Benefits from organic sources by peanut/sorghum under intercropping system using ^{15}N technique

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Abstract: The main point of this study is the interactions of organic sources combination with mineral nitrogen supply levels and effects intercropping productivity. A field experiment was conducted in Nuclear Research Center to study intercropping of Groundnuts/ Sorghum with N application at the rate of 100 kg/ N fed^{-1} as organic materials or mineral fertilizer (Ammonium sulphate) of sole wheat crop and 50 kg/ N fed^{-1} as organic manure or mineral fertilizer of intercropping system, ^{15}N-Labeled Ammonium sulphate with 2% ^{15}N atom excess. The application of intercropping system induced an increase of Sorghum grain yield against the sole system. regardless the cultivation system, the over all means of fertilizer rates indicated (50% MF + 50% OM) treatment was superiority 100% OM)and (75% MF+ 25% OM) or those recorded with either un fertilizer when Sorghum grain yield considered. Comparison heed between organic sources reflected the superiority of compost under sole cultivation, while Groundnuts shoots was the best under intercropping. Data demonstrate compost and wheat straw was significantly and positively of ^{15}nitrogen transfer from the groundnuts to grain sorghum plants compared maize stalk and caw manure, data recorded ^{15}nitrogen transfer was 24.25,22.57,22.34,16.80,and 12.29 kg N fed $^{-1}$.Under combined organic amendment with mineral fertilizer, data showed that the rate of 50%MF+50%OM and 75%MF+25%OM on positively increase than 100%MF of^{15}nitrogen transfer from the groundnuts to shoots sorghum, accounted for 23.63,19.93,15.39 kg N fed $^{-1}$ respectively. Also rate of 50%MF+50%OM and 100%MF in compost was increased of ^{15}nitrogen transfer from the groundnuts to grain sorghum plants compared caw manure data recorded was 24.69, and23.30 kg N fed $^{-1}$.

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1. Introduction

In recent years, there has been increased interest in agricultural production systems in order to achieve high productivity and promote sustainability over time. From ancient times, farmers developed different cropping systems to increase productivity and sustainability; they included crop Rotation, relay cropping, and intercropping of annual cereals with legumes. Intercropping of cereals with legumes has been a common cropping system (**Lithourgidis *et al*. 2004 , 2006).** Intercropping of cereals with legumes improves soil conservation **(Anil *et al*., 1998)**, favours weed control (**Vasilakoglou *et al*., 2005**; **Banik *et al*., 2006**) yield stability (**Lithourgidis *et al*., 2006**).

Incorporation of plant residues in agricultural soils is a useful means to sustain soil organic matter content, and thereby enhance the biological activity, improve physical properties and increase nutrient availability (Kumar and Goh, 2000). The major limits on crop production in organic farming are the availability of soil nitrogen (N) and the control of weeds. In this context, cereal–legume intercropping may offer some benefits through increased N supply from biological N fixation (BNF) and by improved weed **(Sierra and Daudin, 2010).** Also, studied that Limited ^{15}N transfer from stem-labeled leguminous trees to associated grass in an agro forestry system. Total N transferred to the grass before pruning represented 0.27 kg N ha^{-1} day^{-1}, including 0.15 kg N ha^{-1} day^{-1} transferred from the fixed N. Because the relationship between %N transfer and %N fixed is constant, the discussion presented below on the factors affecting the spatial and the temporal trend of the total transfer can be also applied to the amount of N coming from N_2 fixation **(Sierra and Nygren , 2006).**

Low-level nitrogen in Sorghum Stover could be due to stage of maturity at harvest or the state of fertility of soil on which they are grown. Agronomic research have shown that, because legume are capable of fixing soil atmospheric nitrogen by symbiotic fixation mechanism, intercropping sorghum with legume may be a possible way of increasing the nitrogen level of Sorghum Stover. Another advantage of this (intercropping) is the increase of leaf area ratio, dry matter accumulation and grain yield. In addition, an added advantage of intercropping is increased organic matter content **(Quala *et al*., 2011).**

2. Materials and Methods

Field experiment were carried out at the Soils and Water Research Department, Nuclear Research Center, Atomic Energy Authority, Inshas, Egypt on Sorghum and Groundnuts intercropping field experiment as an indicator plant using the materials described below. The Soil sample were air dried, ground and sieved to pass through a 2 mm sieve then subjected to physical and chemical analysis whose results presented in "((Table 1))". Maize stalks, wheat straw and chickpea straw, used as plant residues and Caw manure & compost used as organic manure.

Table1. : Some chemical characteristics of the experimental plant residues and organic manure.

Determinations	**Maize stalk**	**Wheat straw**	**Compost**	**Chickpea straw**	Cow manure
C/N ratio	74.1	72. 58	12.62	29.66	26.0
O.M%	68.96	77.58	56.89	74.13	39.89
N %	0.54	0.96	2.83	1.45	0.89
P%	0.22	0.23	0.84	0.32	0.53
K %	0.39	0.751	0.692	0.980	0.507
Fe (µg g^{-1})	836.50	612.50	2897.5	835.83	2730
Cu (µg g^{-1})	111.75	106.42	212.25	114.17	148.08
Mn (µ g g^{-1})	120.50	117.00	137.83	102.75	130.75
Zn (µ g g^{-1})	161.42	135.5	155.08	225.25	222.58

They were air-dried, ground, thoroughly mixed and kept for some chemical analysis. Experimental work in "((Table 2))", Sandy soil used has pH 7.9; EC 0.27 dS m^{-1}, O.C 0.017%; O.M 0.03%; T.N 0.007%; C/N 2.43 and Ca CO_3 1.0%.

