ISSN 2320-3862
JMPS 2015; 3(5): 07-13

Received: 06-06-2015
Accepted: 09-07-2015

A.F.A. Ebeid
Timber Trees Dept., Hort. Res. Inst. A.R.C., Egypt.

E.F. Ali
Flor. Dept. (Medic. & Arom. Plants), Fac. of Agric., Assiut Univ., Egypt.
Current Address: Taif University, Fac. of Science, Biology Dept. KSA

Mostafa, Mona M.A.
Flor. Dept. (Medic. & Arom. Plants), Fac. of Agric., Assiut Univ., Egypt.

Correspondence:
E.F. Ali
Flor. Dept. (Medic. & Arom. Plants), Fac. of Agric., Assiut Univ., Egypt.

Impact of alley cropping system amended with *Sesbania* and/or nitrogenous fertilizer on growth and yield of *Cymbopogon citratus* (DC) Stapf

A.F.A. Ebeid, E.F. Ali, Mostafa, Mona M.A.

Abstract
The influence of incorporation of *Sesbania* prunings with various rates of nitrogenous fertilizer on growth and yield of lemongrass grown in alley cropping system during 2013/2014 and 2014/2015 seasons were conducted. Alley cropping and N fertilizer improved the soil fertility during the two seasons. The growth and yield parameters (plant height, number of tillers/clump, number of leaves/clump as well as herb yield) were significantly enhanced when grown in alleys supplemented with prunings + 70 kg N/fed during the two seasons. Likewise, nitrogen and potassium contents were induced as a mean of the two cuts. On the other hand, the elevated of carbohydrates, volatile oil and phosphorus contents were observed of lemongrass only + no alley cropping but prunings from outside incorporated treatment compared to the other treatments. On the contrary, the lowest values of growth and yield characteristics for lemongrass were due to lemongrass as sole crop in the two seasons.

Keywords: Alley cropping, Nitrogenous fertilizer, lemongrass, *Sesbania sesban*, soil analysis.

1. Introduction
Cymbopogon citratus (D.C.) Stapf (Poaceae family), commonly known as lemongrass, is a perennial tropical grass with thin, long leaves and is one of the main medicinal and aromatic plants cultivated mostly for its essential oil in tropical and subtropical regions of Asia, South America, and Africa. The oil has considerable commercial importance because it is used in the manufacture of fragrances, flavors, perfumery, cosmetics, detergents, and pharmaceuticals. Moreover, oil possesses antibacterial, antifungal, analgesic, and mosquito repellent properties (Boukhatem *et al*., 2014) [6]. On the other side, in tropical Africa, nitrogen is the most limiting nutrient to crop production; high costs of inorganic fertilizers limit their use in sufficient quantities by most small holder farmers. This has led to increased interest in development of integrated soil fertility management systems that incorporate woody species into crop production systems where leafy biomass provide N to the annual crop. Trees and shrubs are used in hedgerow inter cropping cropland or parkland systems, improved fallows and shaded perennial-crop systems. Large amounts of N and moderate amounts of P have been observed in standing biomass, but much variation occurs in the recycling of these nutrients. However, leguminous trees species have shown some potential for soil fertility improvement through biomass transfer, short term fallows, nitrogen fixation, re-activation of the 'N bulge' and phosphorus scavenging (Hartemink *et al*., 2000) [12]. Also, Palada *et al*. (2005) [19] pointed out that traditional medicinal plants including lemongrass, basil and thyme can be grown in alleys formed by hedgerows of moringa with minimal negative effect on growth and yield during the early stage and competition for light was not critical at the early establishment period of hedgerows. Shukla *et al*. (2002) [24] study the productivity of *Sesbania* alley cropping system with sequentially cropped berseem and maize at different moisture regimes and fertilizers proved that the increase in biomass production of *Sesbania* was associated with reduction of berseem productivity in subsequent years. However, *Sesbania* alley did not significantly affect yield of maize crop over the years. Also, Zaharah *et al*. (2008) [26] study the relative contribution of hedgerow leguminous trees to the maize crop pointed out that leaf prunings from these tree species were easily decomposed and nutrients were released at a rapid rate. The leaf prunings contributed up to 15% of the N taken up by the maize. Hedgerow trees were found to contribute N to the maize, possibly through root decomposition. The results of Quinkenstein *et al.* (2009) [21] showed that alley cropping may be an ecologically advantage outland use system for sustainable food and biomass production in comparison with conventional agricultural practices. As a very flexible, but low-input system, alley cropping

can supply biomass resources in a sustainable way and at the same time provide ecological benefits. The influence of different foliar applications of nitrogenous fertilizer on growth, essential oil accumulation in lemongrass (*Cymbopogon flexuosus* L.) was studied by Aradhna and Yashpal (2014) [4]. Meanwhile, Saeopa and Karwyl (2012) [23] reported that intercropping lemongrass with green beans when the plants are still small will provide the crop with nitrogen, and will assist in weed control. The beans can be cut at ground level during harvesting, leaving the old roots in the soil and the tops as mulch. Hence, the objective of the present investigation was to examine the effect of *Sesbania sesban* prunings and different doses of urea for boosting of growth, biomass and essential oil content in lemon grass applied through foliar application at newly reclaimed soil in Aswan.

