Journal of Science and Technology 12 (03) December 2011
ISSN 1605 – 427X

www.sustech.edu

Effect of Nitrogen, Intercropping With Lablab Bean (*Lablab purpureus*) and Water Stress on Yield and Quality of Fodder Maize

Muna E. Khogali[1], Eltayeb E. A. Ahmed[2] and Sayda O. El Huweris[2]

1. Department of Animal Production, Faculty of Animal Production Science and Technology (Kuku), Sudan University of Science and Technology (www.sustech.edu), Sudan.
2. Department of Botany and Agricultural Biotechnology, Faculty of Agriculture, University of Khartoum, Shambat, Sudan.

ABSTRACT: This study was conducted during the Winter of 2000/01 and 2001/02. It aimsed to investigate the effects of nitrogen application and intercropping with lablab bean on green fodder yield and quality of fodder maize under water stress. Watering intervals of 10 and 20 days were applied four weeks from planting, nitrogen at a rate of 0 and 88kg N /ha was applied two weeks after sowing and planting methods were pure stand of maize, alternating rows and alternating holes of maize and lablab bean. The results showed that neither green fodder yield nor quality of fodder maize was significantly affected by watering intervals. Nitrogen significantly increased green fodder yield in the second season. However it had no effect on contents of crude fiber, calcium, potassium and magnesium but, it reduced phosphorus content and increased crude protein content significantly in the first season. Intercropping reduced green fodder yield significantly during both seasons, increased crude protein significantly, reduced crude fiber non-significantly, did not affect mineral contents of calcium, magnesium and phosphorus, but increased potassium content significantly in the first season. Significantly higher crude protein were attained by intercropped maize under different watering intervals and intercropped maize with nitrogen under different watering intervals in the first season.

KEY WORDS: *Nitrogen application, intercropping, green fodder yield, quality , water stress, Zea mays and Lablab bean.*

INTRODUCTION:

Evaluation of fodder crops is a function of both yield and quality or nutritive value. Fodder of high nutritive value is characterized by high protein content and high digestibility or low fiber content. Nitrogen is a vital element for both fodder quantity and quality as it is a component of protein and chlorophyll. It is thus, essential for photosynthesis, vegetative and reproductive growth and it often determines yield of maize (Igbal et al., 2006; Ayoub). Nitrogen is needed in greater amount than other elements, it can be supplied as a chemical fertilizer or fixed naturally by legumes which grow in a symbiotic relationship with nitrogen-fixing bacteria (Rhizobia) and this reduces the cost of production, compared to chemical nitrogenous fertilizers. In Sudan, studies on effects of nitrogen fertilization on yield and quality of fodder maize were carried under adequate irrigation conditions (Koul, 1997., Gassim, 2001). Irrigation increases and ensures yield in areas with limited rainfall and may permit harvesting of two crops per year instead of one. With the expansion of irrigated agriculture, Sudan will face increasing water shortage in the near future. Increasing demand for water may prompt the need for major changes in irrigation management and scheduling in order to increase the efficiency of crop water use (Kirda, 2000). On the other hand, to cope with the increase in animal population and the shortage in forage in natural rangeland, expansion in irrigated forages may become necessary (Elshiekh et al., 2006). Maize is one the forage crops that had the greatest impact on animal production in many parts of the world. In northern Sudan it is generally grown under irrigation. One way to save ivy's irrigation water is through lengthening of irrigation intervals. However, this may induce water stress and thus lessen yield and quality of maize. Intercropping grasses with legumes were claimed to increase the green fodder yield of the associated grass, improve crude protein content of the grass component (Nadeem et al., 2009), permit efficient use of water (Giller and Wilson, 1991), manages soil fertility (Njunie et al., 2004), controlstem borers with particular reference to *Chilo partellus* (Maluleke et al.,2005), permits better utilization of space and time (Osman and El Amin,1996) and the resources of water and soil nutrients and allow better use of sunshine by having leaf canopies at different heights which might increase the total amount of light intercepted and produce greater yield than an equal area of land devoted to single stand of the same crop (Giller and Wilson,1991). In Sudan, studies of grass /legumes intercropping included sorghum pioneer 88, Sudan grass, fodder sorghum (Abu Sabien) and some tropical grasses. However, very little information has been published regarding maize intercropping with legumes, although it is practiced traditionally in Northern Sudan. Therefore, it may be important to study the performance of fodder maize intercropped with legumes. In Sudan, fodder maize can be used to feed animals during fodder shortage period in early summer. Lablab bean is one of the main fodder crops in Sudan. Generally, its growth is not affected by low soil nitrogen content. Intercropping lablab bean with cereal fodder crop may improve the quality and palatability of the fodder and can be substituted for nitrogen which may be unaffordable by resource-poor farmers. The objectives of this research were to investigate the effects of water stress, nitrogen and maize/ lablab bean intercropping and their interaction on green fodder yield, nutritive value and chemical composition of fodder maize in winter.