A field experiment carried out and arranged in a randomized complete blocks design with three replicates. The drip irrigation system occupied the main plots. Plant residues and caw manure were added before sowing 30 days while compost added was incorporates at planting. Groundnuts (cv. Giza 6) plants was grown either as sole crop or intercropped with Sorghum (cv. Gmaza 9). The intercropping ratios were 1:0 (Groundnuts sole crop, either Groundnuts or Sorghum), 0:1 (Sorghum sole crop), 1:1 (50% chickpea + 50% wheat). The experiment included 51 treatments. Groundnuts/Sorghum intercropping was carried as follows: - A- Groundnuts sole crop, B- Sorghum sole crop, C- 50% Groundnuts +50% Sorghum. The treatments comprises ;51 treatments with 3 replicate as follows :- 1- control ; 2- 100 % Mineral fertilizer; 3- five treatments 100 % organic manure , 4- five5 treatments 25% organic manure+ 75% Mineral fertilizer; five treatments50% organic manure+50% Mineral fertilizer. Treatment could be as follows:- T1 control,T2 100 % Mineral fertilizer (ammonium sulfate), T3 100 % compost ,T4 50 % compost + 50% Mineral fertilizer, T5 25 % compost + 75% Mineral fertilizer, T6 100 % cow manure, T7 50 % cow manure + 50% Mineral fertilizer, T8 25 % cow manure + 75% Mineral fertilizer, T9 100 % chickpea straw, T10 50 % chickpeas straw + 50% Mineral fertilizer, T11 25 %chickpeas straw + 75% Mineral fertilizer, T12 100 % Maize straw, T13 50 % Maize straw + 50% Mineral fertilizer, T14 25 % Maize straw + 75% Mineral fertilizer, T15 100 % wheat straw, T16 50 % wheat straw + 50% Mineral fertilizer, T17 25 % wheat straw + 75% Mineral fertilizer.

Image for Field Experiment

A basic supplemental of N, P and K fertilizers were applied to each plot ($1.60 \times 6m^2$) at the rate of 100 kg/ N fed^{-1} as organic materials or mineral fertilizer ammonium sulfate of sole sorghum crop. Intercropping system was 50 kg/ N fed^{-1} as organic manure or mineral fertilizer and sole groundnuts crop 20 kg/ N fed^{-1} as organic manure or mineral fertilizer, respectively. The phosphoric acid and potassium sulfate were applied as recommended basal doses Ministry of Agriculture. The field experiment, ^{15}N-Labeled ammonium sulfate with 2% ^{15}N atom excess were applied at rates of 100 or 50 kg N fed^{-1} as one full single dose after two weeks from sowing. Same chemical and physical analyses of tested soil samples were determined according to ***Page et al.*, (1982).** Plant digest samples were analyzed for N, P, K, Fe, Mn, Zn, and Cu according to **FAO Bulletin (1982).**

Calculations of N transfer : As the ^{15}N labeled plants and exudates displayed relatively low $\%^{15}N$ values, the enrichment of samples with ^{15}N was expressed as $\delta^{15}N$ (%) rather than as $\%^{15}N$ excess:

$$\delta^{15}N_{sa} = \frac{\text{atom }\%\ ^{15}N_{sa} - \text{atom }\%\ ^{15}N_{at}}{\text{atom }\%\ ^{15}N_{at}} \times 100 \quad (1)$$

Where the subscript sa and at refer to the sample and the atmospheric ^{15}N atom % (0.3663%), respectively. Proportion of N derived from transfer (%Ndft) per grass Total N was estimated separately for each study period:

$$\%\ Ndft(t) = \frac{\delta^{15}N_D(0) - \delta^{15}ND(t)}{\delta^{15}N_D(0) - \delta^{15}NG(t)} \quad (2)$$

Where the subscripts D and G refer to D. aristatum and to N derived from G. sepium, respectively, and 0 and t in parentheses refer to the values at the beginning of the experiment and by the end of each study period, respectively.

Total amount of N transferred (N_{tr}) to grass in treatments F_I and MY was calculated as

$$N_{tr} = \%\ Ndft(10)\ X\ N_D \quad (3)$$

Where $\%Ndft(10)$ is the proportion of N derived from transfer in grass at the end of the 10 week experiment, and N_D denotes the grass final N content. During the experiment, only samples of grass shoots were taken, and prior to the final harvest at week 10, N transfer was, therefore, calculated only as proportional and not in mass terms. Proportion of tree total N transferred to grass ($\%N_{tr}$) was, in turn, obtained from

$$\%N_{tr}=N_{tr}/N_G \quad (4)$$

Where, N_G is the final N content of *G. sepium*. Because of an uneven partitioning of the ^{15}N label within the tree, $D^{15}N$ values of tree roots and exudates may differ **(Sierra *et al.*, 2007).**

Statistical analysis: The analysis of variance for the final data was statistically assayed using the system ANOVA and the values L.S.D from the controls were calculated at 0.05 levels according to **SAS (1987).**

3. Results and Discussion

3.1. Grains yield of Sorghum plant and groundnut plants grown under sole and intercropping systems

Data presented in (Figs.1&2) show that, in general, grain accumulation in sole and intercropping systems for sorghum and groundnut plants were clearly influenced by the addition of organic and or / in organic nitrogen fertilizer . Also, data revealed that the amounts accumulated of sorghum grain yield were superior and more effect in intercropping than that in sole system while, the amounts of groundnut grain yield were the pest in sole system under all treatments .Consequently, in sole system, the high values of sorghum and groundnut grain yield were 11.646 and 1.640 ton /fed observed at o4 treatment in (50% MF- N+ 50% organic- N) ratio, which relatively increased by 56.36% and 16.46% over control, respectively.

