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Use of ^{15}N to study the N fixation, N transfer and yield of intercropped groundnut (*Arachis hypogaea* L.) as affected by genotype and the root barrier

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ABSTRACT

^{15}N-aided intercropping studies of maize/groundnut (Experiment 1), and sorghum/groundnut (Experiment 2) with and without below-ground barriers were conducted. The results revealed that the groundnut variety X-14 was more competitive than Red Spanish and this competitive ability was much higher in association with maize. Root barriers improved the intercropped maize yield in association with X-14 while no root interaction affected on maize yield in association with Red Spanish. Seed and total biomass yield of sorghum in association with X-14 showed a similar trend but those of sorghum when associated with Red Spanish was not affected by intercropping in the presence of a root barrier. Intercropped groundnut derived a higher percentage of N_2 (45-55%) from the atmosphere compared to the monocrops (18-35%) without respond to root barrier and groundnut genotype. ^{15}N-aided studies revealed that part of the N_2 fixed by intercropped groundnut has been transferred to the associated maize crop. N yield was higher in groundnut sole crop compared to that grown in association with both cereal crops.

Key words: *Arachis hypogaea, Sorghum bicolor,* ^{15}N, N_2 fixation, *Zea mays L.*

INTRODUCTION

Nitrogen is the most commonly exhausted nutrient in the soil due to its high demand and heavy losses (Kang 1987). Due to increasing cost of chemical fertilizers and the unacceptability of their continued use due to environmental concerns, legumes are being increasingly used in intercropping systems (Okigbo and Greenland 1976; Dart and Kraantz 1977; Shammugasundaram *et al.* 1980) to supplement N requirement of cereals. The N supplementing ability of the legumes in intercropping systems depends on the magnitude of N_2 fixation, the amount of N accumulated in the root system and the non-harvested residue, the rate and degree of mineralization of the legume residue and the degree of N losses (Henzell and Vallis 1977).

To derive the benefits from intercropping, inter-specific competition for growth factors should be lower than intra-specific competition in single stands (Willey 1979). In legume-cereal mixtures, the legume may suffer from 'competitive depression', affecting its N_2 fixation and N beneficial effects on the associated crop. Accordingly significant interactions between varieties and cropping systems have been observed (Gomez and Zandstra 1977; Francis *et al.* 1978b; Francis 1986). Therefore varieties developed for monoculture may not necessarily yield well in dual culture (Finlay 1974; Francis 1986).

Considerable genotypic variability in N_2 fixation has been reported in different grain legumes (Eaglesham *et al.* 1981; Graham and Temple 1984; Giller *et al.* 1987; Awonike *et al.* 1990). Studies conducted previously have shown that groundnut *(Arachis hypogaea)* has greater N-supplying ability than cowpea (*Vigna unguiculata*), mungbean, (*Vigna radiata*) and gram (*Cicer arietinum*) (Patra *et al.* 1986; Senaratne *et al.* 1991).

Senaratne and Gunasekara (1994) reported significant genotypic differences in pod yield and stover N_2 content in groundnut when intercropped with maize. The percentage N_2 derived from the atmosphere showed a genotypic variation of 47 to 69 % (9 to 18kg N_2 ha^{-1} fixed) and in groundnut, the uptake of soil N_1 was significantly affected by the genotype. Thus it is probable that considerable genotypic variability may occur in N-supplying ability from legumes to cereals.

In pearl millet/groundnut intercropping with below- and above-ground partitions, Reddy and

Willey (1980) reported that the yield advantage with partitions was only slightly less (19%). Also, results showed that partitioning decreased millet yields and increased groundnut yields indicating that below-ground interactions were important in determining the competitive balance of the two crops. However, Willey and Reddy (1980), reported that the rate of dry matter accumulation of the intercrop millet (association with groundnut) was much higher than that 'expected' from its sown proportion (ie. 25% of the sole crop), indicating that this crop experienced much less competition in intercropping than in sole cropping. The rate of dry matter accumulation of the intercrop groundnut was slight but consistently less than 'expected'(ie.75% of the sole crop), indicating that this crop experiences more competition in intercropping than in sole cropping. The yield advantages were largely due to above-ground interactions, presumably better use of light. This indicates that although partitioning had little effect on the overall yield advantage, the reduced millet growth and increased groundnut growth show that it did affect the competitive balance of the two crops.