MATERIALS and METHODS: Field experiment was conducted in November for two consecutive winter seasons (2000/01 and 2001/02) at the Demonstration Farm, Faculty of Agriculture at Shambat, University of Khartoum (Latitude 15^0 40^- N, longitude 32^0 32^- E). The climate of the site is a tropical semi-arid with low relative humidity. The soil of the experimental site is a heavy clay moderately alkaline and of very low permeability. Soil chemical analysis for average of nitrogen and pH are shown in table 1.

Table 1 Soil chemical analysis for avera[illegible]ogen and pH at the experimental area in 2000/01 - 2001/02.

Parameter	First season	Second season
Nitrogen %	0.05	0.053
pH Values	7.9	7.9

The land was ploughed by a disc plough, leveled and ridged 70 cm apart. The experimental design used was Randomized Complete Block arranged in split- split plots, with three replicates. Area of the main plot was 15 mx 8m, the sub-plot area was 15 mx 4 m and that of sub-sub plot was 5 mx 4 m with four rows of four meters length. There was a marginal area of one meter between blocks and main plots as guard area for water control. Maize, cultivar Mugtama 45 and Lablab bean, local type, were used. The crop was irrigated at 7-10 days interval for establishment. The watering treatments were applied to main plots and introduced at the age of four weeks by withholding water for 10 days (W_1) and 20 days (W_2). Nitrogen as urea (46%N), was applied once two weeks after sowing to sub-plots at a rate of 0(0N) and 88kgN/ha (2N). Three planting methods (pm) were allotted to sub-sub-plots: pure stand of maize (PS) planted at a rate of 7 seeds/hole and 10cm apart, alternating rows (AR) planted at the seed rate of 7 seeds/hole and 10 cm apart for maize and 4 seeds/hole and 30cm apart for Lubia and alternating holes (AH) of maize and Lubia at the rate of 7seeds for maize and 4 seeds/holes for Lubia and 20 cm apart. Planting on the top of ridges was done by "Khulal" which is a local planting stick. Two months form planting, plants were sprayed with Folimat against stem borer in the first season.

In the second season two sprayings of Folimat were carried out as preventive measures, one after three weeks and the other after nine weeks from planting. Weeding was done manually during both seasons. Also, a field survey was carried out to test the presence and effectiveness of root nodules by cutting them across and observing the presence of leghaemoglobin which gives the nodules its red functional color. Plants in an area of $0.7m^2$ for pure stand and $1.4m^2$ for alternating rows and alternating holes in the middle ridges of each experimental unit were cut at ground level by sickle (Mungal) and weighed in the field for green yield which was converted to tons per hectare. Five plants from each plot at harvest were completely dried and ground for chemical analysis. Crude protein was determined by micro-Kjeldahl method, and crude fiber according to A.O.A.C (1981). Mineral elements were determined after ashing: phosphorous was measured by spectrophotometer (spectronic 21); potassium was obtained by using coring 400 flame photometer; calcium and magnesium were found by titration with versenate (EDTA). Standard analysis of variance appropriate for split-split- plot design was applied (Gomez and Gomez, 1984). Means were separated by the least significant difference, (LSD) and Duncan Multiple Range Test (D.M.R.T) procedures.