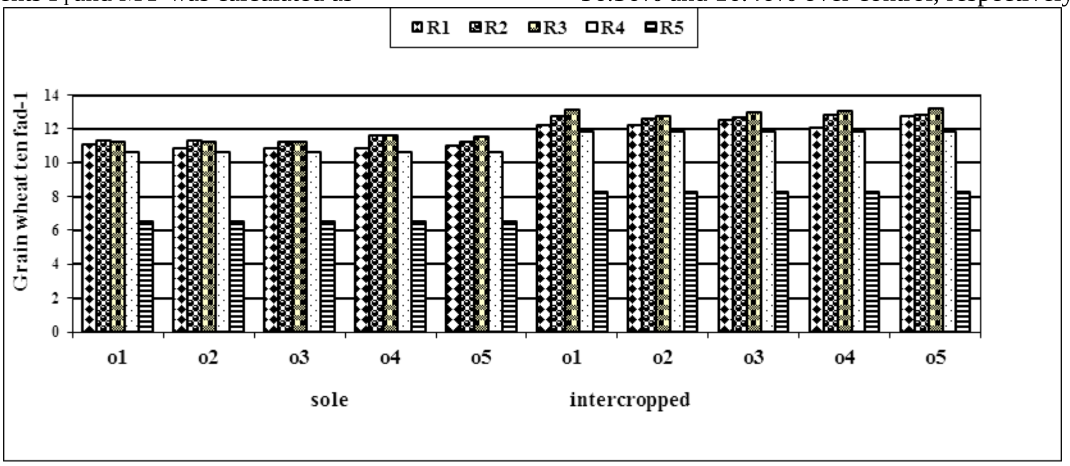

Figure 1. : Grains yield of Sorghum plant as affected by organic /inorganic fertilization under sole and/or intercropping systems ton fed^{-1}

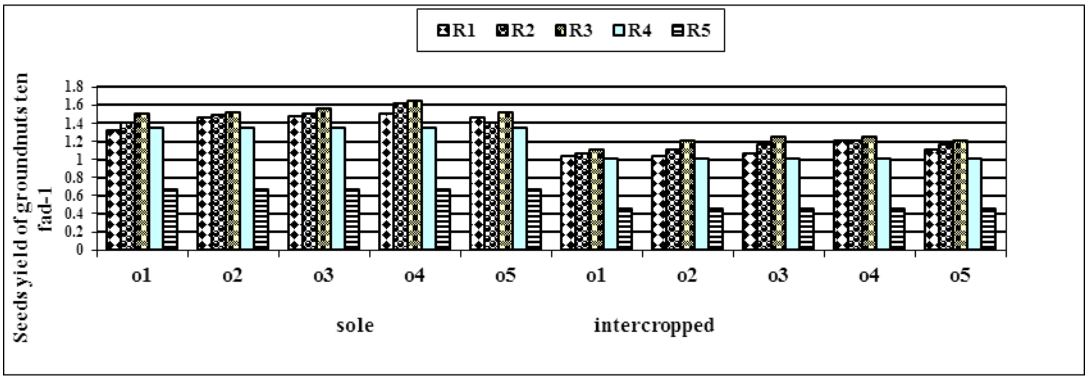

Figure 2. : Seeds yield of Groundnuts plant as affected by organic /inorganic fertilization under sole and/or intercropping systems ten/fed

For intercropping system, the values grain yield were 13.23 and 1.100 ton /fed observed under treatment of o5 and o1 in (50% MF- N+ 50% organic- N) ratio, which relatively increased by 62.8% and 41.6 over control at the same sequence. Our result demonstrated, intercropped groundnut DW and yield were significantly reduced with N fertilization, mostly when large amounts were applied N fertilizer.

Akhter *et al* . (2010) found the higher commutative grain yield of the mixed cropping system as compared to sole crop culture, All the tested wheat cultivars grown in association with chickpea produced almost two times more grain value per hectare compared to the same wheat cultivars grown alone. Although, the yield/grain value of wheat cultivars reduced in co-cropped because of land was partially occupied by the associated chickpea. However, the cumulative grain value of both the component crops was increased two fold over the value of wheat grown as pure crop stand. Also, showed that data of grain and straw yield of four wheat cultivars grown either as mono crop or intercropped with chickpea are given in mono cropping culture, wheat cultivar produced significantly higher grain (3335 kg ha^{-1}) and straw yield (6255 kg ha^{-1}) among all the tested wheat genotypes. In intercropping system, grain yield of wheat was decreased compared to their respective sole stand.

Bhim *et al*., (2005), reported an increase in total/cumulative yield of the crops grown in association as compared to the mono-crop culture, also reported that pea-heat mix cropping system increased total dry matter yield, total grain yield and their N accumulation compared to sole stand crop. Intercropping of cereals and legumes is important for the development of sustainable food production systems, particularly in cropping systems with limited external inputs (***Dapaah et al*., 2003)**. In the tropics, cereal/legume intercropping is commonly practiced because of yield advantages, greater yield stability and lower risks of crop failure that are often associated with monoculture (**Tsubo *et al*., 2005).** Higher wheat-equivalent yield when intercropped compared to respective monocrops was due to higher total productivity because intercropping exploited resources more efficiently **(*Midya et al*., 2005).** It may be due to the legume affect of chickpea on nitrogen nutrition of wheat or facilitative interaction in wheat–chickpea intercrops (**Li *et al*., 2004).**