Studies do not indicate the identification of genotypes of groundnut with high N supplying capacity and more competitive ability for improving and sustaining the productivity of low input cropping systems. Yield advantages in intercropping due to below-ground effect could also be important in identifying whether further improvement in intercropping yields by improving the interactions between the root systems of the component crops.

Therefore two ^{15}N-aided intercropping studies with and without below-ground interactions were carried out to identify the groundnut genotypes with more competitive and high N supplying ability.

MATERIALS AND METHODS

Two ^{15}N-aided intercropping studies in field with and without root barrier were carried out at two different agro-climatic zones of Sri Lanka. The maize/groundnut intercropping experiment was sited at Bata-atha (6° 15′ N and 80° 54′ E, 5 meters above sea level), where soils are classified as Reddish-Brown Earth (Alwis and Panabokke 1972). The experimental site of the sorghum/groundnut intercropping was at Mapalana (6° 07′ N and 80° 05′ E altitude 158m), classified as the low-country wet zone. The soil of the area has been classified as Red-Yellow podzolic (Alwis and Panabokke 1972). Both experiments had eight treatments, which were arranged in a Randomized Complete Block (RCB) design with 4 replicates.

In both experiments, maize and sorghum were planted as intercrops with groundnut (cvs. X-14 and Red Spanish) which was 120cm apart. Three rows of groundnut (X-14 and Red Spanish) were planted in between two rows of maize. The inter-row spacing in maize was 30cm while 15cm in groundnut. Below-ground interaction between maize/sorghum and groundnut was studied by installing below-ground barrier between the respective rows prior to planting. To install the barrier, 30cm wide and 30cm deep trenches were dug out and aluminium sheets of 360cm length and 30cm high were placed in the trenches depending on the treatments. After installation of the barrier, trenches were refilled. To avoid any possible effects of soil disturbance on treatments with a root barrier, a treatment was included where identical trenches were dug and refilled without the aluminium barrier. Monocrop cereals (maize and sorghum) were used as reference crops for the estimation of N_2 fixation by legume in the single and dual stands and also to determine any transfer of N_2 from the groundnut to maize. Monocrops of groundnut (cvs. X-14 and Red Spanish) were also included to compare the growth and yield with intercrops. The monocrop plots were 3.6 x 2.1m while the intercrop plots 3.3 x 2.1m with isotope plots located in the center which was 1x1m in the monocrop plots and 1x2m in the intercrop plots.

The treatments used in the experiments are as follows,

1. Maize/sorghum sole crops (MZ/SO)
2. Maize/sorghum intercropped with groundnut cv. X-14 without root barrier, MZ(SO)/X-14/B^-
3. Maize/sorghum intercropped with groundnut cv. X-14 with root barrier, MZ(SO)/X-14/B^+
4. Maize/sorghum intercropped with groundnut cv. Red Spanish without root barrier, MZ(SO)/RS/B^-
5. Maize/sorghum intercropped with groundnut cv. Red Spanish with root barrier, MZ(SO)/RS/B^+
6. Groundnut cv. X-14 sole crop, X-14
7. Groundnut cv. Red Spanish sole crop, RS

A basal fertilizer application of 50kg ha^{-1} of P as conc. super phosphate and 75kg ha^{-1} of K as muriate of potash were applied to all plots. Labelled ammonium sulphate with 5% ^{15}N atom excess was applied in the isotope plots at the rate of 20kg N ha^{-1} after sowing the seeds while rest of the area was supplied with regular unlabelled ammonium sulphate at the same rate for intercrop plots.