RESULTS and DISCUSSION:

Green fodder yield was not significantly affected by watering intervals during both seasons (Table 2), despite that, a reduction was observed under the long watering interval in the second season. Similar results were reported by Saeed (1988) working on fodder sorghum. This suggested that maize can withstand withholding water for up to 20 days, under conditions similar to those of the present study, without it’s a serious reduction in yield. Nitrogen fertilization had no effect on green fodder yield in the first season. However, a significant increase was obtained in the second season (Table 2). This finding was supported by Hussein (1999) for Pioneer 988 and Omer (1998) for fodder maize. The lack of response to the opplied nitrogen in the first season may be attributed to hevey infestation by stem borer which was more serious in the fertilized plants than the control ones Asimilar finding was reponted by Maluleke, (2005). The significant reduction in fodder yield caused by intercropping (Table 2) was also reported by Ayoub et al. (2004). However, contradictory findings were reported by Ahmed (2006) and Ayoub and Shoaib (2009). The higher green yield produced in the second season may be attributed to effective large nodules and absence of stem borer in that season. The non-significant effect of watering on crude protein content (Table 2 was also reported by Saeed (1988) who found no significant difference in crude protein content of fodder sorghum as a result of different irrigation intervals. Table 2 shows that nitrogen positively affected crude protein content with a significant increase in the first season. This increase is in line with the findings of Koul (1997), Igbal et al. (2006) and Ayoub et al. (2007). Intercropped maize signifycantly exceeded that in pure stand in crude protein content (Table 2). Supporting evidence was reported by Ayoub et al. (2004) and Nadeem et al. (2009). Also, Mapairwe et al. (2002) stated that intercropping fodder legumes with cereals generally resulted in higher fodder crude protein than maize in pure stand. Papas-tylianou (1999) attributed this result to nitrogen transfere from legumes to the associated grass in mixture. Crude protein content was significantly affected by watering x planting methods interaction in the first season only, at the same watering interval, intercropping improved crude protein content of fodder maize (Table 3 and 4). It would seem that the plants made more use of natural nitrogen from inter-cropping in improving protein content than from applied nitrogen when water availability is variable. Watering x nitrogen x planting methods inte-raction effect on crude protein was significant during the first season (Table 6).The highest crude protein contents were observed in intercropped maize with nitrogen under different watering intervals and this may indicate the role of nitrogen from chemical and biological sources in improving crude protein content of fodder maize.

In the present study, neither watering intervals nor nitrogen application or intercropping had any significant effect on crude fiber content (Table 2). Omer (1998) reported that crude fiber content of fodder maize is slightly affected by nitrogen. The non-significant reduction in crude fiber content of maize may be related to the reported inverse relationship between crude fiber and crude protein content (Gasim, 2001). There was no significant effect of watering intervals on mineral contents (Table 2). Despite that, calcium and potassium contents were increased by the short watering interval while magnesium and phosphorus were reduced. Nitrogen application significantly reduced phosphorus content in the first season, reduced calcium content non-significantly in both seasons and insignificantly increased magnesium content in the first season only (Table 2). The reductions in phosphorus and calcium contents due to nitrogen application were supported by the finding of Nadeem et al. (1997). The non-significant effects of nitrogen application on potassium and magnesium contents were in line with the result of El Agib (1997) who reported that potassium and magnesium contents of maize leaves were not significantly affected by urea fertilization. Intercropping increased calcium, magnesium, potassium and phosphorus contents in both seasons and the increase was significant for potassium in the first season (Table 2). Saren and Jana (1999) in India reported that total NPK (nitrogen, phosphorous and potassium) uptake was higher in intercropped maize with pigeon pea than in pure stand of either crop. The significant difference in calcium content due to interaction effect between watering and planting methods in the second season (Table 4), when the highest content was obtained by intercropped maize under short watering interval, is in accord with the result obtained by Saren and Jana (1999), who reported greater uptake of calcium by intercrops. In conclusion, yield and quality of fodder maize were not significantly affected by watering intervals. However, green fodder yield was improved under short watering interval. Intercropping significantly increased protein content and reduced crude fiber content, so it increased nutritive value of maize. Nitrogen improved both yield and protein content of fodder maize. Under water stress crude protein content and mineral content of intercropped maize were increased but, its crude fiber content was reduced during both seasons. Intercropped maize had higher contents of mineral elements, lower content of crude fiber and higher content of crude protein in the second season compared to pure stand of maize with applied nitrogen. Under conditions of water stress and no nitrogen application, intercropped maize had higher crude protein content and low crude fiber content. No significant difference between alternating rows and alternating holes in yield, contents of crude fiber and crude protein but, higher yield was obtained by alternating rows and higher crude protein content was observed for alternating holes pattern of intercropping. The reduction in yield of intercropped maize can be compensated by associated legume (Lablab bean) and together (Maize and Lablab bean) may provide more palatable and nutritious fodder.