2. Material and Methods

This investigation was established during 2013/2014 and 2014/2015 seasons to study the effect of cropping system and different levels of nitrogen fertilization on growth and yield of lemongrass. The study area was located at the Tropical Farm, Kom-Ombo, Aswan, Egypt. Aswan Governorate is one of the hottest, sunniest and driest cities in the world. Averages high temperatures are consistently above 40 °C (104.0 °F) during summer (June, July, August and September) while averages low temperatures remain above 25 °C (77.0 °F). It is one of the least humid cities, with an average relative humidity of only 26%, with a maximum mean of 42% during winter and a minimum mean of 16% during summer. The initial levels of soil (loamy sand soil) pH, E.C. and organic matter were 8.4, 2.37 dsm^{-1} and 0.40%, respectively under irrigated conditions, in alley cropping system with *Sesbania*. Seeds of *Sesbania* were collected from neighboring field and planted during September 2012 in rows which were spaced at 3m apart and at a distance of 50 cm within the row.

2.1 Experimental design and treatments

The experiment was conducted with lemongrass in the interspaces of *Sesbania* hedge, to know the effect of incorporation pruning and different level of nitrogen fertilization on growth and yield of lemongrass. Twelve combination treatments involving cropping system as main plot (4 treatments) and different N level (3 treatments) as sub plot with three replications in split plot design of 3 x 3 m. They were as follows; Alley cropping + *Sesbania* prunings + 0 kg N/ fed., alley cropping + *Sesbania* prunings + 35 kg N/fed., alley cropping + *Sesbania* prunings + 70 kg N/fed., alley cropping + no prunings + 0 kg N/fed., alley cropping + no prunings+35 kg N/fed., alley cropping + no prunings + 70 kg N/fed., lemongrass only + no alley cropping but prunings from outside + 0 kg N/fed., lemongrass only + no alley cropping but prunings from outside + 35 kg N/fed., lemongrass only + no alley cropping but prunings from outside + 70 kg N/fed., lemongrass only + no alley cropping + 0 kg N/fed., lemongrass only + no alley cropping + 35 kg N/fed., lemongrass only + no alley cropping + 70 kg N/fed.

2.2 Procedures

For this purpose *Sesbania* trees were managed by periodic aboveground, leaving 1 m above the ground and leaf pruning carried out at the beginning and middle of the two cropping seasons per year (a total of four leaf prunings/year). Leaf prunings were added to the alleys formed by rows of trees and lemongrass. The leafy biomass was evenly spread on the ground and incorporated in the treatments designated to receive prunings described above. In the alleys, 6 rows of lemongrass were planted, 50 cm apart from each other with 50 cm distance between plants. The lemongrass plant propagated vegetatively through slips obtained by the splitting up of individual clumps; one healthy slip about 20 cm in length was planted per hill. N fertilizer (according to the treatments) were applied to the crop as urea (46% N) at three doses; the first dose at planting, the second dose after the first cut and the third dose after the second cut. The control plots; 0 kg N/fed. Treatment (did not receive any fertilizer). However, the crop was cut using sickles at about 10 cm above the ground. The first cut of lemongrass was taken after 90 days of planting and the second cut was taken 90 days after the first cut.

2.3 Growth and yield parameters for lemongrass

Growth parameters i.e., plant height, number of tillers per clump, number of leaves/ clump as well as herb yield (g/plant) were determined from 10 sampled plants per plot after the first and second cut per year of the crop. Volatile oil percentage was determined by water distillation method described in British Pharmacopea (1963) [9].

2.4 Determination of carbohydrate (%) in lemongrass

For carbohydrate determination of lemongrass leaves; randomly sample (100 mg of leaves) was hydrolysed in a boiling tube with 5 ml of 2.5 N HCl in a boiling water bath for a period of 3 hours. It was cooled to room temperature and solid sodium carbonate was added until effervescence ceases. The contents were centrifuged and the supernatant was made to 100 ml using distilled water. 0.2 ml of sample was pipetted out and made up the volume to 1 ml with distilled water. Then 1.0 ml of phenol reagent was added followed by 5.0 ml of sulphuric acid. The tubes were kept at 25-30 °C for 20 min. The absorbance was read at 490 nm (Krishnaveni *et al*., 1984) [15].