Man Singh *et al*. (2010) Based on results, it is apparent that intercropping of fast growing fodder variety of cowpea both for fodder and green manure in menthol mint for 35 days improved the efficiency of nitrogen fertilizer and economized about 30 $kgNha^{-1}$, improved the soil fertility and yield of succeeding palmarosa crop. This practice is more beneficial when palmarosa or any cereal crop is grown as succeeding crop with limited fertilizer nitrogen. Significant positive interactions between cropping systems or manure and fertilizer treatments were consistently oted for yields and nutrient content of maize and pigeon pea as well as soil N and P status (**Kimaro *et al* ., 2009).**

Zhang *et al*. (2007) Show that Wheat yields was significantly different between intercrops and monoculture. Moreover, among the intercropping systems, the 3:1 system gave significantly higher wheat yields, averaged over 3 years, than the 3:2, 4:2 and 6:2 systems. Differences in grain yield between years were significant as well as the interaction between intercropping systems and years. Among intercropping treatments, no interaction between year and system was found. The interaction was thus wholly due to a comparatively large year effect in wheat monoculture, as a result of the high yield, in relation to the full land cover with the wheat crop. Averaged over three seasons, the grain yield in intercrops ranged from 70% to 79% of the yield in the monoculture (6550 kg ha^{-1}). The 3:1 system gave the highest wheat yield (79% of monoculture), followed by the 6:2 (73%), 3:2 (70%), and 4:2 (70%) systems.

Teklu and Hailemariam (2009) showed that the farmyard manure and N application rates as well as their interaction significantly affected the grain yield of wheat and tef, but their residual effect did not affect the yield of chickpea.

Ghosh (2004) show that cereal fodders depressed the yield of groundnut, an overall benefit was observed when yield of both the crops are considered together. Legumes growing in association or in rotation with cereal crop were found to improve soil fertility as in the**(Akhter *et al.*, 2010).**

3.2. Dry weight of Sorghum and groundnut shoots

Data in (Figures 3&4) pointed out, generally, that the shoot yield of sorghum and groundnut plants grown in sole and intercropping systems were not significantly affected by the application of organic and / or inorganic nitrogen fertilizer. On the other hand, in sole system, the high values of shoot yield were 12.772 and 1.638 ton/fed observed at o2 and o5 treatments in (50%MF-N+50%organic -N)ratio.

Which, relatively, it accounts for 48.85% and 34.48% over control, while, in intercropping system , the highest values of shoot yield were 3.696 and 11.13 ton/fed observed at o4 treatment in(50%MF-N+50%organic -N)ratio, relatively ,it accounts for 12.82% and 35.90 % over control for sorghum and groundnut plants, respectively.

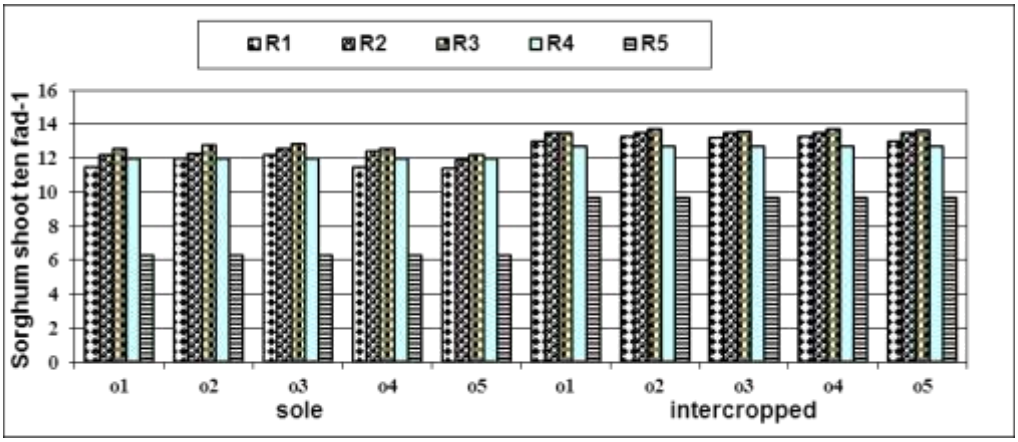

Figure 3. : Dry weight of Sorghum shoot as affected by organic /inorganic fertilization under sole and/or intercropping systems ten fed^{-1}

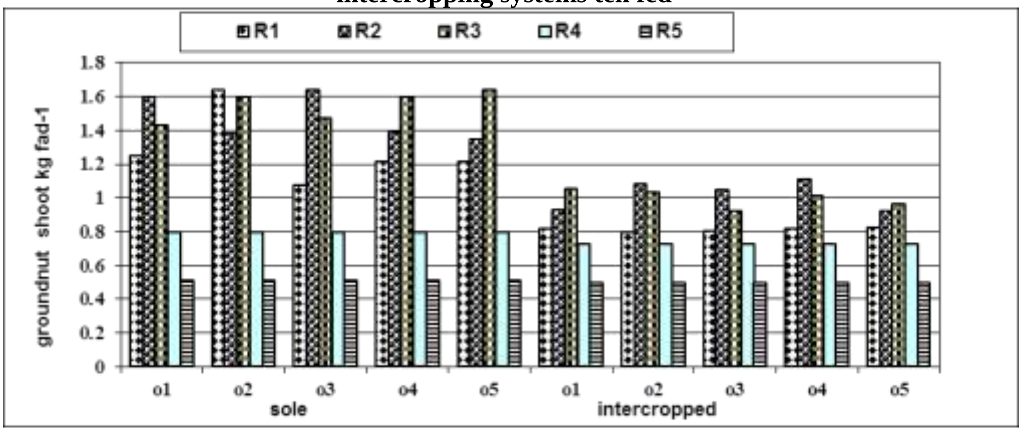

Figure 4. : Dry weight of Groundnuts shoot as affected by organic /inorganic fertilization under sole and/or intercropping systems kg/fed

Eskanderi (2011) found that, dry weight of all intercropping were significantly greater than those of sole crops were and exceeded the expected yield (sole been yield + sole wheat yield). In addition, data revealed that, weed dry weight in intercrops was greater than that for sole wheat. At different fertilizer –N levels to compare wheat and pea grown as sole crops or intercrops in a row – substitutive design. **Bedoussac and Justes (2010)** found that, the sole cropped and intercropped wheat dry weight (DW) and yield were significantly increased by fertilizer N in Exp 1.In Exp2, sole cropped wheat (DW) and field were significantly increased, intercropped pea DW and yield were significantly reduced with N fertilization , mostly when large amounts were applied N fertilizer .

