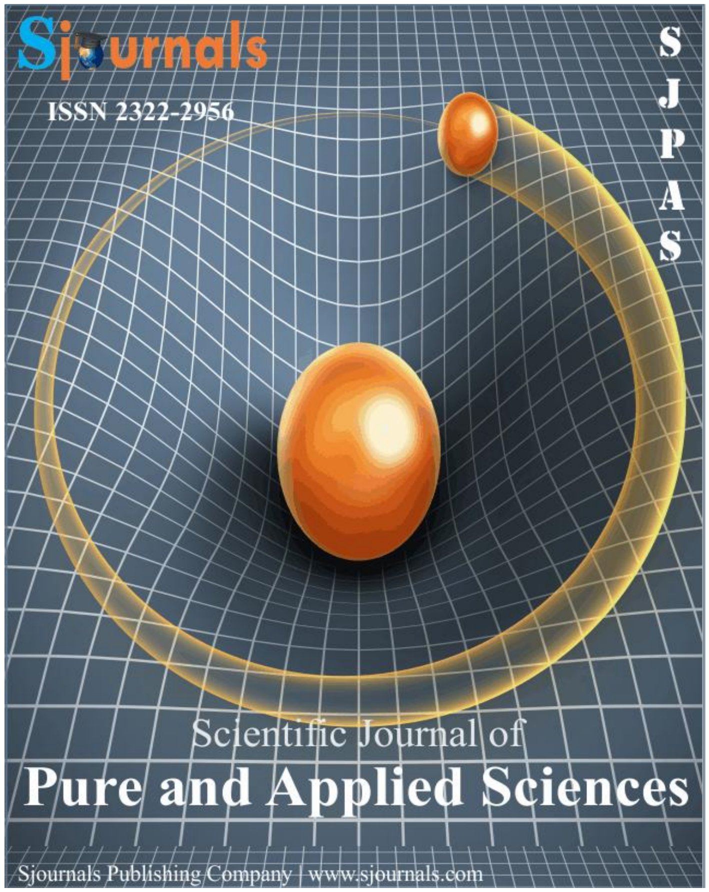
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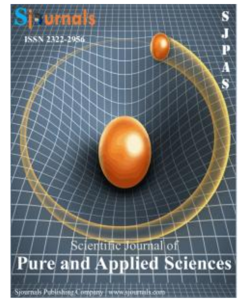
Scientific Journal of Pure and Applied Sciences (2016) 5(9) 496-508
ISSN 2322-2956
doi: 10.14196/sjpas.v5i9.2245



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Original article

Effect of different spacing of Napier grass (*Pennisetum purpureum*) intercropped with or without Lablab (*Lablab purpureus*) on biomass yield and nutritional value of Napier grass

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A R T I C L E I N F O

Article history,
Received 13 August 2016
Accepted 12 September 2016
Available online 19 September 2016
iThenticate screening 16 August 2016
English editing 10 September 2016
Quality control 16 September 2016

Keywords,
Chemical composition
Digestibility
LabLab
Napier grass
Yield

A B S T R A C T

This study was conducted with an objective of determining effect of three spacing of Napier grass intercropped with or without Lablab (Lablab purpureus) on the biomass yield and nutritive value of Napier grass forage in a 2 x 3 factorial arrangement in RCBD with 4 blocks. Spacing was 1m x 0.5m, 0.75m x 0.5m, and 0.5m x 0.5m. Intercropping decreased the electro conductivity but increased the available phosphorous content of the soil and did not affect the pH, organic carbon and total nitrogen of the soil. Spacing, intercropping and their interaction had no significant effect (P>0.05) on dry matter (DM) yield (DMY) and crude protein (CP) yield (CPY) of the Napier grass. Intercropping and interaction of intercropping with spacing resulted to higher total DMY and CPY (P<0.05). The chemical composition of Napier grass was unaffected by spacing and interaction of intercropping with spacing. Intercropping of Napier grass with lablab however, increased the DM contents (P<0.05) of the Napier grass and decreased the ash contents. In conclusion, intercropping with lablab had a positive influence on the TDMY, TCPY, DM, hence increase the total forage yield and nutritive value of Napier grass. Conversely, spacing failed to have significant impact on these parameters. As such 1 m x 0.5m spacing and intercropping with lablab can be of a better choice based on the results of this study.

1. Introduction

List of abbreviations and acronyms

M a s l	Meters Above Sea Level
ADF	Acid Detergent Fiber
ADL	Acid Detergent Lignin
ATARC	Adami Tulu Agricultural Research Center
AOAC	Association of Official Analytical Chemists
CP	Crude Protein
CPY	Crude Protein Yield
DM	Dry Matter
DWss	Dry Weight sub sample
FWss	Fresh Weight sub sample
GDP	Growth Domestic Product
GLM	General Linear Model
HA	Harvesting Area
ILRI	International Livestock Research Institute
LSD	Least Significant Difference
ME	Metabolizable Energy
MOARD	Ministry of Agriculture and Rural Development
NGOs	Non Governmental Organizations
NDF	Neutral Detergent Fiber
RCBD	Randomized Complete Block Design
SAS	Statistical Analysis Systems
TotFW	Total Fresh Weight

Livestock contribute 15 to 17 percent of GDP and 35 to 49 percent of agricultural GDP, and 37 to 87 percent of the household income (Sintayehu et al., 2010). Livestock have multiple uses such as income generation, cash storage, draught and pack services, milk and meat for household consumption, and manure for fuel and fertilizer. Despite the large number of livestock resources the country own, its productivity is extremely low. The major constraint to such low productivity is shortage of livestock feeds in terms of quantity and quality, especially during the dry season (Ahmed et al., 2010). Feed supply from natural pasture fluctuates following seasonal dynamics of rainfall (Solomon et al., 2008). Despite, these problems, ruminants continue to depend primarily on forages from natural pastures and crop residues. The feed problem in the country arises in two related forms: shortage; and high feed prices. Data adapted from MoARD (2008) Livestock Master Plan, indicate that nationwide, 64 million tons of feed are required annually to sustain the livestock population in Ethiopia. However, the same sources estimate that only about 37 million tons are currently available, so that the system satisfies just 58 percent of needs. Grazing as a source of livestock feed has begun to decline in recent years, as a result of increased areas of cultivation, and changing patterns of land use. An adequate supply of livestock feed is crucial to the livelihoods of millions of people across the developing world, and not just for smallholders, but also for pastoralists and the large number of landless who depend mainly on common land for grazing (Sanford and Ashly, 2008).