2.5 Soil analysis

Soil samples of each plot were collected before establishing the sesbania hedgerows and after the two intercropping seasons with lemongrass crop. The soil samples were randomly collected from 0-30 cm soil depth and bulked into a composite soil sample. The composite soil samples were air dried, grounded and sieved with 2 mm mesh for chemical analysis. Soil pH was determined in free ion water and KCl 1 M solution in 1:5 (soil: solution ratio), soil organic carbon by Walkey and Black procedure (Nelson, 1996) [18], total N by Kjeldahl method and available P by Bray 1 procedure (Bray and Kurtz, 1965). Potassium contents of the extract were determined with flame photometer. Meanwhile, Ca and Mg were determined with an atomic absorption spectrophotometer.

2.6 N, P and K analysis in lemongrass leaves

Nitrogen, phosphorus and potassium were determined in dried leaf samples of lemongrass, digested using sulphuric and perchloric acids method (Piper, 1967; Black *et al*., 1965; Jackson, 1978) [20, 5]

The obtained results were tabulated to statistical analysis using Michigan Statistical Program Version C (MSTATC). The analysis of variance (ANOVA) was performed to compare means. Means were compared using Least Significant Differences (LSD) test at 0.05 level.

3. Results and Discussion

Dry land agriculture is confronted with several problems, Alley cropping systems help to provide greater insurance against weather abnormalities. Generally, soil fertility parameters were improved after two years of continuous

cultivation and application of prunings and/or N fertilizer inputs, soil carbon, nitrogen, phosphorus, potassium, magnesium and calcium contents were increased while, soil pH was lower than that of the control by the end of 2014/2015 season (Table 1). Studies by Lal *et al.* (1978) [16] and Wilson *et al.* (1982) [25] also showed improvement in soil physio-chemical properties and biological activities, as measured by earthworm cast production, under *Stylosanthes guianensis*, *Centrosema pubescens*, *Pueraria phaseoloides* and *Mucuna pruriens* grown for only a short period, as compared with natural fallow. The cover crop improved soil bulk density and soil moisture retention and gave better protection against erosion. Also, higher microbial biomass was observed under *Psophocarpus palustris* live mulch than in bare plots.

Table 1: Some of the soil properties before planting (2013/2014) and after two cropping seasons (2014/2015) with *Seasbania* and N-fertilizer application.

Character	Value	
	2013/2014	2014/2015
pH	8.50	8.10
Organic C %	0.84	1.23
Total N %	0.09	1.40
P %	0.2%	4.11
Ca^{2+} %	1.4%	3.80
Mg^{+} %	0.4%	1.17
K^{+} %	0.7	1.84
E.C (dSm^{-1})	1.56	1.12

The performance of alley lemongrass, when fed with *Sesbania* prunings across different rates of N fertilization reflected significantly increased the plant height, number of tillers/ clump, number of leaves/clump and herb yield (g/plant) as tabulated in Tables (2, 3, 4 and 5). The maximum plant growth characteristics of lemongrass were recorded in the alley cropping + *Sesbania* prunings incorporated treatment while, the lowest was due to lemongrass only + no alley cropping. However, among different rates of N-fertilizers, 70 kg N/fed proved to be most effective across different cropping system as reflected by significantly the highest values of the growth parameters for lemongrass during the two seasons. Moreover, the second year of alley cropping gave more plant height, number of tillers/clump, number of leaves/clump as well as herb yield compared to the first year. Also, the second cut for the two seasons resulted in enhanced of growth parameters compared to the first cut. Alley and Vanlauwe (2009) [2] suggested that, as much as, 113 kg N/ha being derived from atmospheric N_2 in a nine-month fallow of *Sesbania sesban* and/or *Crotalaria grahamiana*, or as little as 23 kg N/ha fixed in other similar systems. Moreover, agro forestry systems complement conservation agriculture systems in the provision of soil cover, animal feed, nutrients, household fuel, and hillside protection against soil erosion and wind erosion control through shelter belts (Chandrakar *et. al*, 2014) [10].

Table 2: The effect of alley cropping system and N levels on plant height for lemongrass at the first and second cuts during 2013/2014 and 2014/2015 seasons in Aswan.