Teklu and Hailemariam (2009) showed that the straw yield of durum wheat increased constantly with the increased M and N rates and intercropping. Unlike its grain yield, the maximum straw yield (4308 kg ha^{-1}) of durum wheat was obtained when the maximum rates of M and N (6 t

M ha^{-1}, 60 kg N ha^{-1}) were applied, while the minimum (1276 kg ha^{-1}) was under the control. Similarly, the straw yield of tef increased with increased rates of M and N, attaining the maximum with the highest rates (6 t M ha^{-1} and 60 kg N ha^{-1}).

Gue´nae¨ lle Corre, *et al*. (2009) results that the Barley dry matter accumulation and N acquisition clearly depended on N supply. Barley produced 2.7 and 11.4 t ha^{-1} of dry matter and accumulated 52 and 135 kg N ha^{-1} without and with applied N, respectively. Pea dry matter and N acquisition remained almost constant whatever the soil N supply during the vegetative phase but high soil N supply decreased crop growth and N accumulation after the beginning of pea flowering. At maturity, peas produced 7.7 and 4.7 t ha^{-1} of dry matter and accumulated 190 and 117 kg N ha^{-1} with and without applied N, respectively.

Akhter *et al*. (2010) found that the higher commutative grain yield of the mixed cropping system as compared to sole crop culture. **Bhim *et al*. (2005)** also, reported that the pea-heat mix cropping system increased total dry matter yield, total grain yield and their N accumulation compared to sole stand crop. Therefore in co-cropping system, the cumulative/total yield of both the component crops (wheat & chickpea) , is required to be considered, also, he found that higher cumulative grain yield of the mixed cropping system as compared to sole crop culture. Also, reported that pea-wheat mix cropping system increased total dry matter yield, total grain yield and their N accumulation compared to sole stand crop. **Akhter *et al*. (2010),** showed that data of grain and straw yield of wheat cultivars grown either as mono crop or intercropped with chickpea are given in mono cropping culture, wheat cultivar produced significantly higher grain (3335 kg ha^{-1}) and straw yield (6255 kg ha^{-1}) among all the tested wheat genotypes. In intercropping system, grain yield of wheat was decreased compared to their respective sole stand. **Hauggaard *et al*. (2001)** Show that the barley grain dry matter (DM) and N yield in both sole crops and intercrop was equivalent, whereas pea intercrop showed a considerable decline. The total intercrop grain yield was significantly greater than sole crop yields. The proportion of pea N in the total intercrop grain yield was greater than the proportion of pea in the grain dry matter yield.

3.3. Nitrogen uptake by Sorghum and groundnut

Concerning N-uptake by grain of sorghum and ground nut plants, data in fig 5&6, showed that, in general, mineral – organic –N sources which applied in different ratios, played goodly role in the increase of grains yield under sole and intercropping systems.

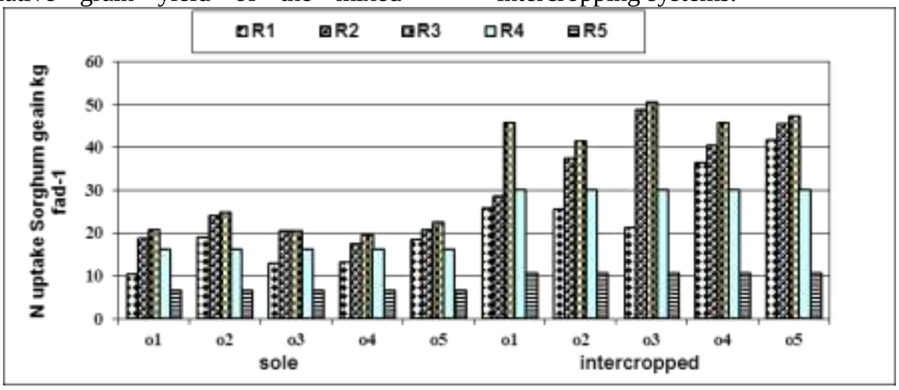

Figure 5. : N uptake of Sorghum grain as affected by organic /inorganic fertilization under sole and/or intercropping systems kg fed^{-}