Table 2. Effects of watering, nitrogen and planting methods on green fodder yield and quality of fodder maize for two seasons.

Treatment		First season							Second season						
		Green fodder yield T/ha	CP%	CF%	Ca%	Mg%	K%	P%	Green fodder yield T/ha	CP%	CF%	Ca%	Mg%	K%	P%
watering	W_1	11.3	5.3	34.2	0.26	0.18	1.45	0.66	50.0	6.6	34.7	0.42	0.27	0.84	0.19
	W_2	12.0	5.3	33.6	0.23	0.19	1. 44	0.69	38.6	7.1	34.6	0.36	0.31	0.83	0.20
	SE±	0.9	0.3	0.5	0.04	0.01	0.04	0.02	3.5	0.9	0.5	0.03	0.02	0.06	0.02
	LSD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrogen	N_0	12.2	4.6	33.8	0.26	0.18	1.41	0.76	33.5	6.5	34.0	0.40	0.30	0.81	0.23
	N_2	11.1	6.0	33.9	0.23	0.19	1.48	0.60	55.1	7.1	35.2	0.37	0.28	0.86	0.16
	SE±	1.1	0.1	0.4	0.01	0.03	0.07	0.03	4.3	0.5	1.0	0.01	0.01	0.07	0.02
	LSD	NS	0.5*	Ns	NS	NS	NS	0.12*	16.8*	NS	NS	NS	NS	NS	NS
Planting Methods	PS	21.1	4.9	35.1	0.20	0.17	1.35	0.69	59.4	5.7	35.1	0.37	0.30	0.76	0.20
	AR	7.0	5.5	33.1	0.25	0.17	1.58	0.71	38.6	6.9	33.8	0.37	0.28	0.84	0.20
	AH	6.9	5.6	33.5	0.29	0.21	1.40	0.63	34.9	7.9	35.0	0.43	0.29	0.90	0.19
	SE±	1.1	0.1	1.2	0.04	0.03	0.06	0.03	3.9	0.6	1.0	0.03	0.03	0.18	0.02
LSD		3.3*	0.3*	NS	NS	NS	0.18	NS	11.4*	1. 7*	NS	NS	NS	NS	NS

NS=not significant/* significant at 5% level, Watering treatments: W1 = watering every 10 days; W2 = watering every 20 days, Nitrogen fertilization: N =1N nitrogen; 2N = 88 kg N/ ha, Planting methods: PS = Pure stand of maize; AR = Alternating rows of maize and lablab bean; AH alternating holes of maize and lablab bean.