2013/2014										
	1st cut					**2nd cut**				
Treatments	**A1**	**A2**	**A3**	**A4**	**Mean**	**A1**	**A2**	**A3**	**A4**	**Mean**
B1	75.68	72.90	75.53	63.97	72.02	80.83	76.65	79.13	66.73	75.84
B2	87.47	84.27	86.04	74.36	83.04	87.37	82.80	86.20	73.03	82.35
B3	99.73	90.60	96.81	79.24	91.60	100.84	91.70	93.63	82.50	92.17
Mean	87.63	82.59	86.13	72.53		89.68	83.72	86.32	74.09	
LSD 5% alley cropping: 1.04 fertilization: 1.86 alley cropping X fertilization: 3.71						LSD 5%; alley cropping:1.11 fertilization: 2.39 alley cropping X fertilization: 4.77				
2014/2015										
	1st cut					**2nd cut**				
Treatments	**A1**	**A2**	**A3**	**A4**	**Mean**	**A1**	**A2**	**A3**	**A4**	**Mean**
B1	82.27	74.30	79.27	64.37	75.05	82.86	75.20	78.12	63.27	74.87
B2	93.12	83.72	85.93	77.48	85.06	90.53	84.74	86.83	75.72	84.46
B3	106.30	93.21	95.60	81.73	94.21	103.57	94.83	91.72	81.53	92.92
Mean	93.90	83.74	86.93	74.53		90.53	84.73	86.84	75.73	
LSD 5% alley cropping: 1.04 fertilization: 2.1 alley cropping X fertilization:4.36						LSD 5% alley cropping: 1.19 fertilization:2.13 alley cropping X fertilization:4.27				

A1: alley cropping + *Sesbania* prunings incorporated; A2: alley cropping + no prunings; A3: lemongrass only + no alley cropping but prunings from outside incorporated and A4: lemongrass only + no alley cropping. B1:0 kg N/ fed; B2:35 kg N/fed and B3:70 kg N/fed

Table 3: The effect of alley cropping system and N levels on number of tillers/clump for lemongrass at the first and second cuts during 2013/2014 and 2014/2015 seasons in Aswan.

2013/2014

	1st cut					2nd cut				
Treatments	**A1**	**A2**	**A3**	**A4**	**Mean**	**A1**	**A2**	**A3**	**A4**	**Mean**
B1	20.57	16.70	17.67	14.87	17.45	21.50	17.40	19.17	16.33	18.60
B2	25.73	21.70	22.80	16.37	21.65	26.50	22.17	24.17	18.07	22.73
B3	30.43	24.17	25.80	22.10	25.63	31.13	25.37	26.70	23.33	26.63
Mean	25.58	20.86	22.09	17.78		26.38	21.64	23.34	19.24	
LSD 5% alley cropping: 0.64 fertilization: 0.96 alley cropping X fertilization: 1.92						LSD 5% alley cropping: 0.43 fertilization:0.56 alley cropping X fertilization: 1.13				

2014/2015

	1st cut					2nd cut				
Treatments	**A1**	**A2**	**A3**	**A4**	**Mean**	**A1**	**A2**	**A3**	**A4**	**Mean**
B1	21.83	17.80	19.13	16.53	18.83	22.07	18.67	20.23	16.93	19.48
B2	26.47	22.37	24.17	18.73	22.93	27.10	23.07	24.37	19.60	23.53
B3	31.70	25.40	27.10	24.47	27.17	31.83	25.97	27.80	24.93	27.63
Mean	26.67	21.86	23.47	19.91		27.00	22.57	24.13	20.49	
LSD 5% alley cropping: 0.28 fertilization: 0.58 alley cropping X fertilization: 1.17						LSD 5% alley cropping:0.23 fertilization:0.51 alley cropping X fertilization:1.02				

A1: alley cropping + *Sesbania* prunings incorporated; A2: alley cropping + no prunings; A3: lemongrass only + no alley cropping but prunings from outside incorporated and A4: lemongrass only + no alley cropping. B1:0 kg N/ fed; B2:35 kg N/fed and B3:70 kg N/fed

Table 4: The effect of alley cropping system and N levels on number of leaves/clump for lemongrass at the first and second cuts during 2013/2014 and 2014/2015 seasons in Aswan.