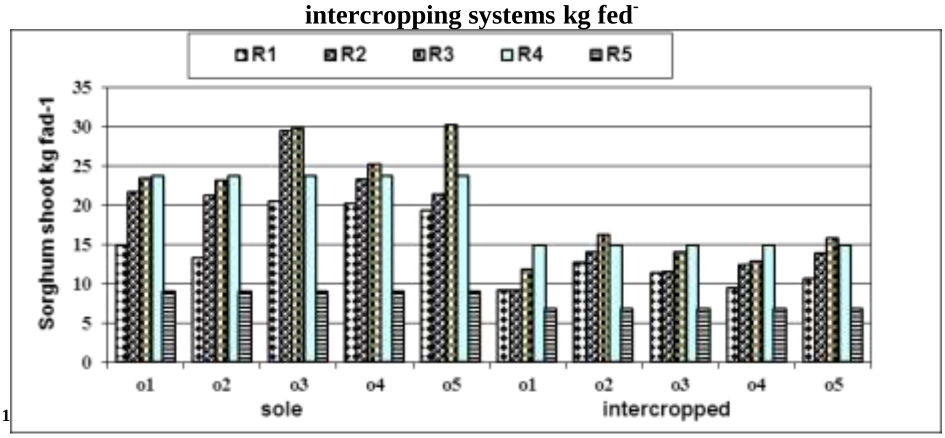

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Figure 6. : N uptake of Groundnuts Seeds as affected by organic /inorganic fertilization under sole and/or intercropping systems kg/fed

Consequently, the high values of N uptake by grain yield were 24.95 and 30.24 kg/fed observed at treatments of o2 and o5 which applied in (50%MF-N+50%organic -N) ratio under sole system, while, under intercropping system, the high values were 50.69 and 16.35 kg/fed observed at treatments of o3 and o2 in (50%MF-N+50%organic -N) ratio for sorghum and groundnut plants.

Data presented in (Figure 7&8) showed that, in general, N-uptake by shoot was more affected by the addition of organic mineral – N sources at different ratio under sole and intercropping system for sorghum and groundnut plants.

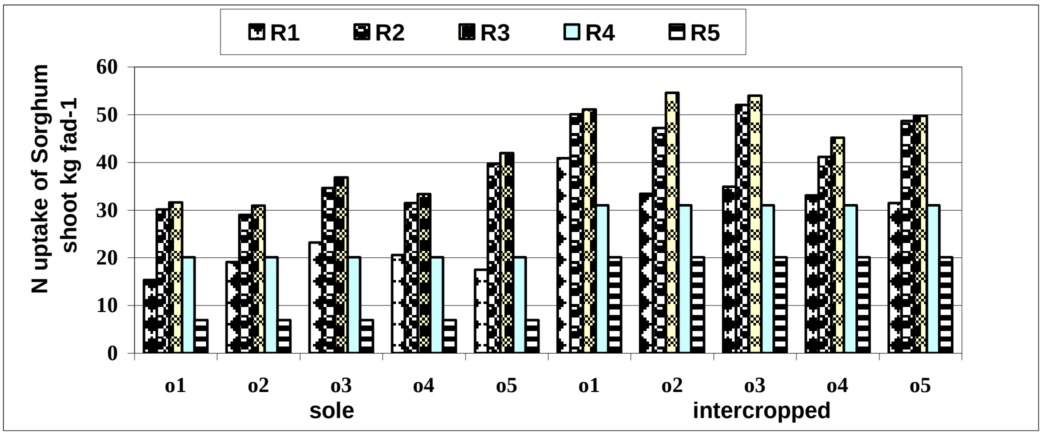

Figure 7. : N uptake of Sorghum shoots as affected by organic /inorganic fertilization under sole and/or intercropping systems kg/fed

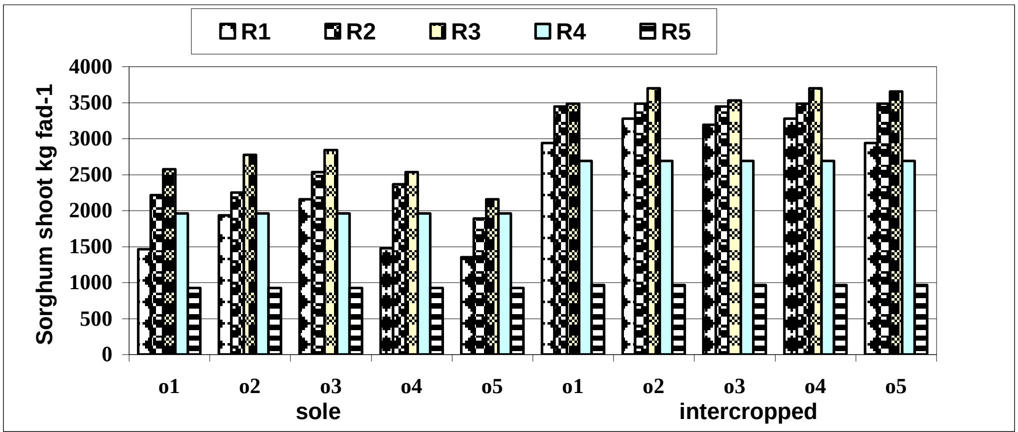

Figure 8. : N uptake of Groundnuts shoots as affected by organic /inorganic fertilization under sole and/or intercropping systems kg/fed

on the other hand, the high values of N-uptake by shoots under sole were, 41.92 and 23.25 kg/fed observed at o5 and o3 treatments in (50%MF-N+50%organic -N) and (75%MF-N+25%organic -N) ,while ,under intercropping system .the high values of N-uptake by shoot were 54.55 and 25.20 kg /fed observed at o2 and o1 treatments in (50%MF-N+50%organic -N) and (75%MF-N+25%organic -N) for sorghum and groundnut plants, respectively . In this regard, **Akhter *et al*. (2010)** showed that intercropped culture accumulated significantly higher N per hectare compared to sole wheat.