Napier grass (*Pennisetum purpureum)* has become by far the most important species due to its wide ecological range of adaptation (from sea level to over 2,000 meters), high yield and ease of propagation and management (Orodho, 2006; ILRI, 2010a; ILRI, 2013). It is originated from central Africa and is commonly used by many farmers today because of its growth rate, drought tolerance, and most importantly, its yield. With an average crude protein content of 9% (ILRI, 2010b) and with DM of about 15 percent (ILRI, 2001), it is favorite for many farming systems in Africa (ILRI, 2010a). It is for example continues to be the major feed for cut-and-carry dairy systems in East Africa (Basweti et al., 2009). Demand for Napier grass has been increasing rapidly in Ethiopia with over 200,000 cuttings of best Napier accessions distributed from ILRI in 2003 and 1.4 million cuttings in 2004 (Hanson and Peters, 2003) to NGOs, Ministry of Agriculture and Development workers for development purposes. The principal use of Napier grass is as forage for dairy animals and studies to assess the yield and nutritional values from a range of maturity types, management regimes and environments have been carried out (Tessema et al., 2002a, 2002b, 2003).

The yields of tropical grasses depend on many factors; most importantly, soil fertility and environmental conditions (ILRI, 2010a). Like other tropical grasses, Napier grass is considered high in structural cell wall carbohydrates that increase rapidly with advance in maturity, whereas the reverse is true with its crude protein (CP) content (Van Soest, 1994). This implies the need for production strategies that can help improve the CP concentration of Napier grass. The conventional methods of improving Napier grass quality through fertilization or use of concentrates to supplement Napier grass diets is limited because most farmers cannot afford these inputs. This has led to poor animal performance mostly attributed to the low protein content in Napier grass. Napier grasses as sole feed were deficient in CP and should be supplemented in order to meet maintenance and lactation requirements of dairy cows (Kabirizi et al., 2007).

One such approach is to establish it in association with legume species to make use of the yield advantage of Napier grass and the high CP content of legume species. Legume forages are cultivated to maintain soil fertility and supplement ruminant diets because the majority of the smallholder farmers cannot afford commercial concentrates. To this effect, the use of tropical legumes like Lablab (*Lablab purpureus*) which are annual or short term perennial species in association with productive, but high cell wall fiber containing grass species such as Napier grass could be an advantage in improving the supply of nutrients to livestock (Taye et al., 2007). The optimization of productivity and nutritive value of grass/legume associations can be achieved by forage management tools such as date of harvesting (Taye et al., 2007), height of harvesting at cutting (Tessema et al., 2002a) and plant spacing (Sumran et al., 2009). Ninety days of harvesting (Taye et al., 2007) and 1m length at harvest (Tessema et al., 2002a) is recommended to get best biomass and Nutritive value of Napier grass. Lablab can be well associated with Napier grass but the association effect of the two plant species on the nutritive values of Napier grass is poorly documented.

Hence, there is no enough data available in Ethiopia about effect of intercropping *lablab purpureus* on the biomass yield and nutritive value of Napier grass. It was necessary to conduct the present experiment in order to generate data on yield and chemical composition of *Pennisetum purpureum* planted at different spacing as intercropping with *Lablab purpureus* or as a sole stand. Therefore, this study was conducted with the objective of determinining effects of different spacing of Napier grass intercropped with or without Lablab (*Lablab purpureus*) on the biomass yield and nutritive value of Napier grass.

2. Materials and methods

2.1. Description of the experimental area

The experiment was conducted at Adami Tulu Agricultural Research Center (ATARC), which is located in the mid rift valley, 167 km south of Addis Ababa on Awassa road. It lies at latitude of 7^{O} 9' N and 38^{O} 7' E longitude. Its altitude is about 1650 meters above sea level (m.a.s.l). It has an average annual rainfall of 760 mm. It has a bimodal rainfall from March to April (short rain) and July to September (long rains) with a dry period in May to June, which separates short rains from long rains (Teshome et al., 2012). The average annual minimum and maximum temperature of the area at the study year were 11.8 ^{O}C and 28.3 ^{O}C (metrology station of Adami Tulu Agricultural Research Center). The soil is loam with sand, silt and clay in proportion of 44%, 34% and 22%, respectively, and the pH of the soil is 7.88 (Teshome et al., 2012). The chemical properties of the soil at 0.15 and 0.5 m depth were pH 8.1 and 8.4, organic matter 2% and 1%, and nitrogen 0.13% and 0.07%, respectively. Available phosphorus was 5 ppm at both depths (Basweti et al., 2009).

2.2. Experimental layout, design and treatments

The experimental design was factorial arrangement in RCBD consisting of three inter and intra row spacing of Napier grass, 1 m x 0.5 m (Tessema et al., 2002a), 0.75 m x 0.5 m (ILRI, 2010b) and 0.5 m x 0.5 m (Taye et al., 2007) without and with *Lablab purpureus* intercropping between the rows of Napier grass. There was four blocks, each containing six plots resulting to twenty-four plots in total with each plot measuring 3 m x 4 m. Distance between plot and replications (blocks) were 1 m and 1.5 m, respectively. Plots in each block were randomly assigned to the six treatments.

The land was ploughed and harrowed with a tractor and then by hoe. The planting material was Napier grass (ILRI 14984) and Lablab (*Lablab purpureus*), which are adapted in Adami Tulu A gricultural Research Center. The material was planted on July 18, 2013. Napier grass was root splited with each material for planting need to contain three shoots and the material was planted 15cm deep inclined at 45^{O} angle (ILRI, 2010b) and the seed of *Lablab purpureus* was drilled in between the rows of Napier grass in a seeding rate of 15 kg/ha in 7cm depth (Antony, 2006; ILRI, 2010b). Weeding was done early and then two times to eliminate re-growth of undesirable plants and removal of the dry root bound Napier in order to promote fodder re-growth by increasing soil aeration. The plots were kept weed free throughout growth period (Orodho, 2006). The Forage was harvested on October 18, 2013.