2013/2014

	1st cut					2nd cut				
Treatments	**A1**	**A2**	**A3**	**A4**	**Mean**	**A1**	**A2**	**A3**	**A4**	**Mean**
B1	167.60	153.60	162.63	145.53	157.34	170.70	157.93	165.53	150.90	161.27
B2	178.17	165.10	171.03	157.63	167.98	180.33	167.60	171.73	162.53	170.55
B3	212.93	178.97	184.73	167.63	186.07	215.10	183.30	189.79	174.50	190.67
Mean	186.23	165.89	172.80	156.93		188.71	169.61	175.68	162.64	
LSD 5% alley cropping: 1.62 fertilization: 2.29 alley cropping X fertilization: 4.59						LSD 5% alley cropping: 1.04 fertilization: 1.89 alley cropping X fertilization: 3.78				

2014/2015

	1st cut					2nd cut				
Treatments	**A1**	**A2**	**A3**	**A4**	**Mean**	**A1**	**A2**	**A3**	**A4**	**Mean**
B1	173.23	162. 47	168.57	152.47	164.18	176.07	165.93	170.30	154.40	166.68
B2	182.63	172.23	173.57	164.30	173.18	184.47	174.40	174.90	165.33	174.78
B3	218.00	184.50	191.83	175.40	192.43	217.70	186.40	191.77	177.67	193.83
Mean	191.29	173.07	177.99	164.06		192.74	175.58	178.99	165.80	
LSD 5% alley cropping: 0.79 fertilization: 2.03 alley cropping X fertilization: 4.05						LSD 5% alley cropping: 0.68 fertilization: 1.86 alley cropping X fertilization: 3.73				

A1: alley cropping + *Sesbania* prunings incorporated; A2: alley cropping + no prunings; A3: lemongrass only + no alley cropping but prunings from outside incorporated and A4: lemongrass only + no alley cropping. B1:0 kg N/ fed; B2:35 kg N/fed and B3:70 kg N/fed.

Table 5: The effect of alley cropping system and N levels on herb yield (g/plant) for lemongrass at the first and second cuts during 2013/2014 and 2014/2015 seasons in Aswan

2013/2014

	1st cut					2nd cut				
Treatments	**A1**	**A2**	**A3**	**A4**	**Mean**	**A1**	**A2**	**A3**	**A4**	**Mean**
B1	213.27	130.01	181.23	108.20	158.18	224.62	135.23	184.42	117.61	165.46
B2	251.03	171.80	234.34	138.67	198.96	261.27	182.83	236.37	150.87	207.83
B3	276.43	218.10	243.78	162.08	225.09	287.47	227.90	257.23	176.57	237.29
Mean	246.91	173.30	219.78	136.31		257.78	181.99	226.00	148.34	
LSD 5% alley cropping: 2.93 fertilization: 5.74 alley cropping X fertilization: 11.48						LSD 5% alley cropping:1.87 fertilization:2.98 alley cropping X fertilization: 5.96				

2014/2015

	1st cut					2nd cut				
Treatments	**A1**	**A2**	**A3**	**A4**	**Mean**	**A1**	**A2**	**A3**	**A4**	**Mean**
B1	220.64	132.13	183.83	113.87	162.61	228.27	134.80	188.90	118.23	167.55
B2	258.36	177.17	234.03	145.17	203.67	267.40	183.53	242.51	155.75	212.31
B3	281.43	223.93	251.30	167.43	231.03	293.34	225.20	251.13	182.77	238.11
Mean	253.44	177.74	223.06	142.16		263.00	181.18	227.52	152.26	
LSD 5% alley cropping:1.62 fertilization: 3.96 alley cropping X fertilization: 7.92						LSD 5% alley cropping: 1.38 fertilization:2.69 alley cropping X fertilization: 5.39				

A1: alley cropping + *Sesbania* prunings incorporated; A2: alley cropping + no prunings; A3: lemongrass only + no alley cropping but prunings from outside incorporated and A4: lemongrass only + no alley cropping. B1:0 kg N/ fed; B2:35 kg N/fed and B3:70 kg N/fed.

Aradhna and Yashpal (2014) [4] found that foliar application of urea at 2 g/plant produced maximum plant height, number of tillers per plant and herb yield whereas maximum increase in essential oil content and leaf area was observed in treatment with 1.5 gm urea/plant as foliar application. The effect of different cropping systems and N fertilization on volatile oil content of lemongrass during 2014/2015 season. Among various alley cropping treatments, lemongrass only + no alley cropping but prunings from outside incorporated proved to be most effective across different cropping system as reflected by enhanced oil content in lemongrass. On the other hand the lowest oil content was noticed with lemongrass only + no alley cropping treatment. The lowest rate of N fertilization resulted in lower yields of oil during the first and second cut (Table, 6). The essential oils from a known weight of freshly harvested leaves were increased with increasing of nitrogen foliar application (Manjunatha *et al*. 2007) [17].