At physiological maturity of crops in both the experiments (before the legume starts loosing foliage), the above-ground parts of the crops were harvested, separated into pods/grains, and stover, dried at 80°c for 72 hours and weighed. The samples were ground and then %N content and %^{15}N atom excess were determined using the Kjeldhal procedure and mas-spectrometer respectively. N_2 fixed was calculated by the procedure presented by Fried and Middleboe (1977). At maturity of the crops in both experiments, cob yield of maize, seed yield of sorghum, pod yield of groundnut and stover yield of maize, sorghum and groundnut were measured.

The determination of N transfer was based on the comparison of ^{15}N enrichment in the non-nitrogen fixing plants grown in association with and remote from the nitrogen fixing legume. Here it is assumed that the availability of soil N is identical in both situations. Hence ^{15}N enrichment was the same in the monocropped and intercropped maize/sorghum. However, if there is any transfer of N from the groundnut to the maize/sorghum, it will result in adecrease of ^{15}N enrichment in the intercropped maize/sorghum relative to the monocropped maize/sorghum. The decrease of ^{15}N can be quantified in terms of amount of N transferred employing the ^{15}N methodology described earlier (Fried and Middleboe 1977).

RESULTS

Effect of intercropping and root barrier on cob/seed and biomass yield of maize and sorghum as affected by groundnut genotype

Cob and biomass yield of maize were significantly suppressed by both genotypes of groundnut (X-14 and Red Spanish) and yield suppression was greater when maize was intercropped with X-14 than Red Spanish. Root barrier improved the intercropped maize yield when associated with X-14 while there was no root barrier effect on maize yield when intercropped with Red Spanish (Table 1). Seed and biomass yield of sorghum in association with X-14 also showed similar trend but those of sorghum associated with Red Spanish was not affected by intercropping or root barrier (Table 1).

Table 1. Effect in intercropping and root barrier on cob/seed and total biomass yield of maize and sorghum as affected by groundnut genotype.

Treatments	Maize/groundunt		Sorghum/groundnut	
	Cob yield of maize ($g\ plant^{-1}$)	TBY of maize ($g\ plant^{-1}$)	Seed yield of sorghum ($g\ plant^{-1}$)	TBY of sorghum ($g\ plant^{-1}$)
MZ (SO)	82.7^{a}	261.9^{a}	28.2^{a}	207.0^{a}
MZ (SO)/X14/B^{-}	8.0^{b}	117.3^{b}	15.7^{a}	42.4^{b}
MZ (SO)/X14/B^{+}	40.9^{b}	144.8^{b}	24.2^{a}	59.8^{b}
MZ (SO)/RS/B^{-}	27.4^{b}	114.9^{b}	29.1^{a}	71.0^{b}
MZ (SO)/RS/B^{+}	27.1^{b}	146 0^{b}	28.8^{a}	68.9^{b}

MZ - Maize, SO - Sorghum, TBY - Total Biomass Yield,
X14 - groundnut genotype X-14, RS - groundnut genotype Red Spanish
B^{-} - Without root barrier B^{+} - With root barrier

Values in a column followed by the same letter are not significantly different at 5% level.

Effect of intercropping and root barrier on pod and biomass yield of groundnut as affected by groundnut genotype

Pod and biomass yield of intercropped groundnut (both X-14 and Red Spanish) in association with sorghum increased while those associated with maize decreased compared to sole crop groundnut. Root barrier had no effect on intercropped groundnut yield except in pod yield of Red Spanish in maize/Red Spanish that was increased by root barrier (Table 2).

Table 2. Effect of intercropping and root barrier on pod and biomass yield of groundnut as affected by genotype.