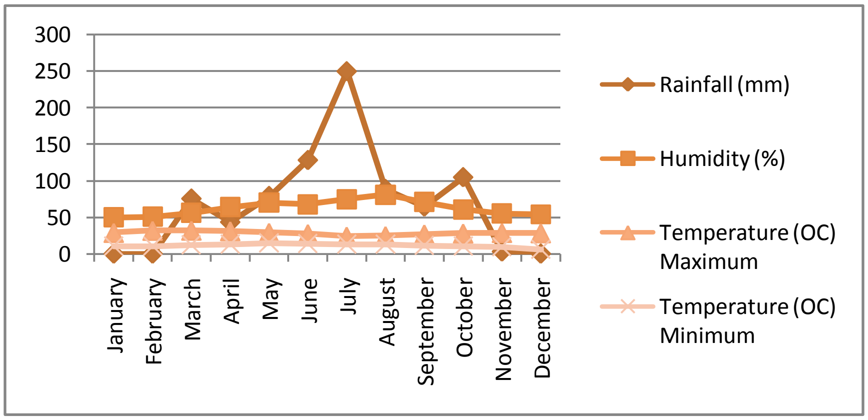

Fig. 1. Rainfall, humidity and maximum and minimum temperature of the study area during the experiment year (2013).

Table 1
Row and plant spacing of Napier grass when intercropped with or without lablab.

Row spacing	Plant spacing	No of plants / ha	Intercropping
1m	0.5m	30000	w
0.75m	0.5m	37500	w
0.5m	0.5m	52500	w
1m	0.5m	30000	w/o
0.75m	0.5m	37500	w/o
0.5m	0.5m	52500	w/o

m = meter; w = with *Lablab purpureus* and w/o = without *Lablab purpureous*.

2.3. Soil sampling and analysis

Three composite soil samples (more than one composite will give an estimate of soil variability) representing nine surface soils, in practice, it is common to collect cores following a zigzag path where a conscious effort is made to force the path into corners and along edges as well as the central parts of the site being sampled (Deb et al., 1995) before planting and from each plot representing five surface soil samples (in each corner and center of plots) of the experimental field after forage harvesting was taken diagonally at a depth of 30 cm in order to make the sample representative. The collected soil samples was dried in open air (so as not to lose the organic carbon and total nitrogen content of the soil), ground, sieved and analyzed for its nitrogen, soil pH, organic carbon and available phosphorus. Soil samples were analyzed at Ziway Soil Research Laboratory. EC was determined by using hydrometer. Total nitrogen was determined following Kjeldahl procedure as described by Cottenie (1980); the soil pH was measured with digital pH meter potential metrically in the supernatant suspension of 1: 2.5 soils to distilled water ratio (Van Reeujik, 1992). Organic carbon was determined following wet digestion method as described by Walkley and Black (1934), and the available phosphorus was measured using Olsen II methods (Olsen et al., 1954).

2.4. Herbage yield determination

Total forage yield per plot was harvested when Napier grass reaches 90 days stage of maturity level (Taye et al., 2007) at 1m length (Tessema, 2002b) and 10% of flowering stage for lablab. The harvested green biomass was separated into grass and legume components. The fresh weight was taken in the field using a top- loading field balance. Fresh subsamples was taken from each plot and each plant species separately, weighed and chopped into short lengths (2-5cm) for dry matter determination. The weighed fresh subsample (FWss) was oven dried at 60 ^{O}C for 72 hours and reweighed (DWss) to give an estimate of dry matter production. The dry matter production (tone/ha) was calculated as (10 x TotFW x (DWss / HA x FWss)) (Tarawali et al., 1995). Dry matter yield (DMY) was multiplied with CP content of the feed samples to determine crude protein yield (CPY).

Where: TotFW = total fresh weight from plot in kg
DWss = dry weight of the sample in grams
FWss = fresh weight of the sample in grams.
HA = Harvest area meter square and
10 = is a constant for conversion of yields in kg m^2 to tone/ha

2.5. Chemical composition analysis

From each plot, samples of Napier grass and one composite sample of Lablab was taken and dried in a forced draft oven at 60 ^{O}C for 72 hours (to get constant weight) and samples was ground using Wiley mill to pass through a 1mm sieve screens for chemical analysis. Chemical composition was analyzed at Haramaya University. The DM content was determined by oven drying at 105 ^{O}C for 24 hours. The ash component was determined by igniting the dried sample in a muffle furnace at 500 ^{O}C overnight. The residue after burning in the furnace was the ash. The nitrogen was determined using the micro-Kjeldahl technique. The CP was calculated as 6.25×Nitrogen. The method of Van Soest and Robertson (1985) was used to determine neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL). Hemicellulose was calculated by subtracting the ADF from the NDF content while cellulose was determined by subtracting the ADL from the ADF content.

2.6. Statistical analysis

Data on biomass yield, chemical composition and soil parameters (before and after harvesting) were analyzed using ANOVA by the general linear model procedure of SAS (SAS, 2002) version 9.1. Means were separated using Least Significant Difference (LSD) at 5% significant level. The model was:

$$Y_{ijk} = \mu + Si + Ij + SIij + B_K + eijk$$

Where: Yijk = individual observation
μ= overall mean
S_i = i^{th} row spacing effect
Ij = j^{th} intercropping effect
SIij = ij^{th} spacing x intercropping interaction effect
B_k = k^{th} block effect
e_{ijk} = residual error

3. Results

3.1. Characterization of the soil of the study area

3.1.1. Chemical properties of the soil

The value of chemical properties of soil before sowing indicates that 0.19 Electro Conductivity (EC), 7.66 PH, 6.2 Available Phosphorous (AP), 4.09 organic carbon and 0.19 total nitrogen (Table 2). The soil of the study area is loam with sand, silt and clay in proportion of 34.97%, 45.65% and 19.38%, respectively.