Similarly, the total carbohydrate content as shown in Table (6) due to this treatment, interaction effect between alley cropping and N rates treatments was also significant increased. On the contrary, sole lemongrass across the different rates of N fertilization resulted in lower growth as exhibited in significantly the lowest N, P and K contents as tabulated in Tables (7 and 8). The highest values of N and K contents in lemongrass were due to alley cropping + *Sesbania* prunings incorporated treatment in the first and second cuts while, the most increment of P content in lemongrass was noticed with lemongrass only + no alley cropping but prunings from outside incorporated treatment in the mean of two cuts. The superiority of alley lemongrass supplemented with loppings (alley cropping + *Sesbania* prunings incorporated treatment) and 70 kg N/ fed over other treatment combinations might be due to better growth and development of lemongrass plants, as indicated by vigorous lemongrass plants having higher plant height, number of tillers/clump, number of leaves/clump and high herb yield. Further, it can also be attributed to the beneficial effect of incorporation of *Sesbania* loppings and supplementation 70 kg N/fed. fertilization on soil properties (Krishna and Allolli, 2005) [14] who pointed out that soil fertility enhanced due to incorporation of loppings as exhibited by increased organic carbon content from initial value of 0.47 to 0.55 per cent. This was also attributed to the additions of N-rich organic materials and their residual effects compared to the continuous cropping without organic amendments. Significant increases in maize yields following addition of legume tree prunings have also been observed in previous studies (Akinnifesi *et al*., 2006) [1]. Similarly, Available P and K were higher in alley lemongrass plants than those in sole lemongrass. Thus favorable soil conditions under alley lemongrass might have helped it to express higher yield potential and enhanced quality traits. The beneficial effects of loppings as a mulch and organic water have been advocated by many research workers (Brewbaker, 1985; Rosecrance and Kuo, 1989) [8, 22]. Further, investigations also revealed the fact that alley crop supplemented with loppings had higher nitrogen, phosphorus and potassium content in their leaves. This might have been also one of the causes for enhancing yield and quality of lemongrass. These results were in conformity with (Haggar *et al*., 1991; Alloli, 1998; Krishna and Allolli, 2005) [11, 3, 14]. Integration of the medicinal plants especially that produced herb and leaves in an alley cropping system appears to be viable agroforestry practices as these systems not only addresses production function but also helps to abate some of the environmental problems such as soil erosion, low fertility etc. as these systems have inherent woody perennial component.

Table 6: The effect of alley cropping system and N levels on essential oil content% and total carbohydrate for lemongrass at the first and second cuts during 2014/2015 season in Aswan.

Essential oil										
	1st cut					**2nd cut**				
Treatments	**A1**	**A2**	**A3**	**A4**	**Mean**	**A1**	**A2**	**A3**	**A4**	**Mean**
B1	0.45	0.43	0.46	0.39	0.43	0.46	0.44	0.45	0.38	0.43
B2	0.46	0.45	0.48	0.41	0.45	0.47	0.45	0.48	0.42	0.46
B3	0.48	0.46	0.49	0.44	0.47	0.48	0.45	0.49	0.44	0.47
Mean	0.46	0.45	0.48	0.41		0.47	0.45	0.48	0.42	
LSD 5% alley cropping: 0.01 fertilization: 0.02 alley cropping X fertilization: 0.03						LSD 5% alley cropping: 0.01 fertilization: 0.02 alley cropping X fertilization: 0.04				
Total carbohydrate (mg mg^{-1} D.W.)										
	1st cut					**2nd cut**				
Treatments	**A1**	**A2**	**A3**	**A4**	**Mean**	**A1**	**A2**	**A3**	**A4**	**Mean**
B1	0.62	0.54	0.64	0.49	0.57	0.59	0.57	0.65	0.46	0.57
B2	0.70	0.63	0.73	0.58	0.66	0.72	0.56	0.76	0.55	0.65
B3	0.78	0.71	0.84	0.62	0.74	0.84	0.63	0.87	0.71	0.77
Mean	0.70	0.62	0.74	0.56		0.72	0.59	0.76	0.57	
LSD 5% alley cropping: 0.02 fertilization: 0.04 alley cropping X fertilization:0.09						LSD 5% alley cropping: 0.01 fertilization: 0.04 alley cropping X fertilization: 0.08				

A1: alley cropping + *Sesbania* prunings incorporated; A2: alley cropping + no prunings; A3: lemongrass only + no alley cropping but prunings from outside incorporated and A4: lemongrass only + no alley cropping. B1:0 kg N/ fed; B2:35 kg N/fed and B3:70 kg N/fed.

Table 7: The effect of alley cropping system and N levels on nitrogen and phosphorus content % in leaves for lemongrass at the first and second cuts during 2014/2015 season in Aswan.