Treatments	Maize/groundnut		Sorghum/groundnut	
	Pod yield of groundnut ($g\ plant^{-1}$)	TBY of groundnut ($g\ plant^{-1}$)	Pod yield of groundnut ($g\ plant^{-1}$)	TBY of groundnut ($g\ plant^{-1}$)
X-14	8 9^{a}	28.9^{a}	9.9^{cd}	17 9^{bc}
MZ (SO)/X-14/B	4 9^{b}	15 2^{c}	12.3^{ab}	26 4^{a}
MZ(SO)/X-14/B^{+}	4 4^{b}	18 3^{bc}	12.3^{a}	24 1^{ab}
RS sole crop	7 3^{ab}	29.2^{a}	5.0^{f}	10 9^{e}
MZ/(SO)/RS/B	3 7^{b}	17 9^{bc}	9.3^{cde}	17 1^{bc}
MZ(SO)/RS/B^{+}	7.1^{ab}	16.3^{c}	10 0^{c}	19.0^{bc}

TBY - Total Biomass Yield, MZ - Maize, SO - Soghum
X-14 - Groundnut Genotype X-14, RS - Groundnut Genotype Red Spanish

Valuse in a column followed the same letter are not significant at 5% level

Effect of root barrier and groundnut genotype on % ^{15}N atom excess, %Ndff, %Ndfs, %Ndfa, N yield and N fixed in groundnut

Experiment 1: Percent ^{15}N atom excess decreased marginally in intercropped groundnut compared to the respective sole crops. Sole crop groundnut fixed about 45% of its N from the atmosphere and intercropped groundnut fixed more N (about 55%) than sole crop groundnut. Root barrier had no effect on %^{15}N a. ex., %Ndff, %Ndfs and %Ndfa in intercropped groundnut (Fig 1).

N yield and N_2 fixed (kg ha^{-1}) were higher in groundnut sole crop. N yield was 119 and 107 kg ha^{-1} and N_2 fixed was 56 and 51kg ha^{-1} in sole crop. X-14 and Red Spanish respectively while N yield was 76

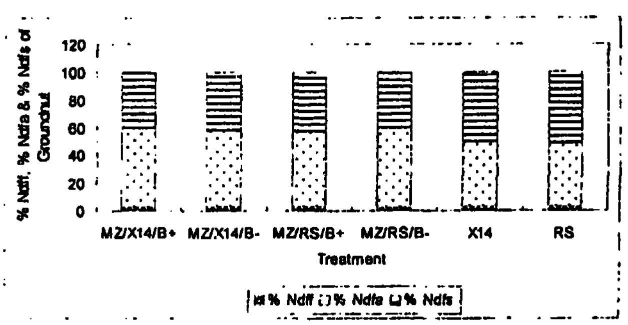

Fig.1 Effect of root barrier and groundnut genotype on %Ndff, %Ndfs and %Ndfa of groundnut in association with maize.

and 82 kg ha^{-1} and N_2 fixed was 42 and 44 kg ha^{-1} in intercropped X-14 and Red Spanish respectively (Table 3).

Table 3. N yield and N_2 fixed (kg ha^{-1}) in groundnut in maize/ groundnut intercropping.

Treatment	N yield (kg ha^{-1})	N_2 fixed (kg ha^{-1})
MZ/X14/B^+	84.23^{ab}	43.46^a
MZ/X14/B^-	76.23^b	42.47^a
MZ/RS/B^+	65.03^a	34.31^a
MZ/RS/B^-	82.42^b	44.6^a
X-14	119.15^a	55.63^a
RS	107.48^{ab}	50.91^a

MZ - Maize X-14 - Groundnut genotype X-14, RS - Groundnut genotype Red Spanish
B^+ - with root barrier B^- - without root barrier

Values in a column followed by the same letter are not significant at 5% level.

Experiment 2: Percentage ^{15}N atom excess increased in intercropped X-14 (ie.0.213) than sole crop X-14 (ie. 0.187) but it had no effect on Red Spanish in association with sorghum. Groundnut fixed a small amount of its N_2 requirement (about 10-35%) and most of the N_2 requirement came from soil (60-90%). Sole crop groundnut fixed more N_2 than intercropped groundnut. Root barrier decreased the N_2 fixation in intercropped X-14 while N_2 fixation was increased by root barrier in intercropped Red Spanish (Fig 2).