Table 3 Effect of watering X nitrogen interaction for green fodder yield and quality of fodder maize for two seasons

Treatment	First season							Second season						
	Green fodder yield T/ha	CP%	CF%	Ca%	Mg%	K%	P%	Green fodder yield T/ha	C.P%	CF%	Ca%	Mg%	K%	P%
$W_1 N_0$	12.8	4.5	33.7	0.28	0.16	1.38	0.74	32.9	6.5	35.3	0. 45	0.28	0.80	0.22
W_1N_2	9.7	6.2	34.7	0.25	0.21	1.51	0.59	67.2	6.7	34.1	0.38	0.25	0.88	0.15
W_2N_0	11.5	4.8	33.9	0.25	0.21	1.44	0.78	34.1	6.5	32.8	0.35	0.31	0.82	0.23
W_2N_2	12.5	5.9	33.2	0.21	0.16	1.44	0.60	43	7.6	36.3	0.36	0.31	0.84	0.17
SE $\pm$	1.5	0.2	0.6	0.02	0.04	0.10	0.04	6	0.7	1.5	0.02	0.01	0.1	0.03
LSD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS=not significant/*significant at 5% level, Watering treatments: W1 = watering every 10 days; W2 = watering every 20 days, Nitrogen fertilization: N0 = No nitrogen; N2 = 88 kg N/ ha, Planting methods: PS = Pure stand of maize; AR = Alternating rows of maize and lablab bean; AH alternating holes of maize and lablab bean.

Table 4 Effects of watering X planting methods interaction for green fodder yield and quality of fodder maize for two seasons.

Treatment	First season							Second season						
	Green fodder yield T/ha	C.P%	C.F%	Ca%	Mg%	K%	P%	Green fodder yield T/ha	CP%	CF%	Ca%	Mg%	K%	P%
W_1PS	20.7 a	5.0 bc	35.0 a	0.20 a	0.17 a	1.36 a	0.68 a	68.1a	5.7 a	35.5 a	0.33 ab	0.33 a	0.75 a	0.21a
W_1AR	7.2 a	5.2 bc	33.0 a	0.24 a	0.14 a	1.56 a	0.68 a	43.3 a	6.0 a	34.6 a	0.48 a	0.22 a	0.86 a	0.16 a
W_1AH	6.0 a	5.8 a	34.5 a	0.35 a	0.24 a	1.44 a	0.64 a	38.6 a	8.0 a	36.0 a	0.44 a	0.25 a	0.92 a	0.21 a
W_2 PS	21.4 a	4.8 c	35.1 a	0.20 a	0.18 a	1.34 a	0.71 a	50.6 a	5.6 a	36.6 a	0.40 ab	0.27 a	0.78 a	0.19 a
W_2 ♀AR	6.8 a	5.9 a	33.1 a	0.26 a	0.21 a	1.61 a	0.75 a	33.9 a	7.9 a	33.0 a	0.26 b	0.33 a	0.82 a	0.24 a
W_2 AH	7.8 a	5.4 ab	32.5 a	0.23 a	0.18 a	1.37 a	0.62 a	31.2 a	7.8 a	34.1 a	0.41 ab	0.33 a	0.88 a	0.17 a
SE $\pm$	1.5	0.2	1.7	0.05	0.04	0.08	0.04	5.5	1.1	2.0	0.05	0.05	0.16	0.03

Means within column followed by the same letters are not significantly different using Duncan Multiple Range Test at 5%, Watering treatments: W1 = watering every 10 days; W2 = watering every 20 days, Nitrogen fertilization: N0 = No nitrogen; N2 = 88 kg N/ ha.
Planting methods: PS = Pure stand of maize; AR = Alternating rows of maize and lablab bean; AH alternating holes of maize and lablab bean.

Table 5. Effect of nitrogen X planting methods interaction for green fodder yield and quality of fodder maize for two seasons.