3.1.2. Effect of spacing and intercropping on soil fertility

Spacing and interaction of spacing with intercropping did not have a significant impact on EC (P>0.05). However, intercropping of lablab with Napier grass reduced the EC of the soil. The pH of the soil analyzed after harvesting showed no significant difference for spacing, intercropping and their interaction. The AP content of the soil after harvest was only significantly affected by intercropping of Napier grass with lablab, and values was higher (P<0.05) for the intercropped group. Effect of spacing, intercropping and their interaction on soil carbon content was not significant (P>0.05). Generally, total nitrogen content after harvest was unaffected by intercropping (P>0.05), but was significantly affected by spacing (P<0.05). As such values for the 1m x 0.5m were higher than the value for 0.5m x 0.5m.

Table 2
Soil fertility as influenced by different spacing of Napier grass and intercropping with lablab.

Treatments	Soil parameter				
	EC (mmhos/cm)	**pH**	**AP (ppm)**	**OC (%)**	**TN (%)**
Before sowing	0.19	7.66	6.20	4.06	0.19
After sowing					
Spacing					
1m × 0.5m	0.20	7. 90	3.69	3.44	0.22[a]
0.75m × 0.5m	0.19	7.94	3.95	3.09	0.174[b]
0.5m × 0.5m	0.20	8.02	3.62	3.34	0.209[ab]
SEM	0.017	0.049	0.345	0.117	0.011
Intercropping					
With Lablab	0.17[b]	7.99	4.28[a]	3.40	0.21
Without Lablab	0.23[a]	7.92	3.40[b]	3.18	0.20
SEM	0.011	0.042	0.251	0.099	0.011
Interaction effect					
1m × 0.5m * w	0.15	7.92	4.12	3.47	0.21
0.75m × 0.5m * w	0.16	7.98	4.54	3.33	0.19
0.5m × 0.5m * w	0.19	8.07	4.19	3.39	0.21
1m × 0.5m * w/o	0.25	7.88	3.80	3.41	0.24
75m × 0.5m * w/o	0.23	7.907	3.36	2.85	0.16
0.5m × 0.5m * w/o	0.21	7.97	3.05	3.29	0.20
SEM	0.018	0.069	0.158	0.412	0.016

[a, b] Means in a column within the same category having different superscripts differ at (P<0.05); AP = Available Phosphorous; EC = Electro Conductivity; m = meter; mmhos= mili mhos; OC = Organic Carbon; pH = power of Hydrogen; ppm = parts per million; SEM = Standard Error of Means; Level; TN = Total Nitrogen; w = with lablab and w/o = without lablab.

3.2. Forage yield

Forage yield of Napier grass as influenced by spacing and intercropping with lablab is given in Table 3. Spacing, intercropping and the interaction of spacing and intercropping did not have a significant effect (P> 0.05) on dry matter and crude protein yield of Napier grass.

Spacing has no significant effect on total forage production (P>0.05; Table 3). Conversely, intercropping and interaction of intercropping with spacing had a significant effect on the total dry matter yield and CPY (P<0.05). As shown in Table 4, spacing has no significant effect (P>0.05) on dry matter and CP yields of lablab. The CP yield of the different spacing of lablab was higher than the CPY of sole lablab (0.81) tone/ha found by Taye et al. (2007).

3.3. Chemical composition

Spacing and the interaction of spacing and intercropping has no significant effect (P>0.05) on the dry matter and ash percents of the Napier grass (Table 5). The effect of spacing, intercropping and interaction of intercropping and spacing on the CP contents of Napier grass was not significant (P>0.05). Spacing, intercropping and interaction of spacing with intercropping has no significant effect on the NDF, ADF ADL, and cellulose and hemicelluloses content of the Napier grass (P>0.05). Lablab composite has higher DM and CP and low ash, NDF and ADF content than all the intercropped and sole Napier grass.

Table 3
Forage yield of Napier grass and total forge yield as influenced by different spacing of Napier grass and intercropping with lablab.

Treatments	Forage yield of Napier grass and total forage yield (ton/ha)			
	DMY	CPY	TDMY	TCPY
Spacing				
1m × 0.5m	6.37	1.04	8.87	1.53
0.75m × 0.5m	7.05	1.00	9.88	1.59
0.5m × 0.5m	9.24	1.19	11.84	1.75
SEM	0.750	0.140	1.296	0.270
Intercropping				
With Lablab	7.58	1.13	12.87[a]	2.21[a]
Without Lablab	7.52	1.03	7.52[b]	1.03[b]
SEM	0.670	0.220	0.718	0.120
Interaction effect				
1m × 0.5m * w	6.43	1.08	11.62[abc]	2.07[a]
0.75m × 0.5m * w	6.62	0.95	12.10[ab]	2.11[a]
0.5m × 0.5m * w	9.68	1.37	14.89[a]	2.47[a]
1m × 0.5m * w/o	6.12	0.99	6.12[c]	0.99[b]
0.75m × 0.5m * w/o	7.66	1.07	7.66[c]	1.07[b]
0.5m × 0.5m * w/o	8.72	1.03	8.79[bc]	1.03[b]
SEM	1.030	0.290	1.008	0.200

[a, b] Means in a column within the same category having different superscripts differ (P<0.05); CPY= Crude Protein Yield; DMY= Dry Matter Yield; ha= hectare; m= meter; SEM= Standard Error of Means; TCPY= Total Crude Protein Yield; TDMY= Total Dry Matter Yield; w= with lablab and w/o= without lablab.

Table 4
Forage yield of lablab as influenced by different spacing of Napier grass and intercropping with lablab.

Spacing	Forage yield of Lablab (tone/ha)	
	DMY	CPY
1m × 0.5m L	5.00	1.21
0.75m × 0.5m L	5.67	1.42
0.5m × 0.5m L	5.12	1.35
SEM	0.520	0.075

CPY= Crude Protein Yield; DMY= Dry Matter Yield; ha= hectare; L= Lablab; m= meter; SEM= Standard Error of Means.

Appendix Table 1
Pre plant soil analysis.