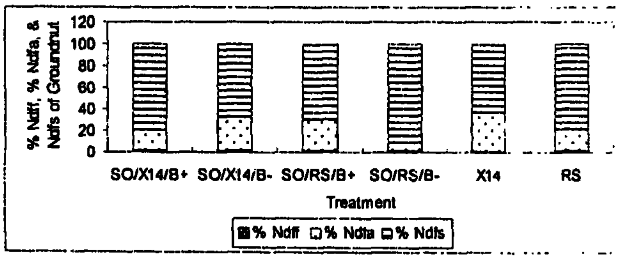

Fig.2 Effect of groundnut genotype and root barrier on %Ndff, %Ndfs and %Ndfa of groundnut in association with sorghum

Intercropped groundnut (ie. X-14 and Red Spanish) gave lower N yield than respective sole crops and intercropped X-14 gave higher N yield than intercropped Red Spanish. Root barrier increased the N yield in intercropped Red Spanish and it had no effect in intercropped X-14. Intercropped Red Spanish fixed a higher amount of N_2 (45 kg ha^{-1}) than sole crop Red Spanish (33kg ha^{-1}) but intercropping was not affected by N_2 fixation of X-14. Sole crop X-14 fixed a higher amount of N_2 (61kg ha^{-1}) than Red Spanish sole crop (33kg ha^{-1}). Root barrier decreased the N_2 fixation of Red Spanish and it had no effect on N_2 fixation of X-14 (Table 4).

Table 4. N yield and N_2 fixed (kg ha^{-1}) in groundnut in sorghum/groundnut intercropping.

Treatment	N yield (kg ha^{-1})	N_2 fixed (kg ha^{-1})
S/X14/B^+	58.87^a	57.28^a
S/X14/B	60.08^a	58.79^a
S/RS/B^+	46.55^a	27.12^a
S/RS/B^-	28.06^a	45.35^a
X-14	62.64^a	61.31^a
RS	34.42^a	33.42^a

SO - Sorghum X-14 - Groundnut genotype X-14, RS - Groundnut genotype Red Spanish
B^+ - with root barrier B^- - without root barrier

Values in a column followed by the same letter are not significant at 5% level.

Percent ^{15}N atom excess, % Ndff, % Ndfs and N yield of maize and sorghum in association with groundnut

Experiment 1: The percent ^{15}N atom excess in intercropped maize was less than in the sole crop maize but the difference was not significant. Root barrier does not significantly affected on the $\%^{15}N$ a. ex. in intercropped maize. Intercropping and root barrier were not significantly affected on the %Ndff and %Ndfs in maize. Intercropping decreased the N yield of maize in association with both groundnut genotypes. Root barrier does not significatly affected on N yield of maize in association with both genotypes of groundnut (Table 5).

Table 5. % ^{15}N atom excess, % Ndff, % Ndfs and N yield of maize in association with gooundnut.

Treatment	% ^{15}N a.ex	% Ndff	% Ndfs	N yield (kg ha^{-1})
MZ	0.614^a	6.56^a	93.42^a	93.16^a
MZ/X14/B^+	0.551^a	4.45^b	95.55^a	76.96^a
MZ/X14/B^-	0.523^{ab}	5.89^a	94.54^a	58.13^a
MZ/RS/B^+	0.416^b	5.46^{ab}	94.11^a	54.43^a
MZ/RS/B^-	0.511^{ab}	5.59^{ab}	94.41^a	78.5^a

MZ - Maize, X-14 - Groundnut genotype X-14, RS - Groundnut genotype Red Spanish,
B^+ - with root barrier, B^- - without root barrier

Values in a columns followed by the same letter are not significant at 5% level.

Experiment 2: Eventhough there was no significant difference, percent ^{15}N atom excess increased in intercropped sorghum except in sorghum/Red Spanish treatment without root barrier compared to the sole crop of sorghum. Root barrier decreased the percent ^{15}N atom excess in sorghum when associated with X-14 while it increased in sorghum when associated with Red Spanish (Table 6).