Hauggaard *et al*. (2009) found that Soil N uptake by barley in intercrops was associated with an increased reliance of pea on N_2-fixation, raising the percent of total N derived from N_2-fixation. However, there is a limit to the inter-specific competitive ability of barley towards soil N in order to keep a strong pea sink to hold up N demand and supply by pea. Independent of climatic growing conditions, including biotic and a biotic stresses, across European organic farming systems pea– barley intercropping is a relevant cropping strategy to adapt when trying to optimize N use and thereby N_2-fixation inputs to the cropping system accumulation in pea–barley intercrops and for predicting the composition of the final mixture according to soil N supply. **Akhter *et al*. (2010),** reported that an increase in grain yield, N uptake by plant and biological N fixation by legumes. **Ofosu-Budu *et al*., (1995)** study cereal-legume intercropping system, they revealed that nitrogenous compounds released mainly from the legume roots or on decomposition of the dead roots and nodule tissues could increase N supply to the associated cereals. **Gill and Azam., (2006)** also, reported an increase in N and P uptake by co-cropped wheat - soybean compared to wheat alone. **Hauggaard *et al*., (2001),** show that the average N concentration in pea and barley sole crop grains were 3.72 and 1.15% N, respectively, whereas pea and barley intercrop grains contained 3.81 and 1.28% N, respectively. The increase in barley grain N concentration due to intercropping was significant. **Thorsted *et al*. (2006)** showed that it is possible under conditions of good water supply to obtain grain yields in intercropped wheat and white clover that are similar to yields of wheat sole crops, but with a higher grain N concentration.

Hamdollah *et al*. (2010) reported that total nitrogen uptake was significantly affected by cropping system. All of intercrops took up signif-icantly larger than amounts of N than sole wheat, the N uptake by intercrops appeared greater than, for sole bean but was statistically not significant. There were no significant differences between intercrops. The mean nitrogen uptake averaged over three intercrops was 7.0 and 1.05 times greater than those sole wheat and sole bean, respectively. **Akhter *et al*. (2010)** showed that intercropped culture accumulated significantly higher N per hectare compared to sole wheat.

Zhao *et al*., (2010) found that the contents of N in leaves, stems, and panicles of wheat in intercropping are significantly, higher than, those of monocropping in heading and maturing stages. Intercropping can significantly increase N accumulation and N uptake rate of wheat plant compared with monocropping. N accumulation in plants of wheat increases by 15.5%to 30.4% in intercropping during growth stages. N accumulation and N content of wheat plant are increased with increasing of nitrogen supply in both monocropping and intercropping, but impacts of N supply on N content, N accumulation and N uptake rate of wheat plant are stronger in monocropping comparison with intercropping. Intercropping advantages reduce with increasing of N application rate. N supply influences intercropping advantages in wheat/ faba bean intercropping, and a rational N supply is important for crop. Other studies with mixtures of legumes and non-legumes also found that a high soil N supply reduced the intercrop advantage **(Schmidtke *et al*., 2004)**. The advantage of cereal sole or cereal intercropping systems can be attributed to significant complementarily in utilization of resources such as the use of different sources of nitrogen. Also, namely fixation of atmospheric nitrogen by legumes and utilization of mineral fertilizer by cereals, together with the utilization of environmental resources at different times during the different growth periods of the crop species (**Qiu-Zhu *et al.*, 2011) . Teklu and Hailemariam (2009)** showed that Similar to that of grain, the straw yields of durum wheat was significantly affected by the different rates of farm yard manure and N, and their interaction. While chickpeas' non-significant response was consistent with that of its grain yield, the straw yield of durum wheat increased constantly with the increased M and N rates.

3.4. Nitrogen transfer from the Groundnuts to shoots and grain of Sorghum

Nitrogen (^{15}N) transfer from the Groundnuts to shoots and grain of Sorghum as affected by organic/inorganic fertilization sources and rates under sole and/or intercropping systems g/plot was presented in "((Table 2))". Direct transfer of ^{15}N as reflected in the atom % ^{15}Nexcess of Sorghum is an estimate of the efficiency and speed at which the label is transferred from Groundnuts.

Table 2 : ^{15}N-transfer from Groundnuts plants to shoots and grains Sorghum plants as affected by organic/inorganic fertilization under sole and/or intercropping systems kg N fed^{-1}.

Organic amendment sources	shoot				grain			
	Mineral fertilizer rate				Mineral fertilizer rate			
	100%	75%	50%	mean	100%	75%	50%	mean
Caw manure	25.53	20.0	20	21.84	15.5	9.80	25.11	16.80
Maize stalk	24.31	18.17	21.23	21.24	6.63	13.52	16.71	12.29
Chickpea straw	11.71	17.38	17.13	15.41	8.31	28.46	30.25	22.34
Wheat straw	12.5	20	16.87	16.46	23.22	23.08	21.40	22.57
Compost	13.98	9.86	7.93	10.59	23.30	24.77	24.69	24.25
mean	17.61	17.08	16.63		15.39	19.93	23.63	

LSD: 0.05	Organic amendment source (O)	Mineral fertilizer rate (E)	Interaction Ox E
Grain	10.23	12.28	14.72
Shoot	25.98	31.19	37.38

The ^{15}N addition direct method attempted to quantify the appearance of the label in the receiver Sorghum plants, the^{15}N added direct method of groundnuts plants resulted in higher atom percentage^{15}Nexcess in sorghum plants using ^{15}N isotope dilation. Data showed that^{15}N-transfer from groundnuts to grain and shoots plants of sorghum was high significantly in hence by application of organic amendment. Results showed that caw manure , maize stalk and wheat straw treatment induced higher than compost and chickpea straw of ^{15}nitrogen transfer from the groundnuts to shoots was 21.48,21.24, 16.46 and 10.59 kg N fed $^{-1}$ for caw manure, chickpea straw , maize stalk , compost and wheat straw. Data demonstrate compost and wheat straw was significantly and positively of ^{15}N transfer from the groundnuts to grain sorghum plants compared to maize stalk and caw manure, data recorded ^{15}N transfer was 24.25,22.57,22.34,16.80,and 12.29 kgN fed^{-1}.