Soil parameter	Method	Unit	Value
pH	Potentio metric	1:2.5	7.660
EC	Hydrometer	mmhos/cm	0.190
AP	Olsen II	ppm	6.200
OC	Walkley and Black	%	4.056
TN	Kjeldahl	%	0.194

AP= Available phosphorous; EC= Exchange of Carbon; mmhos= mili mhos; OC= Organic Carbon; pH= Power of Hydrogen; ppm= parts per million; TN= Total Nitrogen.

Table 5
Chemical composition as influenced by different spacing of Napier grass and intercropping with lablab.

Treatments	Chemical composition (%)							
	DM	Ash	CP	NDF	ADF	ADL	Cell	Hemicell
Spacing								
1m × 0.5m	14.00	17.14	14.58	65.22	38.90	7.2	31.7	26.30
0.75m × 0.5m	14.95	16.73	14.11	66.07	40.16	7.23	32.93	25.91
0.5m × 0.5m	15.06	16.70	13.79	66.17	41.75	7.57	34.18	24.42
SEM	0.45	0.34	2.54	1.29	0.91	0.60	1.05	1.54
Intercropping								
With Lablab	15.42[a]	16.25[b]	14.60	64.86	39.61	6.88	32.74	25.41
Without Lablab	13.94[b]	17.47[a]	13.72	66.11	40.92	7.83	33.09	25.1
SEM	0.32	0.22	0.77	1.04	0.79	0.46	0.90	1.30
Interaction effect								
1m × 0.5m * w	14.87	16.40	15.14	64.00	38.78	6.61	31.68	27.47
0.75m × 0.5m * w	15.59	16.39	14.35	64.85	39.42	6.94	32.50	25.50
0.5m × 0.5m * w	15.78	15.94	14.30	65.31	40.64	7.08	34.03	24.42
1m × 0.5m * w/o	13.15	17.88	14.01	64.43	39.01	7.63	31.70	26.53
0.75m × 0.5m * w/o	14.32	17.53	13.87	67.02	40.9	7.32	33.27	24.20
0.5m × 0.5m * w/o	14.34	17.00	13.27	67.27	42.83	8.54	34.32	23.11
LC	20.43	11.15	20.51	54.32	37.53	6.8	3.73	16.79
SEM	0.51	0.39	0.90	1.86	1.29	0.70	0.69	1.00

[a, b]Means in a column within the same category having different superscripts differ (P<0.05); ADF= Acid Detergent Fiber; ADL= Acid Detergent Lignin; Cell= Cellulose; CP= Crude Protein; DM= Dry Matter; Hemi cell= Hemi cellulose; LC= Lablab Composite; m= meter; NDF= Neutral Detergent Fiber; SEM= Standard Error of Means; w= with lablab and w/o= without lablab.

4. Discussion

Electrical conductivity (EC) of the soil indicates the amount of salt in the soil. Pre planting soil analysis showed that the EC content was 0.19 which is salt free (Table 2) which agrees with that noted by Tekalign et al. (1991). The mean pH of the soil of the composite sample before planting was 7.66, which is almost similar to the pH value of 7.88 reported for Adami Tulu Agricultural Research Center (Teshome et al., 2012). The pH values noted in this study is in the range 4.5- 8.2 soil pH required by Napier grass (Center for New Crops and Plant Productivity, 2002). The available phosphorous was 6.2 which are considered as medium (Driven et al., 1973), while the organic carbon and total nitrogen content of the area before planting was 4.06 and 0.19, respectively indicating the soil to be rich in organic carbon and total nitrogen (Driven et al., 1973; Tekalign et al., 1991). However, the current result fail to agree with that reported by Teshome et al. (2012), which classifies the soil of Adami Tulu Research Center as being low in total nitrogen and organic carbon contents.

Analysis of variance for soil parameters after harvesting the forage indicates that the EC of the soil slightly increased as compared to the value obtained for the soil samples before planting.The values for EC in the current study are indicative of the soil to be salt free (Takalign et al., 1991). This is in agreement with the report of Kabirizi et al. (2007) that noted lablab intercropping increases phosphorus and calcium content of the soil as compared to mono crop. The pH of the soil after harvest was a bit higher as compared to the values before planting. This is because of environmental factor like rainfall, flood and effect of the planting material itself. The available phosphorous (AP) for soil samples after harvest was somewhat lower than the ones before planting. Such values for AP are categorized as low (Driven et al., 1973). This shows that there was more utilization of phosphorous by the grass and/or legume planted. However, the increase in AP with intercropping was lower than the amount of P extracted by the plants as the values for AP for before planting soil samples were higher than the values after harvest and with intercropping, since intercropping facilitate the utilization of phosphorous (Teshome *et al*., 2012). The organic carbon content of the soil was lower for soil samples taken after harvest as compared to the pre-planting soil samples. But according to the Netherlands Commissioned Ministry of Agriculture and Fisheries (1985) all soil of the study area can be classified in the high organic carbon range of availability. All soil samples are considered medium in their organic carbon content (Driven et al., 1973). Total nitrogen content of the soil increased slightly after harvest compared to pre-planting values. In terms of total nitrogen, the soil samples in this study can be classified as rich except for the soil samples in the 0.5m x 0.5m spacing which is categorized under the medium category (Driven et al., 1973). However, according to the Netherlands commissioned by the Ministry of Agriculture and Fisheries (1985) all soil samples fall under medium category.