Table 6. % ^{15}N atom excess, % Ndff, % Ndfs and N yield of sorghum in association with groundnut.

Treatment	% ^{15}N a.ex	% Ndff	% Ndfs	N yield (kg ha^{-1})
SO	0.220	2.45	97.55	36.74
SO/X14/B^+	0.447	2.64	97.36	29.50
SO/X14/B^-	0 356	4.75	95.25	24.23
SO/RS/B^+	0 208	2.23	97.77	36.37
SO/RS/B^-	0.247	3.80	96.20	28.15
	(NS)	(NS)	(NS)	(NS)

NS - Non significant at 5% level
SO - Sorghum, X-14 - Groundnut genotype X-14, RS - Groundnut genotype Red Spanish,
B^+ - with root barrier, B^- - without root barrier

Eventhough there was no significant difference, %Ndff of intercropped sorghum increased and %Ndfs of intercropped sorghum was decreased compared to the sorghum sole crop. %Ndff was further decreased with root barrier while %Ndfs was increased with root barrier in association of both genotypes of groundnut compared to the treatment without root barrier. N yield of intercropped sorghum decreased compared to sole crop of sorghum and the presence of root barrier resulted in an increase of the N yield of intercropped sorghum (Table 6).

Effect of root barrier and groundnut genotype on combined biomass yield of component crops

Experiment 1: Combined biomass yield was higher in intercropped treatments than sole crop treatments except in maize/X-14 without root barrier treatment. Root barrier decreased the combined biomass yield in maize/Red Spanish treatments and it increased in maize/X-14 treatment. The highest combined biomass yield was received from the maize/Red Spanish treatment without root barrier (Table 7).

Experiment 2: The combined biomass yield was higher in intercropped treatments than in the sole crop treatments. Although there was no significant difference, root barrier increased the combined biomass yield (Table 7).

Table 7. Effect of root barrier and groundnut genotype on combined biomass yield of component crops.

Treatment	Combined biomass yield: Experiment 1 Maize/groundnut ($kg\ ha^{-1}$)	Combined biomass yield: Experiment 2 Sorghum/groundnut ($kg\ ha^{-1}$)
MZ/SO	11858^{a}	2957^{d}
MZ(SO)/X14/B^{+}	12321^{a}	5787^{a}
MZ(SO)/X14/B^{-}	9796^{a}	5481^{ab}
MZ(SO)/RS/B^{+}	12638^{a}	5379^{ab}
MZ(SO)/RS/B^{-}	16794^{a}	5161^{abc}
X-14	6780^{a}	3984^{cde}
RS	5609^{a}	2452^{f}

MZ - Maize, SO - Sorghum, X-14 - Groundnut genotype X-14, RS - Groundnut genotype Red Spanish, B^{+} - with root barrier, B^{-} - without root barrier

Values in a column followed by the same letter are not significant at 5% level.

DISCUSSION

Cob and total biomass yield of maize were suppressed by the groundnut and suppression was greater by X-14 compared to Red Spanish. Root barrier improved the cob and total biomass yield of intercropped maize. Seed and total biomass yield of sorghum were also suppressed by X-14 while they were improved by Red Spanish and both these effects were removed by the partitioning of the below-ground parts. Therefore, the results revealed that sorghum has more competitive ability than maize. It is also clear that the competitive suppression by X-14 was greater when it is in association with maize rather than with sorghum.

According to the results, pod and total biomass yield of X-14 was greater than Red Spanish in sole crops in both experiments indicating the presence of genotypic variability of the groundnut yield.