Under combined organic amendment with mineral fertilizer, data showed that the rate of 50%MF+50%OM and 75%MF+25%OM on positively increase than 100%MF of ^{15}N transfer from the groundnuts to shoots sorghum, accounted for 23.63,19.93,15.39 kg N fed^{-1} respectively. Also rate of 50%MF+50%OM and 100%MF in compost was increased of ^{15}nitrogen transfer from the groundnuts to grain sorghum plants compared caw manure data recorded was 24.69, and23.30 kg N fed^{-1} . Intercropping legumes and non-legume increases the opportunity for N-use complimentarily. Determining possible increases in N_2 fixation and N transfer to crops grown in association with legumes remains challenging as the ^{15}N-isotope dilution technique is the only method suited to the study of changes in N_2 fixation and N transfer in intercropping systems.

According to **Wikipedia (2011)**, nitrogen-fixing bacteria such as Azotobactor and Rhizobium, living in the soil and root nodule respectively, can convert the nitrogen in air directly in to nitrate which are soluble in the water. However, some plants are also capable of fixing atmospheric nitrogen because their roots have such nodules that contain nitrogen-fixing bacteria. These plants are leguminous, known as legumes. Bean plant is an example of a leguminous plant. The ammonia produced by nitrogen fixing bacteria is usually quickly incorporated into protein and other organic nitrogen compounds, either by a host plant, the bacteria itself, or another soil organism. **Sierra and Daudin (2010),** conclusion that, although N transfer estimated from natural ^{15}N abundance data confirms that this process may play an important role in the N economy of legume-based systems, these estimates could not be verified using a more reliable method based on tree ^{15}N labeling. Analysis of ^{15}N content in the tree-grass system indicates that the distribution of the ^{15}N added using the stem-labeling technique was limited in space and delayed in time, which prevented such verification. Further experimental work is necessary to develop tree labeling methods suitable to obtain more reliable estimates of in situ N transfer in agro forestry systems.

The observed and simulated values showed an increase in % Ndfa in intercrops compared to sole crops (**Gue´nae¨ lle Corre, *et al*., 2009),** as usually observed in cereal–legume intercrops **(Andersen *et al*. 2005).** The greater competitive ability of barley relative to peas for soil N during the vegetative phase results in a quick decline in soil N in intercrops entailing a higher % Ndfa in intercrops than in pea sole crops **(Corre-Hellou *et al*., 2006).**

Danso *et al.*, (1987) observed that N_2 fixation in faba bean increased when intercropped with barley. Similarly, when pea was intercropped with barley, the % NdfN_2 was significantly higher than for no cropped pea **(Jensen, 1996).** While other stud have produced mixed results, the total amount of N fixed per unit area in intercropped systems is often lower due to decreased legume population densities, and increased competition for light and nutrients by the non-legume. An increase in the total amount of N_2 fixed could occur when the intercropped legume uses more effectively limited resources. For example, intercropping climbing beans with maize plant could lead to an increase in leaf area index, plant biomass and N_2 fixation. When the ^{15}N-isotope dilution approach is used to quantify difference in N_2 fixation between mono and intercropped grain legumes, the assumption is made that the additional dilution of ^{15}N in the intercropped legume compared to the monocropped legume is caused by an increase in N_2 fixation. The validity of this assumption has not been widely tested. Following the application of labeled ^{15}N fertilizer, there is an initial ^{15}N enrichment of the available soil N pool, which then declines exponentially during the growing season **(Witty, 1983)**. Direct or indirect transfer of fixed-N to the intercropped non-legume has been observed **(Giller *et al*., 1991),** however, its agronomic significance remains unclear **(Giller and Cadisch, 1995).** Quantifying N transfer between legumes and non-legumes using ^{15}N-isotope dilution methods is dependent on the assumption that changes in the atom%^{15}N value of the intercropped non-legume are caused by transfer of less ^{15}N enriched N from the N_2-fxing legume to the non legume. The decline in the atom %^{15}N should not reflect a change in competition for N between the legume and non-legume. Furthermore, as N transfer is bi-directional. **Tomm *et al*. (1994)** mentioned that N accumulation by the non-legume represents net and not total N transfer. The simulated contribution of N_2 fixation varied between 49 and 69% in pea sole crop and between 78 and 91% in intercrops. On average, pea–barley intercrops reduced the amount of soil mineral N by 32%, reducing the risk of leaching. Big differences between pea sole crops and pea–barley intercrops were already observed at the beginning of pea flowering. Therefore, if the non-legume shows a different N uptake pattern than the legume, a subsequent difference in the atom % ^{15}N excess value of the legume and non-legume may not solely be the result of an increase in N_2 fixation but also due to the difference in the ^{15}N isotopic composition of the available N pool over time. **Abaidoo and van Kessel (1989)** grew nodulating and non-nodulating soybeans in monoculture and intercropped with maize. Both intercropped N_2-fxingand non-nodulating soybean showed a decrease in its atom % ^{15}N excess value compared to intercropped soybean. Obviously, decline in the atom % ^{15}N excess value of the intercropped non-N_2-fxing soybean was not due to an increase in N_2 fixation, but was likely the result of temporal and spatial differences in the accumulation of available soil ^{15}N by the two plant species over time. Similarly, a significant decline in the atom % ^{15}N excess value of maize grown intercropped with a non-nodulating soybean, **Martin *et al*. (1991)** cannot be interpreted as coming from N transfer and makes conclusions about possible changes in N_2 fixation by intercropped grain legumes precarious.

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