Nitrogen content %										
	1st cut					2nd cut				
Treatments	**A1**	**A2**	**A3**	**A4**	**Mean**	**A1**	**A2**	**A3**	**A4**	**Mean**
B1	0.99	0.77	0.83	0.59	0.80	0.91	0.70	0.84	0.58	0.76
B2	1.23	0.80	0.95	0.73	0.93	1.08	0.81	0.91	0.70	0.87
B3	1.35	0.87	1.11	0.80	1.03	1.26	0.89	1.04	0.75	0.98
Mean	1.19	0.82	0.96	0.71		1.09	0.80	0.93	0.67	
LSD 5% alley cropping: 0.04 fertilization: 0.05 alley cropping X fertilization: 0.10						LSD 5% alley cropping: 0.01 fertilization: 0.04 alley cropping X fertilization:0.08				
Phosphorus content % in leaves										
	1st cut					2nd cut				
Treatments	**A1**	**A2**	**A3**	**A4**	**Mean**	**A1**	**A2**	**A3**	**A4**	**Mean**
B1	0.22	0.21	0.25	0.20	0.22	0.22	0.22	0.25	0.20	0.22
B2	0.27	0.23	0.27	0.22	0.25	0.25	0.24	0.28	0.22	0.25
B3	0.28	0.25	0.28	0.25	0.26	0.28	0.25	0.30	0.25	0.27
Mean	0.27	0.23	0.27	0.22		0.25	0.24	0.28	0.22	
LSD 5% alley cropping: 0.01fertilization: 0.01 alley cropping X fertilization: 0.03						LSD 5% alley cropping: 0.01fertilization:0.01 alley cropping X fertilization: 0.02				

A1: alley cropping + *Sesbania* prunings incorporated; A2: alley cropping + no prunings; A3: lemongrass only + no alley cropping but prunings from outside incorporated and A4: lemongrass only + no alley cropping. B1:0 kg N/ fed; B2:35 kg N/fed and B3:70 kg N/fed.

Table 8: The effect of alley cropping system and N levels on potassium content % in leaves for lemongrass at the first and second cuts during 2014/2015 season in Aswan.

Potassium content % in leaves 1st cut					
Treatments	**A1**	**A2**	**A3**	**A4**	**Mean**
B1	0.71	0.68	0.74	0.57	0.68
B2	0.89	0.88	0.95	0.71	0.86
B3	1.17	1.03	1.16	0.82	1.04
Mean	0.92	0.86	0.95	0.70	
LSD 5% alley cropping:0.03fertilization: 0.05 alley cropping X fertilization: 0.09					
Potassium content % in leaves 2nd cut					
Treatments	**A1**	**A2**	**A3**	**A4**	**Mean**
B1	0.75	0.71	0.73	0.53	0.68
B2	0.95	0.78	0.85	0.65	0.81
B3	1.18	0.89	1.09	0.74	0.97
Mean	0.96	0.79	0.89	0.64	
LSD 5% alley cropping: 0.03 fertilization: 0.04 alley cropping X fertilization: 0.07					

A1: alley cropping + *Sesbania* prunings incorporated; A2: alley cropping + no prunings; A3: lemongrass only + no alley cropping but prunings from outside incorporated and A4: lemongrass only + no alley cropping. B1:0 kg N/ fed; B2:35 kg N/fed and B3:70 kg N/fed.