Groundnut cultivar X-14 when intercropped with maize and sorghum produced lower yield than when grown as a sole crop and it was further decreased with root barrier in association with maize. There was however, no root barrier effect in association with sorghum. Intercropped Red Spanish also gave lower pod yield than sole crop but root barrier increased the pod yield of intercropped Red Spanish. Senaratne and Gunesekara (1994) reported similar results. They observed significant genotypic differences of pod yield and stover N content in groundnut when intercropped with maize. The results of the present experiment clearly show that both pod yield and total biomass yield of groundnut were suppressed by the cereal crops - maize and sorghum and the suppression in Red Spanish can be overcome with root barrier but root barrier did not effectively overcome such suppression of X-14. Reddy and Willey (1980) reported similar results. Another experiment conducted by Reddy and Willey (1980) concluded that there was no evidence that partitioning decreased millet growth as in the previous experiment. In fact there was evidence of rather better growth in both the partitions and dug out intercrop treatments.

Combined biomass yield increased in intercrop treatments in both experiments of maize/groundnut and sorghum/groundnut indicating that competitive balance of the two component crops favourably benefited to increase the combined biomass yield. Root barrier increased the combined biomass yield in intercrop treatments except in maize/Red Spanish treatment. These results again show the different competitive ability of the component crops and their effect on combined biomass yield.

Intercropped maize gave lower %^{15}N atom excess value compared to maize sole crop indicating that a certain extent of N_2 fixation by groundnut may transfer to maize plant and it was resulted to decrease the %^{15}N atom excess of intercropped maize. But %^{15}N atom excess in intercropped sorghum increased in association with X-14 but it decreased in association with Red Spanish. Root barrier decreased the %^{15}N atom excess in sorghum in association with X-14 while it was increased in sorghum in association with Red Spanish. Percentage ^{15}N atom excess was decreased in intercropped groundnut compared to the respective sole crops in both experiments of maize/groundnut and sorghum/groundnut. These results clearly show that intercropped groundnut fixed more N than respective sole crops and it resulted in the decrease in the %^{15}N atom excess in intercropped groundnut.

According to the results, %Ndfa of groundnut was higher (about 45-55%) in maize/groundnut experiment than sorghum/groundnut experiment (about 18-35%) in both sole and intercrops. These results revealed that the N_2 derived from groundnut is favoured in association with maize rather than with sorghum. Also, since both sole and intercrop groundnut in association with maize derived more N_2 from atmosphere without affecting cropping system, it is clear that the amount of %Ndfa may depended not only on the cropping systems but also on the climatic factors since these two experiments were conducted at two different locations. Thus, maize/groundnut experiment conducted at low country dry zone (Reddish Brown Earth Soil) in Bata Atha derived more N_2 than the sorghum/groundnut experiment conducted at low country wet zone in Mapalana (Red-Yellow Podzolic Soil).

N yield was higher in groundnut sole crop than in intercrop groundnut in both experiments of maize/groundnut and sorghum/groundnut. N_2 fixation was higher in sole crop groundnut than in intercrop groundnut in maize/groundnut intercrop but it was greater in intercropped Red Spanish while lower in intercropped X-14 in sorghum/groundnut experiment compared to the respective sole crops. N_2 fixation decreased with root barrier in sorghum/groundnut intercrop without affecting groundnut genotype but N_2 fixation decreased with root barrier in maize/Red Spanish while it increased with root barrier in maize/X-14 intercropping compared to the treatments without root barrier. Similar results were reported by Willey and Reddy (1980). They observed in later stages of growth, the millet in the partitioned intercrop was much paler than in other treatment and was apparently suffering more N stress.

CONCLUSION

The experiment indicated the presence of genotopic differences in the two groundnut genotypes (X-14 and Red Spanish) and two cereal crops (maize and Sorghum) with regard to competitive ability. X-14 has much higher competitive ability than Red Spanish where intercropping with both maize and sorghum. Yield suppression of maize by X-14, groundnut can be improved by the partitioning of below-ground parts. Intercropped groundnut fixed more N_2 than respective sole crops. Intercropped groundnut fixed about 45-55% of N_2 in association with maize while N_2 fixation by groundnut in association with sorghum was only 18-35%. A certain extent of fixed N_2 by goroundnut was transferred to the associated maize crop.

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