Treatment	First season							Second season						
	Green fodder yield T/ha	C.P%	C.F%	Ca%	Mg%	K%	P%	Green fodder yield **T/ha**	C.P%	CF%	Ca%	Mg%	K%	P%
N_0PS	22.1 a	4.2 a	34.0 a	0.20 a	0.18 a	1.28 a	0.77 a	49.5 a	5.6 a	33.8 a	0.38 a	0.33 a	0.79 a	0.21 a
N_0AR	7.0 a	4.6 a	33.3 a	0.29 a	0.19 a	1.51 a	0.83 a	47.4 a	6.5 a	33.8 a	0.39 a	0.26 a	0.79 a	0.25 a
N_0AH	6.7 a	5.0 a	34.1 a	0.30 a	0.19 a	1.46 a	0.68 a	23.6 a	7.5 a	34.5 a	0.43 a	0.31 a	0.85 a	0.23 a
N_2 PS	19.3 a	5.5 a	36.1 a	0.20 a	0.17 a	1.41 a	0.62 a	69.2 a	5.7 a	36.3 a	0.35 a	028 a	0.74 a	0.19 a
N_2♀AR	7.1 a	6.4 a	32.8 a	0.21 a	0.16 a	1.66 a	0.60 a	49.9 a	7.4 a	33.8 a	0.35 a	0.30 a	0.89 a	0.15 a
N_2 AH	7.0 a	6.2 a	32.9 a	0.28 a	0.23 a	1.35 a	057 a	46.2 a	8.3 a	35.6 a	0.42 a	0.27 a	0.95 a	0.15 a
SE$\pm$	1.5	0.2	1.7	0.05	0.04	0.08	0.04	5.5	1.1	2.0	0.07	0.07	0.16	0.03

Means within column followed by the same letters are not significantly different using Duncan Multiple Range Test at 5%, Watering treatments: W1 = watering every 10 days; W2 = watering every 20 days, Nitrogen fertilization: N0 = No nitrogen; N2 = 88 kg N/ ha.
Planting methods: PS = Pure stand of maize; AR = Alternating rows of maize and lablab bean; AH alternating holes of maize and lablab bean.

Table 6 Effects of watering, nitrogen and planting methods on green fodder yield and quality of fodder maize for two seasons.

	Green fodder yield T/ha	C.P%	C.F%	Ca%	Mg%	K%	P%	Green fodder yield T/ha	C.P%	CF%	Ca%	Mg%	K%	P%
W_1 N_0PS	23.8 a	4.2 f	32.8 a	0.20 a	0.16 a	1.21 a	0.69 a	51.4a	5.6 a	33.1 a	0.32 a	0.36 a	0.73 a	0.21 a
W_1 N_0AR	8.1a	4.5 f	33.2 a	0.29 a	0.13 a	1.48 a	0.82a	25.9a	4.9 a	37.5 a	0.55 a	0.19 a	0.83 a	0.19 a
W_1 N_0AH	6.7a	4.8cdef	35.3 a	0.34 a	0.18 a	1.46 a	0.70 a	21.2a	8.8 a	35.3 a	0.48 a	0.30 a	0.85 a	0.27 a
W_1 N_2 PS	17.6a	5.8 b	37.3 a	0.20 a	0.18 a	1.50 a	0.66a	84.8a	5.8 a	33.9 a	0.35 a	0.30 a	0.76 a	0.20 a
W_1 N_2AR	6.3a	6.0 b	32.9 a	0.19 a	0.16 a	1.63 a	0.53 a	60.7a	7.0 a	31.6 a	0.40 a	0.25 a	0.88 a	0.12 a
W_1 N_2AH	5.2a	6.9 a	33.8 a	0.35 a	0.30 a	1.41 a	0.58 a	56a	7.2 a	36.7 a	0.40 a	0.20 a	0.99 a	0.14 a
W_2 N_0PS	21.9a	4.2 f	35.3 a	0.20 a	0.19 a	1.34 a	0.84 a	47.6a	5.5 a	34.5 a	0.45 a	0.29 a	0.85 a	0.20 a
W_2 N_0AR	5.8a	4.8cdef	33.4 a	0.29 a	0.25 a	1.53 a	0.84 a	28.8a	8.0 a	30.1 a	0.23 a	0.32 a	0.75 a	0.30 a
W_2 N_0AH	6.8a	5.3b d	33.0 a	0.25 a	0.19 a	1.45 a	0.67 a	26a	6.1 a	33.7 a	0.38 a	0.32 a	0.84 a	0.20 a
W_2 N_2 PS	20.9a	5.3 a	34.9 a	0.20 a	0.17 a	1.33 a	0.58 a	53.6a	5.7 a	38.7 a	0.35 a	0.25 a	0.71 a	0.18 a
W_2 N_2AR	7.8a	6.9 a	32.8 a	0.23 a	0.16 a	1.69 a	0.67 a	39.1a	7.8 a	35.9 a	0.30 a	0.34 a	0.89 a	0.17 a
W_2 N_2AH	8.8a	5.4 bc	31.9 a	0.20 a	0.16 a	1.29	0.56a	36.4a	9.4 a	34.4 a	0.43 a	0.33 a	0.91 a	0.15 a
SE $\pm$	2.2	0.2	2.4	0.07	0.06	0.12	0.06	7.8	1.6	2.8	0.09	0.09 a	0.23 a	0.05