4. References

1. Akinnifesi FK, Makumba WI, Kwesiga FR, Maghembe AJ. Sustainable maize production using gliricidia/maize intercropping in Southern Malawi. Expl Agric. 2006; 42:1-17.
2. Alley MM, Vanlauwe B. The Role of Fertilizers in Integrated Plant Nutrient Management. 1st ed., IFA, Paris, France, TSBF-CIAT, Nairobi, Kenya, ISBN, 2009, 59.
3. Alloli TB. Production potential of vegetable crops under eucalyptus and leucaena based agroforestry systems. Ph.D. thesis, University of Agricultural Sciences, Dharwad, 1998.
4. Aradhna S, Yashpal S. The effect of foliar applied urea on growth, yield, and oil contents of lemon grass variety-OD-19. Journal of Medicinal Plants Research 2014; 8(1):18-
5. Black CA, Evans DD, Ensminger LE. Methods of soil analysis. Agron J Amer Soc Agron Inc Publ., Madison, Wisconsin, U.S.A, 1965.
6. Boukhatem MN, Ferhat MA, Kameli A, Saidi F, Kebir HT. Lemon grass (*Cymbopogon citratus*) essential oil as a potent anti-inflammatory and antifungal drugs. Libyan J Med. 2014; 9:25431.
7. Bray RH, Kurtz LT. Determination of total, organic, and available forms of phosphorus in soils. Soil Sci 1945; 59:39-45.
8. Brewbaker JL. The tropical for maize cultivation. In: 'Breeding Stratgies for Maize Production Improvement in Tropics (Eds. Brandoline, A and F. Salamini), FAO, Italy, 1985, 47-77.
9. British Pharmacopea. Determination of volatile oil in drugs. Published by Pharmaceutical Press. London. W.C.I., 1963.
10. Chandrakar HL, Chandrakar K, Ujjaini M, Yadav KC. The effect of fertilization on growth & yield of rain fed blackgram in custard apple based agri-horti-system with alley cropping pattern on vindhyan soil. Inter J Sci Res Publi. 2014; 4(1):2250-3153.
11. Haggar JP, Warren GP, Beer JW, Kass D. Phosphorus availability under alley cropping and Mulched and unmatched sole cropping system. Plant and Soil 1991; 137:275-283.
12. Hartemink AE, Buresh RJ, van Bodegom PM, Braun AR, Jama B, Jassen BH. Inorganic nitrogen dynamics in fallows in maize on an Oxisol and Alfisol in the highlands of Kenya. *Georderma* 2000; 98:11-33.
13. Kawther AE, Selim SM, Nasr SA. Nitrate and nitrite accumulation in potato tubers in relation to mineral nitrogen and bio fertilization. Annals Agric. Sci 2002; 47:107-122.
14. Krishna BE, Allolli TB. Influence of Cropping System and Source of Nutrients in leucaena Based Alley Cropping System on Yield and Quality of Tomato. Karnataka. J Agric Sci. 2005; 18(2):464-468.
15. Krishnaveni S, Balasubramanian T, Sadasivam S. Phenol Sulphuric acid Method. Food Chemistry 1984; 15:229.
16. Lal R, Wilson GF, Okigbo BN. No-till farming after various grasses and leguminous cover crops on a tropical Alfisol 1. Crop performance. Field Crops Res 1978; 1:71-

84.
17. Manjunatha GO, Pradeep KH, Patil SK, Lamani VK. Effect of IBA and NAA on vegetative propagation of Sarpgandha through leafy and non leafy shoot cuttings. Biomed 2007; 4:335-341.
18. Nelson S, Total carbon, organic carbon, and organicmatter. In: Methods of Soil Anal. Part 2, 2nd ed., A.L. Page *et al*., Ed. Inc. Madison, WI. Agro. Am. Soc. Agro 1996; 9:961-1010.
19. Palada MC, Beeker BN, Mitchell JM, Nair PKR. The integration of medicinal plants and culinary herbs in agroforestry systems in the Caribbean: A study in the U.S. Virgin Islands. Proc. WOCMAP III, Conservation Cultivation & Sustainable Use of MAPs Eds.: A. Jatisatienr, T. Paratasilpin, S. Elliott, V. Anusarnsunthorn, D. Wedge, L.E. Craker and Z.E. Gardner Acta Hort. 676, ISHS 2005; 2:147-153.
20. Piper CS. Soil and Plant Analysis. 2nd Ed., Asia Pub. House, Bombay, India, 1967.
21. Quinkenstein A, Llecke JW, Bohm C, Grunewald H, Freese D, Schneider BU *et al.* Ecological benefits of the alley cropping agroforestry systemin sensitive regions of Europe. Environmental science and policy 2009; 12:1112-1121.
22. Rosecrance RC, Kuo W. Maize yields from an alley cropping experiment with nine tree species in Hawaii. Nitrogen Fixing Tree Research Report 1989; 7:36-37.
23. Saeopa A, Karwyl L. Lemongrass Production. Second print, Agriculture, Forestry and Fisheries, Republic of South Africa, Compiled by Directorate plant production in collaboration with members of Saeopa and Karwyl Consultancy, 2012, 20.
24. Shukla NP, Rekib A, Burman D. Productivity of *Sesbania* alley cropping system with sequentially cropped berseem and maize at different moisture regimes and fertilizers. Tropical Agricaltural Research and Extension 2002; 5(1-2).
25. Wilson GF, Lal R, Okigbo BN. Effects of cover crops on soil structure and onYIELD of subsequent arable crops grown under strip tillage on an eroded Alfisol. Soil Till. Res 1982; 2:233-250.
26. Zaharah AR, Chintu R, Ziana ZZ, Bah AR, Rashidah WAK. Management of Agroforestry Systems for Enhancing Resource use Efficiency and Crop Productivity. Iaea, Vienna, ISSN 1011- 4289, 2008.