Absence of significant difference as a result of spacing on dry matter yield of Napier grass is in conformity with the finding of Chinosaeng et al. (2000) which noted lack of effect of plant spacing on the dry matter yield. Likewise, Njoka *et al*. (2006) did not observe significant effect (P>0.05) in dry matter and crude protein yields of Napier grass when it is intercropped with Seca stylo and siratro, rather herbage yield of Napier grass was depressed, but in subsequent seasons during the production phase Napier grass benefited from legumes by producing high herbage. Napier grass/legume grown in Central Kenya also did not give a higher grass DM yield (Mwangi, 1999) as cited by Mwangi et al. (2010). Nevertheless, the lack of difference with spacing in the current study contradicts with many other previous findings. For instance, Tesssema (2008) noted difference in DM yield among the different plant density in Napier grass, and dry matter yield increased as plant density increased. Sumran et al. (2009) obtained the maximum green matter yield of forage at 0.5m x 0.5m spacing. In other studies Napier grass biomasses increased when inter and intra row spacing is decreased (Sumran et al., 2009). Bahatti et al. (1985) also noted that green and dried weight yield increase at low inter and intra row spacing. Sumran *et al*. (2009) obtained the highest total dry matter yield of 70.84 ton/ha from 50 x 40 cm plant spacing than that from other higher plant spacing. The higher yield at closer spacing are attributed to the higher tiller height and number per unit area, as well as to increased leaf tiller, and number of leaves per tiller. According to Taye et al. (2007), intercropping of lablab resulted in significant effect on CPY of the Napier grass. This finding disagrees with the present finding. This may be due to the harvesting of the two crops together by the author, which is different from the present experiment where the crops were harvested separately. Dry matter yield and CPY increased when Napier grass was intercropped with lablab as compared to the sole Napier grass. This is due to the additive effect of lablab intercropping on total forage production. The result is in agreement with the finding of Taye et al. (2007) which showed that association of Napier grass with lablab produce significantly higher dry matter yield and CPY when compared to sole Napier grass. The higher total DM production of the mixture of Napier and legume than the sole Napier grass was also noted by Njoka et al. (2006) which is in line with the results of the current finding. The higher DM yield was therefore the additive effect of the legume DM rather than its effect on grass performance. This would imply that the Napier grass/legume mixture was possibly utilizing resources (soil, space etc.) more efficiently, resulting in a higher forage DM yield.

No significant effect on chemical composition of Napier grass due to Spacing is in agreement with previous reports (Chinosaeng et al., 2000; Tessema, 2008) which noted no significant effect on chemical composition of Napier grass due to plant density. However, intercropping has significant effect on dry matter and ash contents (P<0.05) in which lablab intercropping increased the DM but decreased the ash content. The result of this finding is in conformity with the finding of Njoka et al. (2006) which noted that intercropping has significant effect on DM and ash contents of Napier grass. Njoka et al. (2006) and Ojo et al. (2013) similarly noted insignificant increases in CP content of Napier grass when with other legumes or lablab. Conversely, Taye et al. (2007) noted that intercropping Napier grass with lablab resulted to significantly higher CP content of the harvested forage at ninety days, but in that study both lablab and Napier grass was harvested together as a mixture. The CP content of Napier grass in the current study was greater than the 10.63% reported before (Tessema, 2002a) at the spacing of 1m x 0.5m and 90 days of harvesting. Differences could attribute to several environmental factors such as variation in climatic condition and soil fertility. The result is in line with the suggestion of Van Soest (1982), which noted the CP content of the young herbage to be as high as 14 to 16%. This level of CP is above the recommended minimum level of CP in the diet of ruminants for optimum rumen function (Van Soest, 1994).

Regarding the spacing effect it agrees with the finding of Tessema (2008) which noted that plant density has no significant effect on the NDF, ADF ADL, and cellulose and hemicelluloses content of the Napier grass. Njoka et al. (2006) also reported that the level of fibers remained unaffected, but only the ADF content was significantly more in sole Napier grass than Napier grass grown with legumes. However, the current result disagrees with the finding of Taye et al. (2007) which noted that intercropping Napier grass with lablab has significant effect on NDF, ADF, ADL and hemicelluloses contents of the forage. Taye et al. (2007) also noted that association of Napier grass with lablab could be of an advantage in reducing ADF content of forage only when it is accompanied with early utilization of the biomass and intercropping Napier grass with lablab has no advantage in reducing the ADL content. This difference is may be due to harvesting both Napier grass and lablab together as a mixture and analyzing together unlike in the current experiment where the two forage species were harvested and analyzed separately.

Decrease in NDF content has been associated with increasing digestibility and hence feed intake (Vansoest, 1982; MacDonald et al., 2002). Roughage diets with NDF content of 45-65 and below 45% were generally considered as medium and high quality feeds, respectively (Singh and Oosting, 1992). The NDF percentage of Napier grass recorded in this experiment ranged below the 66.2% average value reported for tropical grasses and lies in about a medium quality feed category (Van Soest, 1994). Roughages with less than 40% ADF is categorized as high quality and those with greater than 40% as poor quality (Kellems and Church, 1998), and the ADF value of Napier grass in the present study when intercropped with lablab is less than 40% indicating enhancement of the feeding value of the grass. Napier grass in all the treatments consisted ADL value below 10% which limits DM intake (Reed et al., 1986). Cellulose and hemicelluloses contents of the treatments were nearly the same as those of most tropical grasses, 31.9% and 35.4% respectively as noted by Moore and Hatfield (1994).

The NDF content of lablab is in a medium range of quality (Singh and Oosting, 1992) as roughage diets with NDF content of 45-65 are considered as medium quality feeds. The ADF content of lablab is in the medium range of quality (Kazami et al., 2012) since legumes with less than 31% ADF value are rated as having superior quality whereas those with values greater than 55% are considered as inferior quality. The cellulose and hemicelluloses content of lablab composite was less than the contents of intercropped and sole Napier grass.

5. Conclusion

All of the soil parameters were not affected (P>0.05) by plant spacing and interaction of intercropping with spacing except TN which is significant for spacing. Intercropping decreased the EC but increases the AP content of the soil. The AP and OC content of the soil after harvest were lower than the original soil sample taken before planting. Intercropping and interaction of intercropping with spacing resulted to higher total DMY and CPY. This is due to the additive effect of lablab intercropping. Intercropping of Napier grass with lablab increased the DM and OM contents (P<0.05) of the Napier grass. It is concluded that intercropping with lablab had a positive influence on fertility of the soil and the nutritive value of Napier grass through enhancing chemical composition and total forage yield. Conversely, spacing failed to have significant impact on forage yield and chemical composition of Napier grass. Therefore, to strengthen this research it is necessary to see the effect of lablab intercropping to the next stage of re-harvesting Napier grass, since this research has been done for the first three month stage of growth. It is good to do the research by adjusting planting date as lablab may reach its stage of harvesting before Napier grass. It is advisable to do animal feeding trial on both forage varieties together to see the associative effect of these forages on animal performance.

