972. Studies on mixtures of dwarf sorghum and beans (*Phaseolus vulgaris* L.) with particular reference to plant population. *J. Agric. Sci. Camb.* 179: pp. 531-540.

Reddy M. S. and Willey R. W. 1980. The relative importance of aoove and below-ground resource use in determining yield advantages in pearl millet/groundnut intercropping; paper presented at the second symposium on intercropping in Semi- Arid Areas, university of Dar-es-Salaam, Marogoro, Tanzania, Aug. pp. 4-7.

Senaratne R., Liyanage N. D. I. and Ratnasinghe D. S. 1993. Effect of K on nitrogen fixation of intercrop groundnut and the competition between intercrop grounanut and maize. *Fertilizer Research* 34: pp. 9-14.

Trenbath, B. R. (1976). Plant interactions in mixed crop communities. In : Papendic R. I. at. al (editors), multiple cropping Spec. *Publ No 27, Am. Soc. Agron., Madison, W. I. pp. 129-169.*

Willey, R. W. (1974). Intercropping - its importance as its research needs. Part I. Competition and yield advantages. Part II. Agronomic relationships. *Field crop Abstracts 32.*