Means within column followed by the same letters are not significantly different using Duncan Multiple Range Test at 5%, Watering treatments: W1 = watering every 10 days; W2 = watering every 20 days, Nitrogen fertilization: N0 = No nitrogen; N2 = 88 kg N/ ha.
Planting methods: PS = Pure stand of maize; AR = Alternating rows of maize and lablab bean; AH alternating holes of maize and lablab

REFERENCES:

1. Ahmed, A. H. (2006). *Agro-qualitative Studies on Spring Planted Forage sorghum intercropped with forage Legumes in Different Geometrical Arrangement.* Ph.D. Thesis, Department of Agro. Univ. Agric. Faisalabad, Pakistan.

2. A.O.A.C. (1981). *Official methods of analysis. Association of official analytical chemists*, Washington, D. C.

3. Ayoub, M., Tanveer, A., Nadeem, M. A., AND and Shah, S. M. A. (2004). Studies on the fodder yield and quality of sorghum grown alone and in mixtures with rice bean. *Pak. J. Life Soc*. Sci. 2:46-48.

4. Ayoub, M., Nadeem, M.A., Tanveer, A., Tahir, M. and Khan, R. M. A. (2007). Interactive effects of different nitrogen levels and seed rates on fodder yield and quality of pearl millet *Pak. J. Agric.Sc*i. 44: 592-596.

5. Ayoub, M. and Shoaib, M. (2009). Studies on fodder yield and quality of sorghum grown alone and in mixtures with guara under different planting techniques. *Pak.J. Agric.Sci*. 46:25-29.

6. El Agib, M. A. (1997). *Effect of Organic and Inorganic Fertilizers and Soil Types on Different Chemical Elements and Calcium-Magnesium Ratio (Ca:Mg).* M.Sc. thesis, Faculty of Agriculture, University of Khartoum, Khartoum, Sudan.

7. Elshiekh, E.A.E.; Elnesairy, N.N.B. and Mahdi, A.A. (2006). Effect of Sinorhizobium Inoculation and Chicken Manure on Nodulation and Forage Yield of Alfalfa (*Medicago sativa* L.) in a Semi-arid Environment. *University of Khartoum Journal of Agricultural Science.* 14 : 182-197.

8. Gasim, S. A. (2001). *Effect of Nitrogen, Phosphorus, and Seed Rate on Growth, Yield and Quality of Fodder Maize (Zea mays L.)* M.Sc. Thesis, Faculty of Agriculture, University of Khartoum, Khartoum, Sudan.

9. Giller, K. E. and Wilson, K. J. (1991). *Nitrogen fixation in Tropical Cropping systems.* C.A.B international, Walling fored, PP 173-174.