Acknowledgments

I would like to thank Oromia Agricultural Research Institute for financing all the required budget for this research work. Thanks to Adami Tulu Agricultural Research Center in giving me land for the experiment. Tessema Badhasa is acknowledged in helping me during partial dry matter analysis. I am very grateful to thank Mr. Abdela Nigussie who assists me in soil analysis at Ziway Soil Research Laboratory. It is also necessary to recall Mr. Dakalo Dashe, Haramaya University laboratory technician of Animal nutrition in the support he rendered during the proximate analysis of the plant samples.

References

Ahmed, H., Abule, E., Mohammed, K., Treydte, A.C., 2010. Livestock feed resources utilization and management as influenced by altitude in the Central Highlands of Ethiopia. Livest. Res. Rural. Dev., http://www.lrrd.org/lrrd/22/12/cont2212.htm.

Anthony, W., 2006. Lablab fact sheet for grain and graze. Tropical forages: An interactive selection tool. CSIRO Sustainable Ecosystems, Department of Primary Industries & Fisheries (Qld), Centro International de

Agricultural Tropical (CIAT) and the International Livestock Research Institute (ILRI). Australia and the University of New England.

AOAC, 1990. Official methods of analysis of association of official analytical chemists (15th edition), Washington, DC.

Basweti, E., Hanson, J., Asebe Abdena, 2009. Evaluation of productivity and nutritional quality of a range of tropical grasses, Zwai, Ethiopia.

Center for new crops and plant products, 2002. Pennisetum purpureum K. Schumach. Perdue University. http://hort:perdue.edu/newcrop/duke_energy/Pennisetum_purpurium.html.45p.

Chinosaeng, W., Nuntachomchoun, P., Suksaran, W., 2000 .Effect of plant spacing on yield and chemical compositions of three varieties of Napier grass in Petchaburn Province. Ann. Rep. Anim. Nutr. Div.

Cottenie, A., 1980. Soil and plant testing as a basis of fertilizer recommendations. FAO soils bulletin 38/2, FAO, Rome.

Deb, P.D., Al, H., Marty, J., 1995. A guide to soil sampling and analysis on the national forests of the inland Northwest United States. United States Department of Agriculture. Forest Service Intermountain Research Station. General Technical Report INT-GTR-326.

Driven, L., Robert, B., Cate, B., Nelson, L.A., 1973. Discontinuous model for rapid correlation, interpretation and utilization of soil analysis and fertilizer response data. International soil fertility evaluation and improvement program technical bulletin No.7.

Hanson, J., Peters, M., 2003. Meeting the need for herbage seeds in developing countries. In: Loch D.S. (Ed). Proceedings of the fifth International Herbage Seed Conference, Herbage seeds in the new millennium – new markets, new products, new opportunities.

ILRI (International Livestock Research Institute), 2001. ILRI 2000-2001: Deciphering the code of life to benefit the poor. ILRI, Nairobi, Kenya, 22-25.

ILRI (International Livestock Research Institute), 2013. Getting superior Napier grass to dairy farmers in East Africa. Napier Grass Stunt and Smut Project. http://bit.ly/Qfts3v. Int. Livest. Res. Instit., www.ilri.org/foragediversity.

ILRI, 2010a. Information leaflet on livestock feeds and feeding technologies for small-scale farmers. Report of World Food Prize Borlaug-Ruan Intern, Trisha Collins.

ILRI, 2010b. Napier or elephant grass ILRI 14984 (Pennisetum purpureum) for livestock feed on small-scale farms. Information leaflet on livestock feeds and feeding technologies for small-scale farmers. Fodder Adoption Project fodderadoption.wordpress.com.

Kabirizi, J., Mpairwe, D., Mutetikka, D., 2007. The effect of integrating forage legumes in smallholder crop/livestock farming systems on food, fodder and animal performance. Conf. Int. Agr. Res. Dev., October; 9-11.

Kariuki, J.N., Boer, H., Tamminga, S., Gitau, G.K., Gachuiri, C.K., Muia, J.M., 1998. Rumen degradation and intestinal digestion of protein in Napier grass and other Kenyan forages. Anim. Feed. Sci. Technol.

Kariuki, J.N., Tamminga, S., Gachuiri, C.K., Gitau, G.K., Muia, J.M.K., 2001. Intake and rumen degradation in cattle fed napier grass (*Pennisetum purpureum*) supplemented with various levels of *Desmodium intortum* and *Ipomoea batatus* vines. S. Afr. J. Anim. Sci., 31(3), 149.

Kazemi, M., Tahmasbi, A.M., Naserian, A.A., Valizadeh, R., Moheghi, M.M., 2012. Potential nutritive value of some forage species used as ruminants feed in Iran. Afr. J. Biotechnol., 11, 12110-12117.

Kellems, R.O., Church, D.C., 1998. Livestock Feeds & Feeding. (4^{th} edition.). Prentice-Hall, Inc., New Jersey, USA, 573.

McDonald, P., Edwards, R.A., Greenhalgh, J.D., Morgan, C.A., 2002. Animal Nutrition 6^{th} edition. Long man group. United Kingdom Ltd, England. 607-693.

MOARD's Livestock Master Plan, 2008. Livestock development master plan study. Phase 1 Report: Data Collection and Analysis. Volume H-Animal Nutrition (November).

Moore, K.J., Hatfield, R.D., 1994. Carbohydrates and forage quality. 229-298. In: Fahey G.C., Collins, M.D., Mertens, R., Moser, E., (eds). Forage quality, evaluation and utilization: Madison, USA: American Society of Agronomy Inc., Crop Science of America Inc. and Soil Science Society of America Inc.

Mwangi, D.M., Wambugu, C., 2010. Forage legume technologies: Participatory experiences with farmers and community-based organizations in Central Kenya. Kenya Agricultural Research Institute (KARI) and International Centre for Research in Agro forestry (ICRAF), Nairobi and Embu, Kenya.

Njoka-Njiru, E.N., Njarui, M.G., Abdulrazak, S.A., Mureithi, J.G., 2006. Effect of intercropping herbaceous legumes with Napier grass on dry matter yield and nutritive value of the feedstuffs in semi arid regions of eastern Kenya. Agr. Trop. Subtrop., 39(4), 2006.

Ojo, V.O.A., Dele, P.A., Amole, T.A., Anele, V.Y., Adeoye, S.A., Hassen, O.A., Olanite, T.A., Edowu, O.J., 2013. Effect of intercropping panicum maximum var. Ntchisi and *Lablab purpureous* on the growth, herbage yield and chemical composition of *Panicum maximum* var. Ntchisi at different harvesting time. Pak. J. Boil. Sci., ISSN 1028.8880/ DOI.10.3923/pjbs.2013. 2-3.

Olsen, S., Cole, C., Watanabe, F., Dean, L., 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. USDA Circular Nr 939, US Gov. Print. Office, Washington, D.C.

Orodho, A.B., 2006. The role and importance of Napier grass in the smallholder dairy industry in enya. http://wwww.fao.org/AG/AGP/AGPC/doc/newpub/napier/napier_kenya.htm.

Reed, J.D., Yilma, K., Fossel, L.K., 1986. Factors affecting the nutritive value of sorghum and millet crop residues. In: J.D. Reed, B.S. Capper and P.J.M. Neate (eds. Plant breeding and the nutritive value of crop residues. Proceedings of ILCA, workshop held at Addis Ababa, Ethiopia, 233-251.

Sanford, J., Ashly, S., 2008. IGAD livestock policy initiative: Livestock livelihoods and institutions in the IGAD region. IGAD LPI Working paper No. 10-08.

Singh, G.P., Oosting, S.J., 1992. A model for describing the energy value of straws. Indian Dairyman XLI: 322-327.

Sintayehu, G., Samuel, A., Derek, B., Ayele, S., 2010. Diagnostic study of live cattle and beef production and marketing. Constraints and opportunities for enhancing the system. The report commissioned by the Bill & Melinda Gates Foundation at the request of the Government of Ethiopia.

Solomon, B., Solomon, M., Alemu, Y., 2008. Influence of rainfall pattern on grass/legume composition and nutritive value of natural pasture in Bale Highlands of Ethiopia. Livest. Res. Rural. Dev., http://www.cipav.org.co/lrrd/lrrd20/3/ cont2003.htm.

Sumran, W., Pornchai, L., Chutipong, A., 2009. Effects of plant spacing on yields and nutritive values of Napier grass (Pennisetum purpureum Schumach.) under intensive management of nitrogen fertilizer and irrigation. Pak. J. Nutr., 01.

Tarawali, S.A., Tarawali, G., Lirbi, A., Hanson, J., 1995. Method for the evaluation of forage legumes, grasses and fodder trees for feed use as livestock feed. Int. Livest. Res. Inst. Nairobi, Kenya.

Taye, B., Solomon, M., Prasad, N.K., 2007. Effects of cutting dates on nutritive value of Napier (Pennisetum purpureum) grass planted sole and in association with Desmodium (Desmodium intortum) or Lablab (Lablab purpureus). Livest. Res. Rural. Dev., 19(1), 2007.

Tekalign, T., Hague, I., Aduayi, E.E., 1991. Soil, plant, water, fertilizer, animal manure and compost analysis manual. Plant Science Division Working Document No. 13. International Livestock Centre for Africa (ILCA), Addiss Ababa, Ethiopia.

Tesema Zewdu, Baars, R., Alemu Yami, 2002a. Effect of plant height at cutting, source and level of fertilizer on yield and nutritional quality of Napier grass (Pennisetum purpureum). Afr. J. Rang. Forag. Sci., 19, 123-128. 8.

Tesema Zewdu, Baars, R., Alemu Yami, 2003. Effect of plant height at cutting and fertilizer on growth of Napier grass (Pennisetum purpureum). Trop., Sci., 43, 57-61.

Tesema Zewdu, Baars, R., Alemu Yami, Negassa, D., 2002b. In sacco dry matter and nitrogen degradation and their relationship with in vitro + matter digestibility of Napier grass (Pennisetum purpureum Schumach.) as influenced by height of plant at cutting. Aust. J. Agr. Res., 53, 7-12.

Teshome, A., Nigussie, D., Yibekal, A., 2012. Sweet potato growth parameters as affected by farm yard manure and phosphorus application at Adami Tulu agricultural research center, central rift valley of Ethiopia. Agr. Sci. J., 2(1), 1-12.

Tessema, Z., 2008. Effect of density on morphological characteristics, yield and chemical composition of Napier grass (*Pennisetum purpureum* (L.) Schumach). E. Afr. J. Sci., 2(1), 55-61.

The Netherlands Commissioned by Ministry of Agriculture and Fisheries, 1985. Agricultural compendium for rural development in the tropics and subtropics. The Netherlands ministry of agriculture and fisheries Amsterdam, Netherlands.

Van Reeujik, L.P., 1992. Procedure for soil analysis 2nd edition, Int. Soil Reference and Information Center (ISRIC), the Netherlands, 371.

Van Soest, P.J., 1982. Nutritional ecology of ruminants O and B books Inc. Corvallis.

Van Soest, P.J., 1994. Nutritional Ecology of the Ruminant, Comstock Publishing Associates. A division of Cornell University Press, Ithaca and London.

Van Soest, P.J., Robertson, J.B., 1985. Analysis of forages and fibrous foods. A laboratory manual for animal science. 613, Cornell University, Ithaca, New York, USA.

Walkley, A., Black, I.A., 1934. An examination of the Degtjareff method for determining organic carbon in soils: Effect of variations in digestion conditions and of inorganic soil constituents. Soil. Sci., 63, 251-263.

How to cite this article: Mohammed, U.S., Animut, G., Urge, M., 2016. Effect of different spacing of Napier grass (*Pennisetum purpureum*) intercropped with or without Lablab (*Lablab purpureus*) on biomass yield and nutritional value of Napier grass. Scientific Journal of Pure and Applied Sciences, 5(9), 496-508.