10. Gomez, A. and Gomez, A. A. (1984). *Statistical Procedures for Agricultural Research (2nd Ed.)* John Willy and sons. Newyourk. PP 97- 107.

11. Hussein, H. M. (1999). Effect of *Nitrogen Fertilization on Fodder Yield and Quality of Pioneer 988(Sorghum bicolor L. X Sorghum sudanese (Pipper) and Lablab bean (Lablab purpeurus L.) in mixture and pure stand*. M.Sc. Thesis, Faculty of Agriculture, University of Khartoum, Khartoum, Sudan.

12. Igbal, A., Ayoub. M., Zaman, H. and Ahmed, R. (2006). Impact of nutrient management and legumes association on agro qualitative traits of maize forage *Pak. J.Bot*. 38, 1079-1084.

13. Kirda, C. (2000). Deficit Irrigation Scheduling Based on Plant Growth Stages Showing Water Stress tolerance. In: *Deficit Irrigation Practices. FAO Water Report* NO. 22, FAO, Rome.

14. Koul, B. G (1997). *Effects of Sowing Methods, Nitrogen Levels and Seed Rate on Yield and Quality of Fodder Maize* (*Zea mays* L.) M.Sc. thesis, Faculty of Agriculture, University of Khartoum, Khartoum, Sudan.

15. Maluleke, M.H.; Addo-Bediako, A. and Ayisi, Kk. (2005). Influence of Maize/ Lablab Intercropping on Lepidopterous Stem borer Infestation in Maize. *Journal Economic Entomology* 98: 384 – 388.

16. 16. Mapairwe, D. R., Sabiiti, E. N., Ummuna, N. N., Tegegne, A. and Osuji, P. (2002). Effect of Intercropping Cereal Crops with Forage Legumes and Source of Nutrients on Cereal Grain Yield and Fodder Dry Matter Yields. *African Crop Science Journal* 10:81-97.

17. Nadeem, M. Y., Khan, K. A. R. and Jamil, M. (1997). Interactive effect of salinity and nitrogen on growth and chemical composition of spring maize, *Journal of Agricultural Research.* 35: 285-295.

18. Nadeem, M. A., Igbal, Z., Ayoub, M., Mubeen, K. and Ibrahim,M. (2009). Effect of nitrogen application on forage yield and quality of forage maize sown alone and in mixture with legumes . *Pak. J. Life Soc. Sci.*7,161-167.

19. Njunie, M. N., Wagger, M. G. and Lunna – Orea, P. (2004). Residue Decomposition and Nutrient Release Dynamics from two Tropical Forage Legumes in a Kenyan Environment. *Agronomy Journal* 96:1073 – 1081.

20. Omer, E. A. (1998). *Effects of Farmyard Manure and Urea Fertilization on the Growth and Forage Yield of Two Maize (Zea mays L.) Cultivars.* M.Sc. Thesis, Faculty of Agriculture, University of Khartoum, Khartoum, Sudan.

21. Osman, A. K. and El Amin, E. M. (1996). Intercropping as an instrument for optimal land resources utilization and conservation: Case of western Sudan dry land farming. University of Khartoum Journal *of Agricultural Sciences* 4:78- 90.

22. Papastylianou, I. (1999). Response of pure stand and mixtures of cereals and legumes to nitrogen fertilizer and residual effect on subsequent barley. *Journ*al *of Agricultural Sciences. Camb.* 115: 15-22.

23. Saeed, M. S. (1988). *Studies of the Effect of Nitrogen fertilization and Irrigation Practices on the Yield of Fodder Sorghum.* M. Sc. Thesis, Faculty of Agriculture, University of Khartoum, Khartoum, Sudan.

24. Saren, B. K. and Jana, P. K. (1999). Effect of irrigation and intercropping system on yield, water use, concentration and uptake of nitrogen, phosphorous and potassium in maize (*Zea mays* L.) and groundnuts *(Arachis hypogea*) grown sole and intercrop. *Indian Journal of Agricultural Sciences* 69:317-32